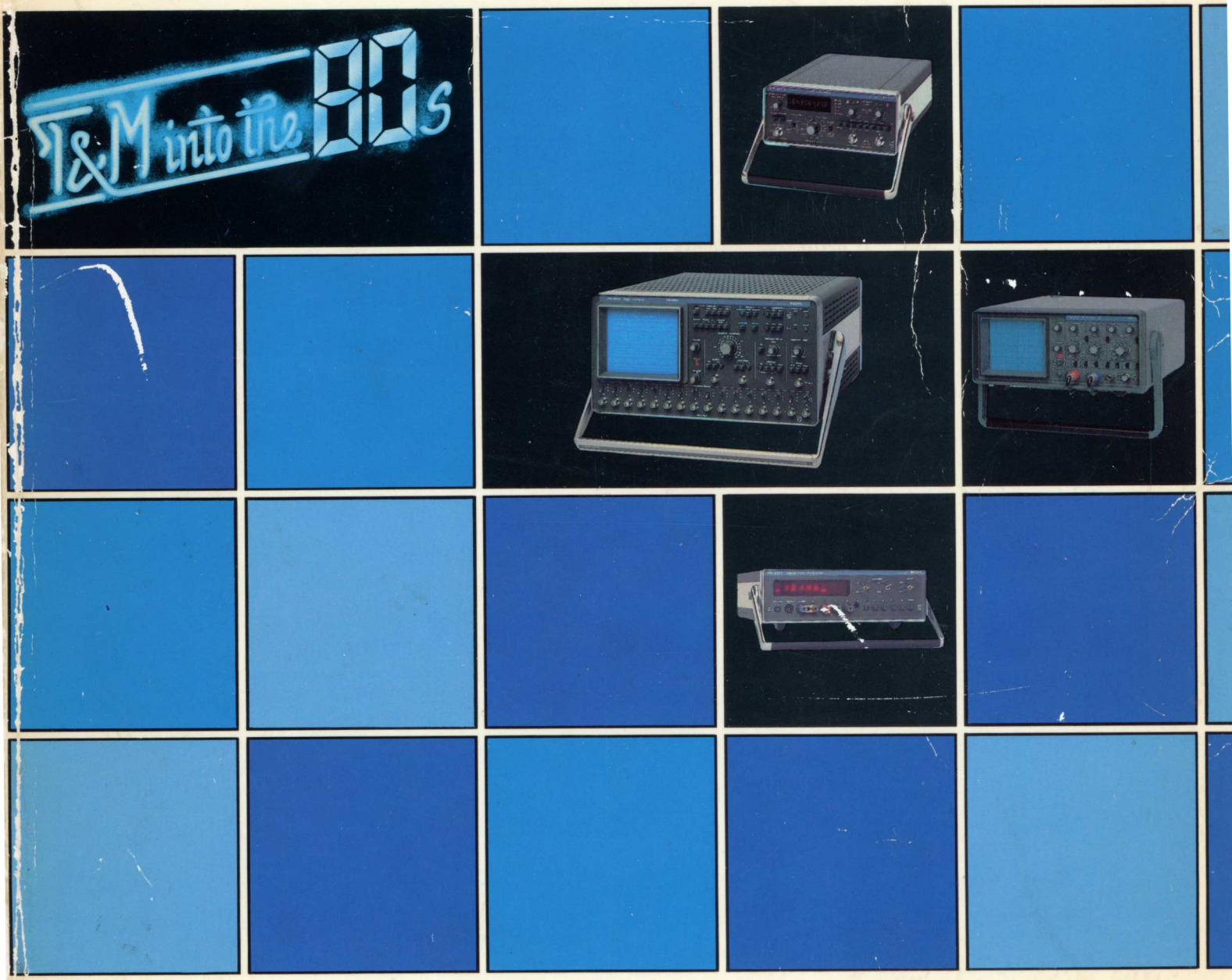
test and measuring instruments

catalog 1980/81



PHILIPS

test and measuring instruments catalog 1980/81

This publication describes the 1980/81 programme of Philips Test and Measuring instruments. Many new products are included. These are introduced briefly on pages 8 to 10 and described fully within the classified product sections.

Information appears on after-sales and training-support services; also on the availability of further technical information on the products contained in this catalog. Enquiry cards will be found inside the back cover.

In addition to the normal contents list (page 2) there is a products part number list at the back of this catalog to speed product identification from part number information.

A number of products have been supplied under NATO-stock numbers. Information is available on request.

Philips Test & Measuring Dept. reserve the right to modify and improve instrument performance specifications without notice.

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Professional TV equipment

Microwave equipment

DC power supplies AC stabilizers & DC/DC converters

Measurement of mechanical quantities

Miscellaneous

Reflect and predict

Every new decade presents the opportunity to reflect on the past ten years and predict some pattern for the next. As Philips Test and Measuring Instruments Department moves into the 80's it is perhaps an appropriate moment in the changing world of electronics to do so.

Progress in the 70's

The overall range of T & M products has shown many and various improvements that have more than equalled the original intentions.

Individual product groups have expanded their ranges of instruments at the same time improving levels of reliability, design sophistication, performance, size and weight, of practically all units. The more enhanced products that have emerged during this decade result mainly from a combination of new innovations and considerable advances in component styling, plus Philips own concentrated research, development and design capability. It is the blend of these main ingredients that has vielded the maximum exploitation of all the new benefits for the user...

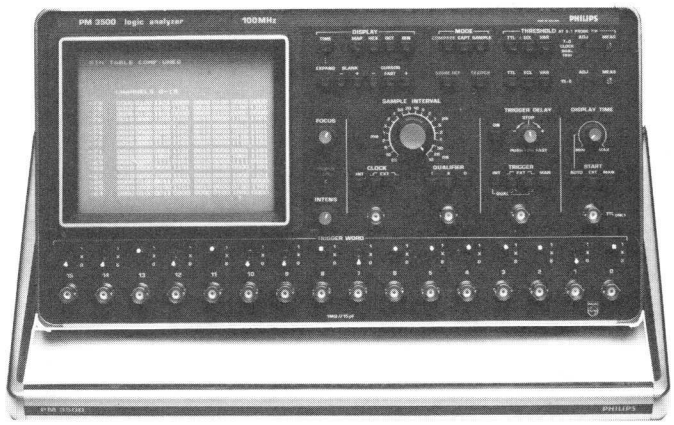
One of the major advancements during this decade was probably component miniaturization which vastly improved portability and allowed many, once-bulky instruments, normally restricted to bench use, to be carried without effort. It also allowed sharp price cuts in digital instrumentation, putting digital voltmeters, for example, within everyones' reach.
With the important plus of allowing new breakthroughs in circuit design!

With the arrival of the 80's however, the most significant advance in the world of electronics must be the fast-moving process of a massive migration from the analog approach into digital technology.

Digital versus analog?

Analog devices are by no means outmoded and will continue to be in demand for a considerable time to come. But the *rate* of changeover is already producing a demand for digital instrumentation which currently promises to outstrip that for analog equipment.

For this reason Philips' own digital test and measuring instruments programme is already becoming well established. This, as a result of dedicated research activities concerned with the problems of measurement in the data domain, during the 70's. Some of the results of these activities will be found in this catalog. But that is not the whole story!



The PM 3500 Logic analyzer which was introduced in 1979 is part of a new range of data test equipment which will be progressively extended

New demands – new solutions

Introduced during 1979, these new families of digital devices significantly span the two decades; they also herald the fast-changing pattern for instrumentation in the 80's. However, it is important to understand that whilst these new and exciting developments form a logical extension of T & M's advance into the field of digital test equipment, this is not at the expense of the traditional analog programme.

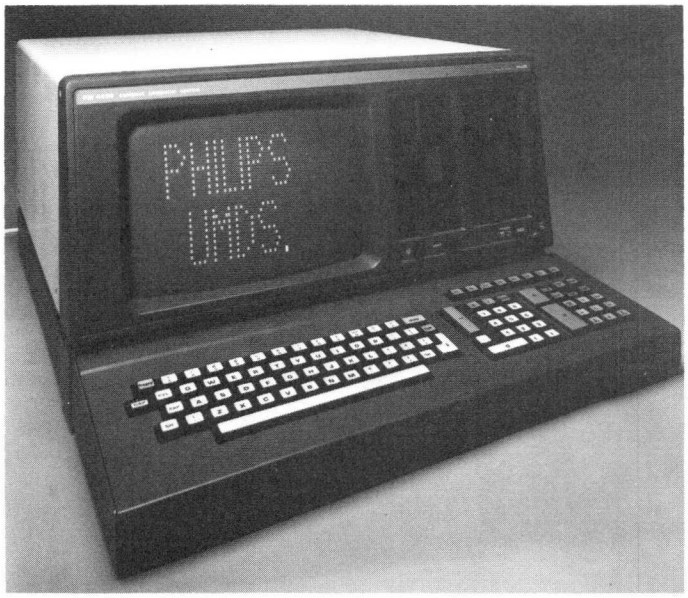
Philips, with its considerable resources, is perfectly capable of supporting *both* application areas – and plans to do so.

Wide hardware and software experience

Looking briefly at the new products, because of a wide, in-depth, experience as a user and supplier of software and hardware, Philips is in a strong position to provide maximum, long-term support for both activities. The logic analyzer and logic scope, both part of the new digital programme, already reflect a level of sophistication that is unique for 'first generation' devices and gives great promise for follow-on products.

Of equal importance, the availability of the Philips Microcomputer Development System reveals another direction in the overall Philips digital development programme.

A key feature of this system design is that it is not short-term obsolescent. In fact the reverse is true. The initial system not only offers virtually limitless possibilities for the user – because it is truly universal – but allows both Philips design teams and the user to utilize its current and potential capacity, well into the future.



The Philips microcomputer development system PM 4421 is a powerful aid to economic success in microcomputer applications.

Long-term confidence

Philips is Europe's largest and one of the world's biggest instrumentation manufacturers. It *makes* and *uses* microprocessors; it *makes* and *uses* computers; it *makes* and *uses* test instruments and systems. Microcomputer Development Systems represent the obvious combination of these skills.

And what is very important is the fact that Philips is a large, worldwide organization, fully capable of underwriting strong, continued, support for these state-of-the-art developments, for a long time to come. Many more decades, at the very least!

Facing the future

The previously mentioned commitment to the 'traditional' T & M test equipment programme is emphasized by the recent opening of an integrated oscilloscope production and development facility at Enschede, Eastern Holland. This will allow the introduction of new designs more easily. The new factory is intended to meet the growing demand for Philips products world wide. It provides 6000 m^2 of production area which can be doubled if required.

Production lines are flexible for easy adaptation to meet changing market requirements. All development work for Philips oscilloscopes will also be concentrated on the same site. Facilities include environmental testing.
The factory can also be supplied easily from Philips component factories – such as the solid state facilities at Nijmegen. Nearness to this and other Philips production and development facilities allows implementation of advanced computer aided design equipment – not normally possible in such a compact unit.

Meeting increasing demand

Another oscilloscope production facility is scheduled to start operations in Mahwah, New Jersey, to supply the North American market. The bringing on-stream of two new production facilities provides an indication of the increasing demand for Philips instruments.

Worldwide service

This is the ultimate benefit for Philips buyers – wherever their location, because Philips worldwide service facilities are available almost everywhere. With a staff of some 400,000 people of more than 70 nationalities and over 70 sales and service centres spanning the globe, Philips can offer a full, professional after-sales service backup, almost anywhere.

The new factory at Enschede, Holland which will become the European manufacturing centre for oscilloscopes

Summary of other Philips publications

Additional information
Full technical specifications and any other information that may be required will be gladly sent on request by the local Philips organization in your country. The addresses are included at the back of this catalog.
In countries where Philips is not represented, enquiries sent to N.V. Philips, Test and Measuring Instruments Department, Eindhoven, Netherlands, will receive our prompt attention. In addition to this catalog, Philips also provide the following publications in the field of electronic measuring and microwave instruments.

'T & M News'
Published six times a year, this 8-page news sheet features the latest information on new instruments and applications to keep readers up-to-date with the T & M programme.

'T & M Report'
Covers one instrument in depth, dealing with both performance features and how it can be used to the best advantage. Issued at random intervals.

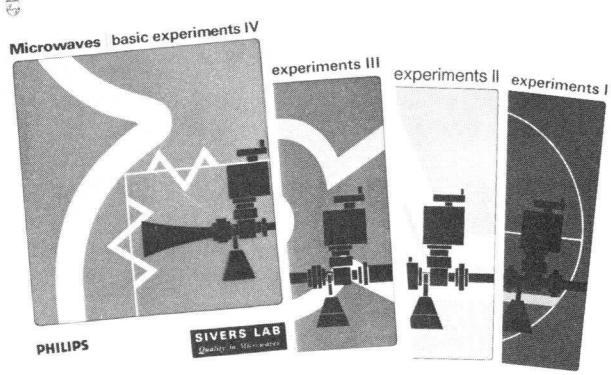
Technical datasheets and brochures
Comprehensive technical details on individual products are given in our range of datasheets and brochures.

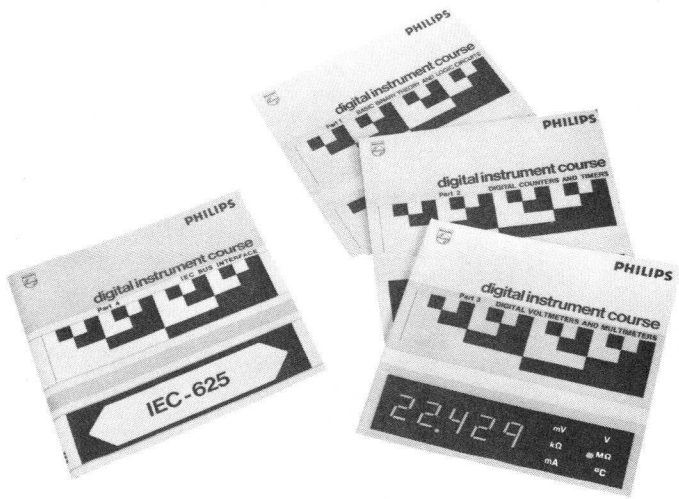
'Instruments and components for microwaves'
Contains fully documented information on all available microwave devices; approx. 90 pages.

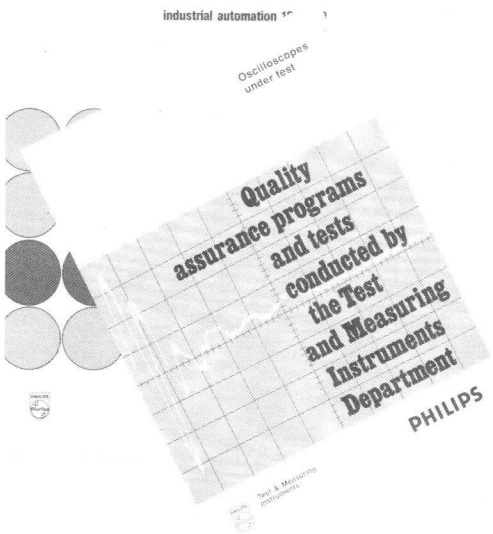
'Microwaves, basic experiments' (4 booklets)
Four separate educational booklets providing an easy-to-understand introduction to microwave techniques; approx. 20 to 30 pages per issue.

'Education in applied microwaves'
This comprehensive brochure describes all the items of 'hardware' and educative literature that are currently available.

'Digital Instrument Course'
The 4 parts inform you on digital equipment of today:
1. Basic binary theory and logic circuits
2. Digital timers and counters
3. Digital voltmeters
4. IEC Interface







'Oscilloscopes under test'
A review of quality control and environmental testing proceedures, applied during the manufacture of Philips oscilloscopes in particular and other T&M products in general. Comprehensively illustrated.

'Professional TV measuring equipment'
Approx. 100 pages describing the large selection of Philips professional television measuring equipment.

'Process control instrumentation'
A catalog on the Philips range of transmitters, indicators, recorders, signalling units, motor actuators, analysers and sequential programmers.

'Electrical measurement of mechanical quantities'
A survey of the very wide range of Philips equipment in this area.

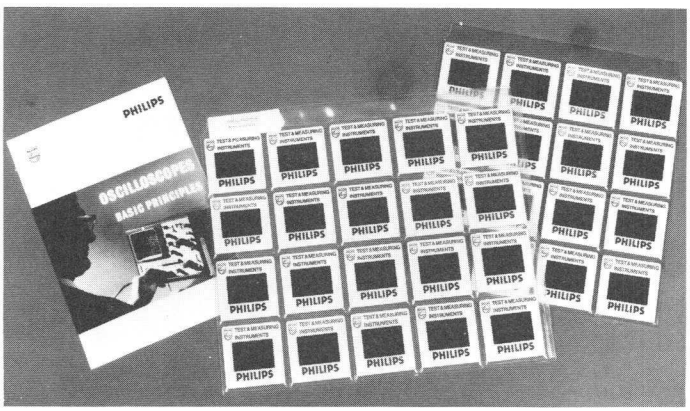


Fig. 1

Software support
The publications and visual course illustrated are designed to aid the many users as Philips' oscilloscopes in as many applications areas as possible. Special emphasis has been given to education and those who wish to become acquainted with the basic principles, as well as to the more specialised and advanced techniques such as sampling and multiplying. The set consists of:

1. 'Oscilloscopes Series 1 Basic Principles' (Fig. 1)
Describes and explains the main functions of oscilloscopes, such as the CRT, vertical and horizontal amplification, time base and triggering.

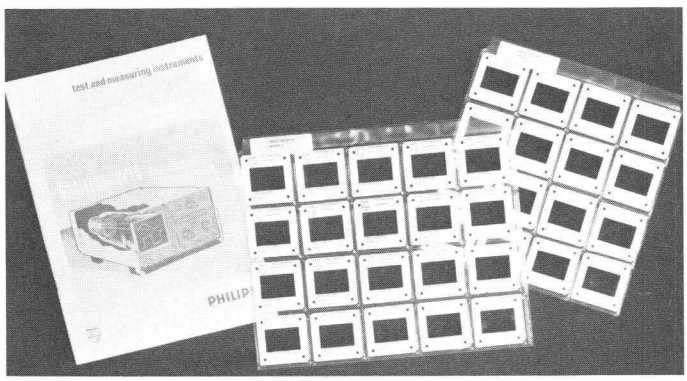


Fig. 2

2. 'Oscilloscopes Series 2 Dual Channel and Delayed Sweep' (Fig. 2)
Describes and explains the uses and ways of operation of dual beam and dual trace instruments, horizontal magnification and delayed sweep arrangements.

New publications are, of course, appearing all the time and more details can be obtained from your local Philips organisation. A complete world-wide, address list appears at the back of this catalog.

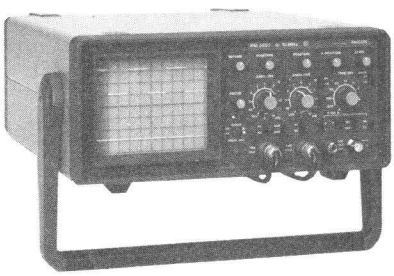
New products 1980

New items appearing in this issue are briefly reviewed in this section.

For more comprehensive data, turn to the page number, shown against each item.

OSCILLOSCOPES

15MHz dual-trace oscilloscope PM 3207



- 15MHz/5mV
- Large 8×10cm screen
- Auto, TV triggering
- Same sensitivity on X and Y channels
- B-invert facility
- Triggering from A or B channel
- Double insulation

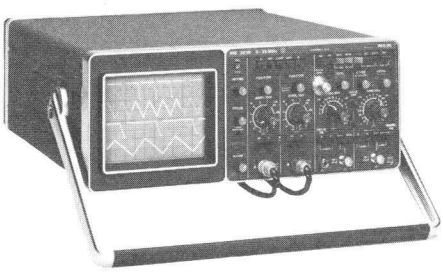
Very weak signals are no problem for the 5mV sensitivity of both X and Y axes. The 'B-invert' facility allows signals to be displayed inverted and also permits a $Y_A \pm Y_B$ display when used in conjunction with the add facility. A stable trace is assured by Auto triggering which allows trigger level adjustment between peaks while facility for triggering via A or B inputs avoids tiresome lead-changing during a measurement. Extremely compact instrument with TV triggering, double insulation to stop ground loops, plus full IEC 348 electrical safety requirements. Very sophisticated, yet economically-priced instrument. P 40.

35MHz oscilloscope PM 3216

- 35MHz/2mV
- Signal delay
- Triggering includes: pk-pk Auto,
- DC-coupling, Auto TV, Ext
- Variable trigger hold-off
- Ext Z-modulation input
- Max sweep speed 10ns/cm
- Double insulation

Complements the PM 3212 by providing the same basic facilities plus wider bandwidth and other features. These include an external trigger sensitivity or 200mV/2V, variable trigger hold-off and an external Z-modulation input. It also has an extra 100ns/div position on the time base. This single time base oscilloscope features a large, 8×10cm display with high light-output. The internal graticule can be illuminated when in a low light level environment, or when taking photographs. Double insulation between the line and the unit eliminates the need for a protective earth connection and avoids problems of earth loops and hum. Battery option available. Compact, low-weight and portable. P 36.

35MHz oscilloscope PM 3218



- 35MHz/2mV
- Signal delay
- Comprehensive triggering includes:
- pk-pk Auto, DC-coupling, Auto TV, Ext
- Delayed time base
- Ext Z-modulation input
- Max sweep speed 10ns/cm
- Double insulation

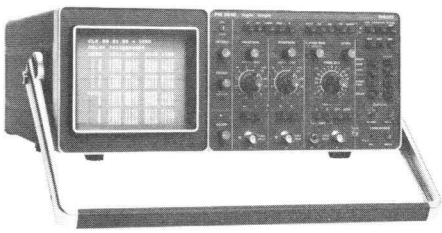
Complements the PM 3214 and also completes the family of four models PM 3212/14/16/18 to give a wide selection of price/performance ratios. Useful features include alternate time base displays, normally associated with more expensive instruments and an Auto triggering facility which displays the zero line with no input and allows the trigger level to be set and held within the pk-pk amplitude of an input signal. This provides unambiguous triggering for a wide variety of measurements. For digital applications the DC-coupled triggering will handle variable-duty cycle waveforms. TV frame and line triggering is achieved by two buttons. Combined with the 2mV sensitivity this makes the oscilloscope useful for faultfinding, even in IF stages. The high light-output, 8×10cm screen is fitted with a continuously variable illuminated graticule. A very versatile instrument. Available in battery-powered versions. P 38

Logic analyzer PM 3500

- 16 display channels and 504-word memory
- 100MHz clock rate
- Easy changeover from state to time domain
- Glitch-catching on events as short as 3ns
- Good ergonomic design for ease of use
- Comprehensive diagnostic routines
- Threshold selection of TTL, ECL, CMOS, etc., simultaneously on any two groups
- Display formats in binary, hexadecimal, octal, mapping
- Compare mode facilities

The location and analysis of faults in the data domain are achieved by this single instrument. Instantaneous changeover form timing to state analysis allows immediate comparison of software commands and hardware results. The input threshold can be fixed at either TTL/ECL levels or made continuously variable to match any other logic family being tested. Asynchronous sampling is possible up to 100MHz which is sufficient for microprocessors, minicomputers or mainframe testing. Glitches as short as 3ns can be captured and displayed as full clock width pulses. It is possible to trigger on these and there is a separate input for external triggering. State display can be binary, hexadecimal, octal or in mapping form to suit different user-applications. P 57.

Logic scope PM 3540



- Unique combination of logic analyzer and oscilloscope

Scope:

- Full 2mV sensitivity over total 25MHz bandwidth
- Trigger sources – A, B, Composite, Ext and from logic analyzer

Logic analyzer:

- 16 display channels with 64-word memory
- 10MHz synchronous clock rate
- Clock qualifiers
- Good ergonomics for easy operation
- Display formats in binary, hexadecimal, octal
- Compare mode facility
- Built-in diagnostic routines

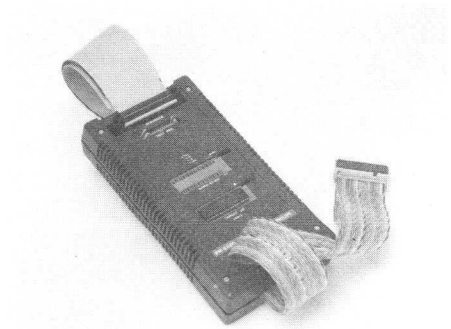
PM 3540 combines a 16-channel, 10MHz logic analyzer with a versatile, 25MHz/2mV oscilloscope to ensure complete, true logic testing. Fault location is achieved by the logic analyzer section and the realtime oscilloscope display enables faults to be analyzed and corrected. Handles both hardware and software problems. Microprocessor control provides maximum display versatility. Specially designed probes supplied for connection to circuit under test. Operates with a wide variety of different logic families. As with PM 3500, the PM 3540 has built-in diagnostic routines which test the instrument down to functional level. P 60.

PMDS PM 4421

- Integrated system for HW + SW + system development and debugging
- Universal μP, μC and PROMS
- Designed for future developments
- True realtime emulation
- Multiprocessor (target) system debugging capability
- Extensive breakpoint and trace facilities
- Pascal
- Electronic design automation

The Philips MDS is a complete development system which offers advanced software development facilities and true realtime emulation capabilities. It is also a universal development system which supports the 8085, Z80 and 6500 families, plus other, impending microprocessors. It has been designed with future requirements in mind. The initial 8-bit microcomputer support will shortly be extended to 16-bit machines. PMDS will support microprocessor systems with up to four parallel debuggers and is able to emulate a mixture of microcomputer architecture in parallel. It also offers portability of software between microcomputers by offering the high-level language PASCAL. Its function as a design tool can be extended to engineering analysis and administration and an add-on option allows IEC-bus control facilities. P 65.

Intel 8085 support



- The PM 4421 Philips Microcomputer Development System can be supplemented by a number of hardware and software options to provide real-time emulation capability for a range of different microprocessors
- The complete support system for the intel 8085 microprocessor consists of:

cross-assembler PM 8460

debugger PM 8480

microcomputer adapter box (MAB) PM 8420

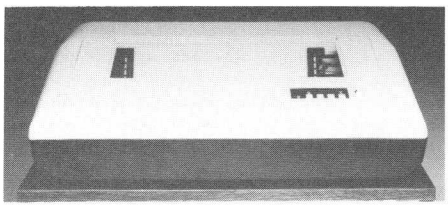
The cross-assembler is an automatic extension of the standard PM 4421 software package which translates assembly-language modules into object modules that are acceptable as input for the universal linker. The debugger PM 8480 controls the universal debug unit and its options. This control is based on a set of commands to be given by the user. Microcomputer adapter box PM 8420 is the hardware unit acting as interface and buffer between the PMDS and the target microprocessor. P 71.

Universal PROM programmer PM 4491

- Universal; programs bipolar PROM, PAL, MOS, EPROM, FPLA, PMUX, FPGA and diode matrix
- Standard 4k×8 (32k bits) RAM for data storage; expandable to 16k×8 (128k bits)
- New plug-in Programming Paks can easily be changed without disturbing RAM memory
- Remotely operated via serial interface (RS232C and 20 mA current loop)
- Automatic self-test and error detection
- Internal continuous RAM test to flag power-induced memory failure
- External switch-selectable baud rates to 19 200 bits/s

The PM 4491 Universal PROM programmer complements the versatility of the PM 4421 Philips Microcomputer Development System, and gives the user full freedom of choice of the PROMs to be used in a prototype system. The PM 4491 is made by Data I/O, acknowledged leaders in the field of programming equipment, and its functions include loading, copying and verifying PROMs, patching and examining data, and insertion of PROM checksums. P 74.

High-speed matrix printer PM 4490

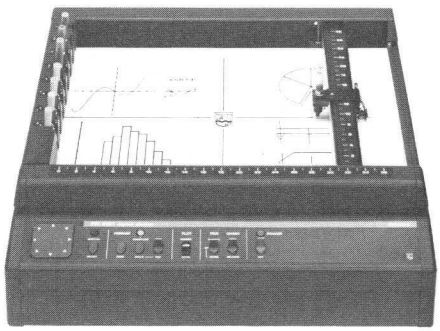


- Full 96 ASCII character set
- Serial interface
- 7 wide×9 high dot matrix for up to 63 dots of printing flexibility
- Built-in high reliability

Enables bi-directional printing of data up to 180ch/s. The print head provides a 9 high × 7 wide dot matrix, true underlining and prints upper and lower case and descenders. The print head has no moving cores attached and the unique design substantially reduces drag and minimizes tip wear. The overall mechanical system is designed for minimum wear and maximum reliability. The printer will accept almost any form of paper up to 0.46mm (0.018-in) thick and 406mm (16-in) wide. Programmable forms and font control are facilitated by built-in microprocessor. A battery-powered format retention system holds format settings up to 96 hours in the event of line failure. P 75.

RECORDERS

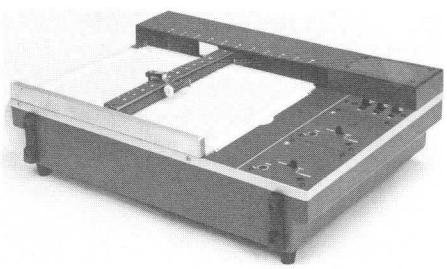
Multipen intelligent plotter PM 8151



- Microprocessor-controlled for high speed and accuracy
- Programmable choice of 8pens, nylon-tip or rotring
- 120 characters of 5 different fonts, upper and lower case
- Scaled X and Y axes and full grids
- Window plotting and programmable offset both with off-scale data handling
- 800 bytes input buffer, expandable with 1k byte

Microprocessor-controlled, PM 8151 will accept digital data from any source such as, IEC-controllers, desk computers, time-sharing systems or offline stations – directly or via a modem. Input data is rapidly and accurately converted into graphic representation of test values, design data or calculations, as formatted by the computing system. It will handle extremely complex drawings and can be programmed to print out in several languages. There is a choice of standard drafting pens allow drawings to be made in Indian ink (rotring) of standard nylon-tipped pens in various colours. A window plotting facility effectively 'magnifies' a selected section of a trace, without change of programme. All complexities are handled by the microprocessor making the instrument very easy to use. Self-diagnostic routines are built in. P 95.

Economy X-Y recorder PM 8040



- High writing speed and pen acceleration
- Excellent accuracy and reproducibility
- High rejection of interference signals
- Chart roll facility
- Electrostatic charthold and pinpoint light alignment
- Disposable nylon pen cartridges
- Sturdy die-cast frame and housing
- Easily adaptable to OEM requirements

The PM 8040 is an economy A4 format X-Y recorder with a single calibrated input sensitivity. It is designed for application in single purpose measuring set-ups, or in combination with other dedicated equipment.
The electronic part and the mechanics are conceived from the same basic design as the well proven range of Philips multipurpose X-Y recorders.
Its characteristics make the instrument extremely useful for the OEM-user of those seeking reliability, accuracy and ease of operation. P 91.

MULTIMETERS AND VOLTMETERS

Electronic multimeter PM 2505

- 62 measuring ranges
- High V & A sensitivity
- Linear resistance ranges
- Automatic polarity indication
- Unique meter movement for high accuracy and repeatability
- Low power consumption

An extremely versatile, yet remarkably compact multimeter, the PM 2505 features very high accuracy and repeatability, high sensitivity and a constant, 10MΩ input impedance. Unlike conventional analog multimeters which tend to use non-linear reversed scales for resistance measurement it has an easy-to-read linear scale giving accuracies well in advance of the usual 7 to 10% levels. Moreover, continuity checks (with less than 5Ω point-to-point resistance) are simplified by means of a built-in sound signal. Of advanced design, the moving coil system is very robust, free of backlash, immune from external magnetic interference and does not radiate magnetic fields. Full overload protection is provided on all ranges and state-of-the art circuitry consumes minimal power giving an estimated operating life of 1000 hours for the two 9V supply batteries. **P 110.**

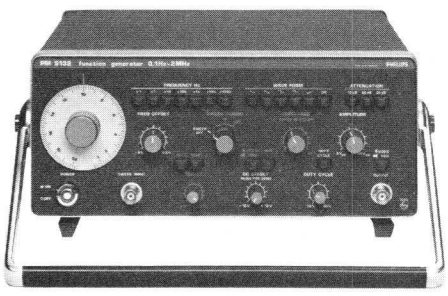
LOW FREQUENCY EQUIPMENT

Function generator PM 5131

- 0.1Hz . . 2MHz frequency range, logarithmical sub-ranges
- Sine, triangle, or square, wave signals and DC
- $30V_{p-p}$ maximum output
- Stepped & variable output attenuation up to 80dB
- Variable DC-offset
- Vernier frequency adjustment
- Internal & external sweep facility
- TTL output

This function generator produces sine, square and triangle waveforms and will satisfy applications extending from education to the broad, general-purpose area. It has a high, $30V_{p-p}$ output and facilities for both internal and external sweep which can cover the audio frequency range in a single sweep, if required. Frequency is adjustable in 3 logarithmic ranges between 0.1Hz and 2MHz and a vernier control allows settings to be varied between + and −20%. Attenuation is either in calibrated steps of 10dB up to 60dB or in combination with the 20dB continuous attenuator. DC-offset is variable between −10 and +10V. Output impedance is 50Ω and there is a separate TTL output. **P 149.**

Function generator PM 5132



- 0.1Hz . . 2MHz in 7 overlapping ranges
- Sine, triangle, square, + and − pulses, DC $30V_{p-p}$ output for waveforms, $15V_{p-p}$ for pulses
  80dB attenuation stepped and variable
- Variable DC-offset
- Internal and external linear single or continuous sweep
- Hold, reset, external triggering
- Variable duty cycle
- TTL output

This general-purpose instrument will be very attractive for educational applications as well as in laboratories. It produces sine, triangle and square waveforms, plus positive- and negative-going pulses, plus DC. The waveform outputs are $30V_{p-p}$ and pulses are available up to $15V_{p-p}$. Attenuation of 80dB is achievable either in steps of 10dB from 0 to 60dB plus a continuous 20dB. Duty cycles for all waveforms are variable between 10% and 90% and DC-offset is selected independently for any waveform, being adjustable between −10 and +10V. Sweep facilities are varied for internal or external sweep and there is a choice of 50Ω, 600Ω and TTL outputs. **P 151.**

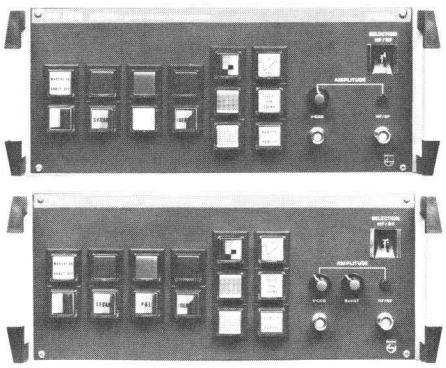
Microprocessor-based synthesizer PM 5190

- Sine, triangle and square wave outputs
- Microprocessor control simplifies use
- Feather-touch push-button selection of parameters with $\pm 1 \times 10^6$ accuracy
- Unambiguous LED display of frequency, amplitue, DC-offset
- IEC-bus as standard for automated use or remote control
- Separate TTL output

Sine, triangle and square wave signals at nominal frequencies of 1mHz to 2MHz are available with a high setting accuracy of $\pm 1 \times 10^6$. Selection is by push-button and is indicated on a 6-digit LED display. External modulation up to 90% is possible on sine and triangle waveforms IEC-bus interface is standard, allowing remote control and use in automated systems. Display also shows DC offset and signal amplitude as well as frequency. Two outputs of 50Ω plus separate TTL socket on front panel. Microprocessor control greatly simplifies use and speeds operator-familiarity. **P 153.**

AUDIO/VIDEO TEST EQUIPMENT

Colour pattern generators PM 5215-SECAM PM 5217 SECAM/PAL



- X-TAL-controlled RF output, single or multi channel
- Available for different TV systems such AS L, B, G, K and D (on request)
- Large choice of various test patterns
- Synchronization according to TV standard
- Automatic blinking for test of 'portier' circuits
- Choice of positive or negative video polarity and variable video amplitude

Both generators PM 5215-SECAM and PM 5217-SECAM/PAL can be fitted with up to 4 different RF channels offering a wide choice of test patterns. Both are especially designed for after-sales service of CTV, TV colour monitors and video recorders.
The inherently high quality X-tal controlled RF output, plus their versatility make these instruments ideal for fast, accurate video measurements in professional areas as production and quality control. P 171.

COUNTERS AND TIMERS

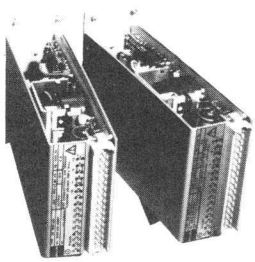
High resolution counters PM 6667 and PM 6668

- 120MHz (PM 6667) and 1GHz (PM 6668)
- Microprocessor control
- High resolution computing counter
- Easy operation through built-in intelligence
- Auto triggering on all waveforms and duty cycles
- Self-diagnosis routine
- 15VRMS sensitivity
- High stability Xtal oscillators 10^{-7}/month
- Clear high-contrast LCD display

The microprocessor-controlled PM 6667 and PM 6668 frequency counters span a frequency range 10Hz...120MHz and 10Hz...1GHz respectively, with unbeatable economy. Operation is fast, easy and error free and the computing power provides high resolution capabilities not found in traditional counters.
Use of a microprocessor and large-scale C-MOS digital circuitry also reduces component count, producing two extremely compact, high-performance counters. Apart from the excellent $15mV_{RMS}$ sensitivity, other features made possible by the basic design concepts include the elimination of the traditional ± 1 cycle error, choice of two measurement times NORMAL or FAST and an automatic self-test routine at switch-on. MTBF is 40 000 hours. Both units accept a wide line voltage range, including 12V batteries and an optional built-in rechargeable battery pack is available P 190.

POWER SUPPLIES

DC/DC converters PE 1100 and PE 1101



- Designed for DIN 41.494 rackmounting
- Switched-mode technology for $\geqslant$65 . . 70% efficiencies
- Transient suppresion 75dB (sym) and 65dB (asym)
- Galvanic separation
- Interference N level to VDE 0875 (input) and IEC 478 (output)
- MTBF of 50 000 operating hours

Constructed for use in Eurodimension 19-in rackmounts, both DC/DC converters exhibit high conversion efficiencies due to the use of high-frequency switched-mode technology. Figures for transient suppression and interference at the inputs and outputs are extremely good. Model PE 1100 supplies 5V at 6A and model PE 1101 provides an output of 12V at 3A. Both designs incorporate galvanic separation. Calculated MTBFs of 50 000 operating hours ensure long, trouble free usage. Both units are overload-protected, can be used in series or parallel operation and are remotely controllable. The plug-in chassis occupy a 10T standard width. P 255.

Modular power supplies

The modular power supply programme has been further extended by the introduction of more models, including 10T units for DIN 41.494 rackmounting. P 238.

Custom-built power supplies

Where power supply requirements cannot be met from the very wide range of Philips standard units, special designs will be investigated by our team of experts in this field. Already, many designs exist from earlier enquiries and these tend to be linked with applications relating to specific types of electronic equipment.

For example, these include power supplies for telex equipment, in point-of-sale cash registers with print out facilities, microcomputers, etc. DC/DC converters also feature and there are some designs which incorporate constant voltage transformers. Some of these specially created power supplies are described in the 'tailor-made' section. P 257.

PROFESSIONAL TV EQUIPMENT

Again, the PTV programme sees further additions to its already considerable range of high-grade equipment. Since this entire range is already covered in detail in a separate catalog it is recommended that users of professional television equipment contact their local Philips representative for a copy of the latest issue. In cases of difficulty, please direct enquiries to the Test & Measuring Dept., Eindhoven. The current PTV range of equipment is featured on P 214.

Oscilloscopes

Unit	Sensitivity	Bandwidth	Features	Page
PM 3262	2mV/div	100MHz	Dual-trace with trigger view channel	16
PM 3266	2mV/div	100MHz	Dual-trace with transfer storage	18
PM 3265	5mV/div	150MHz	Dual-trace, delayed sweep portable with multiplier	21
PM 3265E	5mV/div	150MHz	Dual trace with alternate time base	21
PM 3263	2mV/div	100MHz	Dual-trace with μ-processor controlled timing	23
PM 3244	5mV/div	50MHz	Four-channel, portable, multisource triggering	26
PM 3243	5mV/div	50MHz	Dual time base, storage scope with 40MHz multiplier	28
PM 3234	2mV/div	10MHz	Dual-beam, with delay lines and storage	30
PM 3233	2mV/div	10MHz	Dual-beam with delay lines	32
PM 3225	2mV/div	15MHz	Single-trace TV triggering	34
PM 3226	2mV/div	15MHz	Dual-trace, compact, TV triggering	34
PM 3226P	2mV/div	15MHz	As PM 3226	34
PM 3212	2mV/div	25MHz	General purpose, with automatic TV triggering	36
PM 3214	2mV/div	25MHz	As PM 3212 plus delayed sweep and alternate timebase	38
PM 3216	2mV/div	35MHz	General purpose, with automatic TV triggering	36
PM 3218	2mV/div	35MHz	As PM 3216 plus delayed sweep and alternate time base	38
PM 3207	5mV/div	15MHz	Dual-trace with TV triggering	40
PM 3211	2mV/div	15MHz	Dual-trace, general purpose	42
			Accessory chart	44
			Passive probes	45
			Active probes	48
			Miscellaneous accessories	51
			Cables, adapters, camera	52

Introduction

There are many advantages to be found when making competitive evaluations of Philips oscilloscopes. To begin with, the designs incorporate many original Philips innovations.

These new concepts have emerged from a highly professional design team which has enjoyed the benefits of a high level of investment in continuous research programmes. Backed by an in-house availability of advanced component design and manufacture – including CRT's.

Moreover, operational feedback of performance and new applications from our many customers and the company's own, considerable, source of users has furthered opportunities to improve products, introduce new techniques.

Beyond the design stage, sophisticated testing facilities subject new ideas to rigourous mechanical, electrical and climatic routines, from which only the best ingredients of a design can survive!

Few concessions only, have been made to produce the very best technological product within the established market cost bracket.
It is this total capability of design, procurement, fabrication, and world distribution, plus a global after-sales service capability that has secured and maintained Philips prominent position in the oscilloscope market place, today.

Reviewing some of Philips firsts can produce a formidable list, for example:
- Multiplication of two analog signals
- Dual delay **plus** digital delay
- Dual-beam operation for unambiguous displays
- Cold switching (internal remote control)
- Digitally delayed sweep for measuring in data domain
- Flexible triggering for simplicity of operation
- Double insulation for avoiding ground loop problems

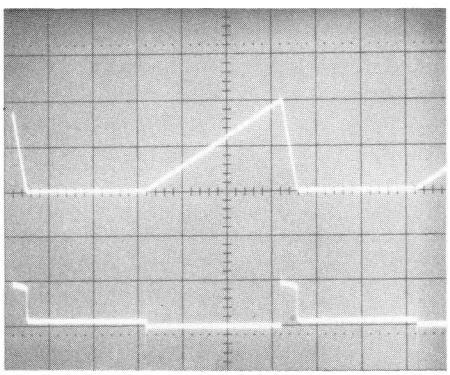


Fig. 1. Oscillogram of the power dissipation (lower trace) during the flyback period of the sawtooth voltage (upper trace).

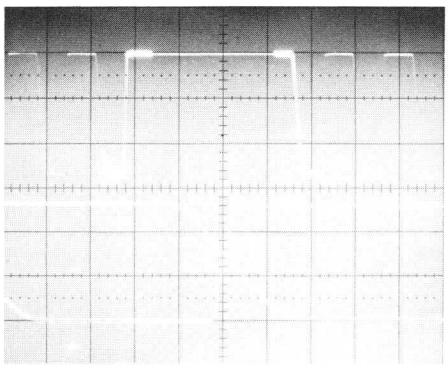


Fig. 2. Oscillogram showing the pulse-width measurement utilizing the increased accuracy achieved by using the alternate time base display facility.

Multipliers

An example of the multiplying technique, is to be found on the PM 3243, which encorporates a 40MHz multiplier, this bandwidth being well in excess of the normal external multipliers with only 5 to 10MHz capability. The double differential amplifier circuit, with cross-coupled collectors, which forms the heart of the system is contained on a single monolithic chip.
It is a four quadrant type to ensure correct representation of all incoming polarities. Use includes accurate measurement of power, phase differences, power factors, etc.

Dual delay

This facility, based on a built-in microprocessor, plus associated circuitry, is featured in the PM 3263. It provides those advanced facilities demanded for very complex measurements, in, for example, telecommunications and data processing environments. In particular, it is invaluable for: *time interval measurements* between two signals on the same trace *or* two events located on different traces; *direct frequency measurements* where the delayed sweep mode is used to achieve fine adjustment of the time interval to one period. A bush button is used to activate the microprocessor, which then produces a 1/T calculation and displays it on the LED panel.

The operator is thus relieved of the necessity to undertake tedious calculations. The LED display is in engineering notation. This panel is also used to warn the operator of faulty instructions and is itself subjected to regular self-test routines by the microprocessor.

A further advantage of this unique circuitry is the resulting simplification of the control panel layout – an important operator benefit which allows the user to concentrate fully on the measurement in hand.

Storage

The combination of true dual-beam operation and half-tone storage on the PM 3234 produces uninterrupted recordings, even of single-shot events. The facility allows single events to be stored and analyzed subsequently, a feature rarely found in medium-priced 'scopes.

A more sophisticated arrangement is employed in the PM 3266 which uses a 3-mesh CRT shown diagrammatically in Fig. 4. This allows events to be stored up to one hour. The two storage modes are *fast*, with a 1000div/μs writing speed

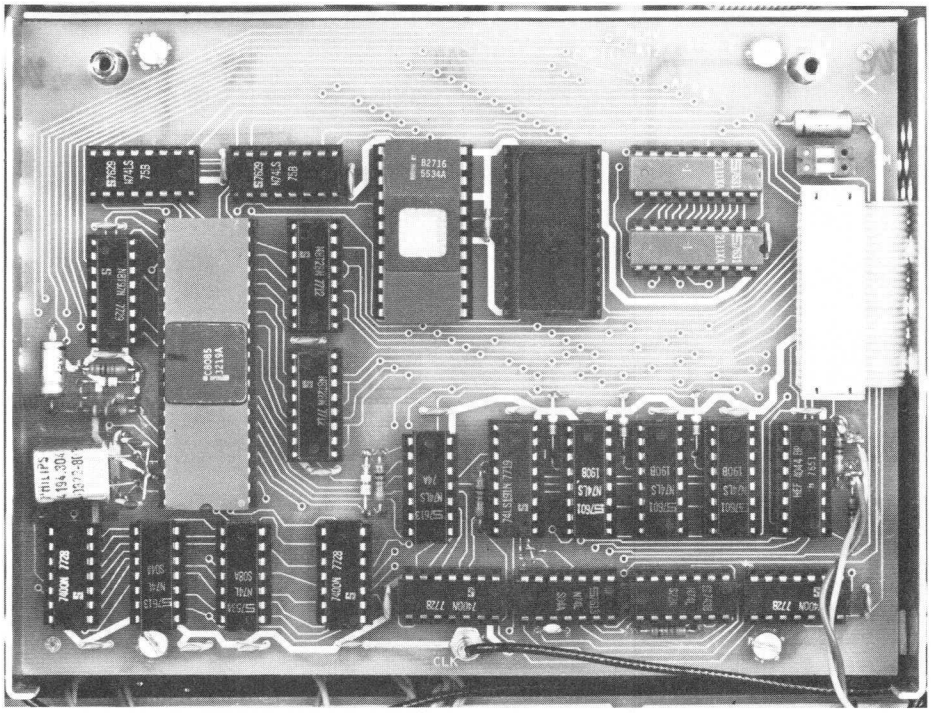


Fig. 3. The microprocessor is pcb-mounted with various associated components. Besides generally organizing all the delay features, it formats the display which warns the operator when the instrument is out of calibration or incorrectly set up.

and *write*, having a 0.25div/µs writing speed; this latter mode also incorporates a *max. write* feature with a speed of 2.5div/µs. PM 3266 can thus be used in digital systems for capturing glitches, for example. Other applications include quality control during semiconductor manufacturing processes, testing TV picture tubes, reed relays, etc.

Triggering

Flexible triggering is another area of advanced development and on most Philips instruments, trigger bandwidth invariably exceeds the Y-bandwidth, allowing extremely short transients to be captured. Auto trigger and peak-to-peak auto trigger circuits ensure freerun triggering at all input amplitudes, being derived from and adjusted by the input signal amplitude.

TV trigger is easy to operate and an invaluable facility for the professional TV engineer. It incorporates auto freerun with the previously mentioned peak-to-peak auto arrangement plus, TV sync separation and TV line/frame selection. A practical example is the PM 3240X model which permits line-by-line selection using the TV waveform applied to the main or delayed timebase.

Multi-source triggering allows a wide choice of trigger sources for main and delayed timebases and another innovation is the provision of LED's to warn the user of incorrect trigger conditions.

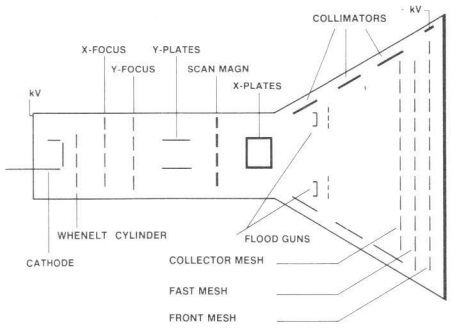


Fig. 4. Simplified diagram of the CRT design principles for the PM 3266, showing the set of meshes used in the high-speed transfer system and the scan magnifier lens system which produces the full scan display.

Avoiding ground loops

Problems associated with ground loops have been overcome using double insulation techniques. This allows an instrument to be powered from a 2-wire AC line input, less a ground connection, without introducing any additional hazards for the user.

Many other benefits

In contrast to the 'mixed' time base featured on most portable oscilloscopes, the horizontal sweep can be switched to alternate on the PM 3262, PM 3263, PM 3266 and PM 3214. Thus the brightened main time base and the delayed time base can be displayed simultaneously over the total screen width. It is therefore possible at all times, to see clearly which part of the pulse pattern is shown magnified (figs. 5, 6 and 7).

With view to providing those features that will ease the users problems, many other design aspects have been incorporated. Weight and size are of prime importance and the use of monolithic ICs, miniaturized components, direct conversion power supplies, as well as cold switching, has made a significant contribution in this direction. Magnesium alloy chassis, too have further reduced overall weight.

A study of the facilities and features of the total Philips oscilloscope programme reviewed in the section will quickly confirm the claim: that when you buy Philips you buy the best of experience, quality, reliability and service, on a total, worldwide scale.

Fig. 5. The main time base is brightened through the delayed time base.

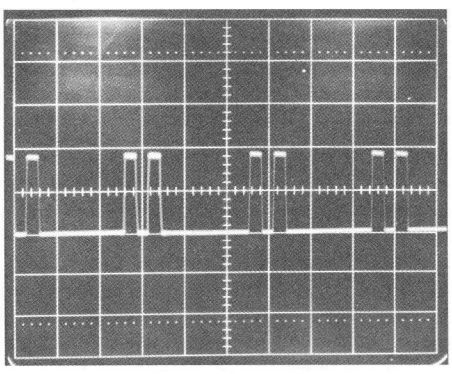


Fig. 6. Here the delayed time base is shown on its own.

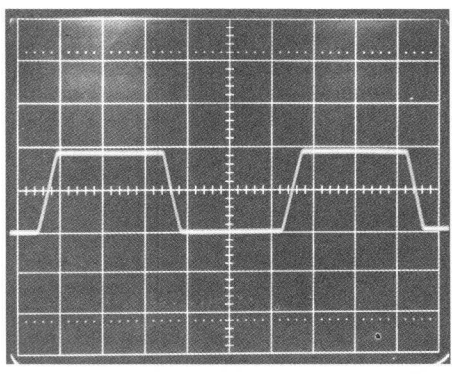
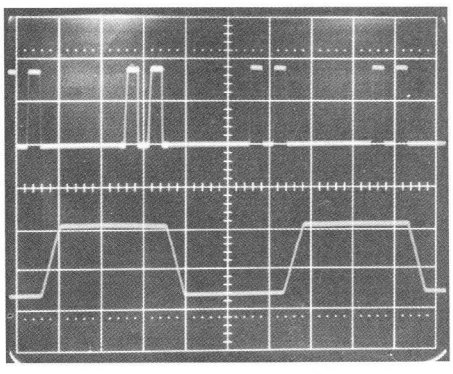


Fig. 7. In the alternate time base operating mode the main and delayed time bases are displayed simultaneously over the complete width of the screen.



100MHz dual-trace universal oscilloscope PM 3262

100MHz/5mV (2mV at 35MHz)

Third channel for simultaneous viewing of trigger pulses

Alternate time base display facility

New CRT gives bright display, high writing speeds

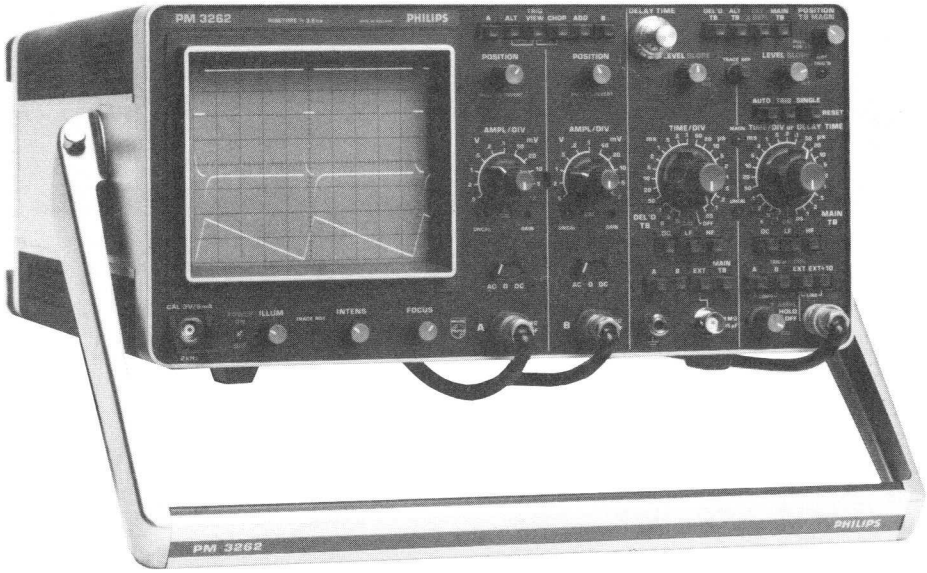
Composite trigger capability

Out of calibration warning lamps

Compact lightweight package

The PM 3262 will meet practically every measurement problem likely to be encountered in todays advanced or everyday electronics environments alike, be they sophisticated R & D labs, computer, telecommunications or general service workshops. Its 100MHz/5mV characteristics (35MHz at 2mV) are more than adequate for use with Schottky TTL and similar logic techniques whilst its 150MHz trigger bandwidth allows the display of high-speed, current-mode logic signals. Its very attractive features include:

- **Trigger view** which allows the active trigger point to be observed on a third channel.
- **Alternate time base switching** allows simultaneous display of complete signal and magnified detail over the whole screen width.
- **Composite triggering** which facilitates display of non-time-related signals, without being affected by the vertical position controls.
- **Acceptance of most trigger inputs** due to the wide, 50mV...24V dynamic range which may be overloaded up to 400V in combination with a bandwidth of over 150MHz.
- **External Z-modulation facility** allows the instrument to cope easily with specifications adapted to TTL voltage levels (e.g. from logic analysers).
- **'Out of calibration' warning** indicated by front panel lamps.
- **New, improved-design Philips CRT** further uplifts all the improved facilities with its extra sharp focus, giving a clear, bright trace coupled with its very high writing speeds.



TECHNICAL SPECIFICATION

CRT

Type
Philips rectangular domed mesh type tube with 17kV acceleration potential and metal backed phosphor

Screen type
P31 (GH) phosphor standard
P 7 (GM) phosphor optional

Useful screen area
8×10 div of full centimeters

Graticule
Internal graticule with centimeter divisions and 2mm subdivisions along the central axes. 10% and 90% lines are indicated. Illumination continuously variable

VERTICAL OR Y-AXIS

Response
DC: 0Hz...100MHz (35MHz at 2mV)
AC: 7Hz...100MHz

Risetime
3.5ns

Deflection coefficients
2mV...5V/div
in steps in 1-2-5 sequence. Uncalibrated continuous control between steps 1 : > 2.5

Accuracy
±3%

Display modes
- Channel A only
- Channel B only
- Alternate
- Chopped at approx. 1MHz
- Channels A and B added
- Trigger view
- Trigger view with channels A and B alternate
- Trigger view with channels A and B chopped

Channels A and B can be inverted

CMRR
> 100:1 up to 2MHz
> 20:1 at 50MHz

Input impedance
1MΩ//15pF
RC time, AC coupled: 22ms

Maximum input voltage
$400V_{DC+ACpk}$ derating above 500kHz

Maximum deflection
Undistorted deflection of 24div
Shift range 16div

Signal delay
15ns visible delay

Trigger view

Display	: External or internal trigger signal
External	: 100mV/div
External ÷ 10	: 1V/div
Trigger point	: Screen centre ±0.3div

Time delay between vertical input and external input: 3ns

HORIZONTAL OR X-AXIS

Horizontal deflection can be obtained from either the main timebase or the delayed timebase or a combination of the two, or from the signal source

selected for X-deflection. In this case X-Y diagrams can be displayed using Y_A, Y_B, the Ext connector or the Line as a signal source

Horizontal display modes
- Main timebase
- Main timebase intensified by delayed timebase
- Delayed timebase
- Main timebase and delayed timebase simultaneously displayed (alternate)
- X-Y or X-Y/Y operation with X-deflection by Y_A, Y_B, Line or Ext source

HORIZONTAL AMPLIFIER

Response
DC...2MHz (−3dB)

Deflection coefficient
50mV/div using Ext connector and 500mV/div via Ext ÷10 switch
Uncalibrated continuous control 1 : >3. When Y_A or Y_B are used, sensitivities are 2 mV...5V/div

Measuring accuracy
±3%

Phase error
3° at 100kHz

MAIN TIME BASE

Modes
- Auto (RC time 100ms)
- Triggered
- Single shot

Time coefficients
1s...50ns/div in 23 calibrated steps, in 1-2-5 sequence. Uncalibrated continuous control between steps, (with UNCAL warning lamp should main timebase slip out of calibration). ×10 magnifier extends max. sweep rate to 5ns/div

Accuracy
±2% (+20°C...+30°C)
±3% (+ 5°C...+40°C)
Additional error for ×10 magnifier ±1%

Variable hold-off
Sweep hold-off time can be increased by a factor of 10

DELAYED TIME BASE

Modes
Delayed timebase starts, either immediately after the delay time or, upon arrival of the first trigger pulse after the delay time

Time coefficients
0.5s...50ns/div in 22 calibrated steps, 1-2-5 sequence. Uncalibrated continuous control between steps (with UNCAL warning lamp should delayed timebase slip out of calibration). ×10 magnifier extends max. sweep rate to 5ns/div

Accuracy
±2% (+20°C...+30°C)
±3% (+5°C...+40°C)
Additional error for X10 magnifier ±1%.

Calibrated sweep delay
Continuous calibrated control between 0 and 10× main timebase setting

Incremental delay time accuracy
0.2% typical

Delay time jitter
Better than 1 : 30000

MAIN TIME BASE TRIGGERING

Trigger source
Internal Y_A, Y_B, Composite, Line, External, External ÷10

Slope
+ or −

Level range
Int: 24div
Ext: +1.2V...−1.2V
Ext ÷10: +12V...−12V

Trigger sensitivity

	30MHz	100MHz	150MHz
Int	0.5div	1.5div	2div
Ext	50mV	150mV	200mV
Ext ÷10	500mV	1.5V	2V

Trigger coupling
DC : DC...full bandwidth
HF : 30kHz...full bandwidth
LF : internal 0...30kHz
external 7Hz...30kHz

Ext. trigger input impedance
1MΩ ±2% in parallel with 15pF approx

Maximum allowable input voltage
$400V_{DC+ACpk}$

Trigger jitter
Better than 0.5ns

DELAYED TIMEBASE TRIGGERING

Trigger source
Internal : Y_A or Y_B
External : Other characteristics are identical to TRIGGERING OF THE MAIN TIMEBASE

CALIBRATION

Calibrated voltage
$3V_{p-p}$ ±1% square wave

Calibrated current
$6mA_{p-p}$ ±2% square wave

Z-MODULATION

Input
DC-coupled, TTL compatible 'High' Level blanks display

Input impedance
10kΩ

Maximum input voltage
50V

Response time
35ns

POWER

Line voltages : AC 100...127V
AC 220...240V
DC 250...350V
Line frequency : 46...440Hz
Power consumption : 50W

DIMENSIONS AND WEIGHT
(w×h×d) 316×154×410mm
(12.4×6.1×16.1-in)
9.6kg (21lb)

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organization in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use: ±5°C to +40°C
Limits for operation: −10°C to +55°C
Storage and transport: −55°C to +75°C

Altitude
Operating: to 5000m (15000ft)
Non-operating: to 15000m (45000ft)

Humidity
21 days cyclic damp heat 25°C–40°C R.H. 95%

Shock
30g: half sine wave shock of 11ms duration:
2 shocks per direction for a total of 12-shocks.

Vibration
Vibrations in three directions with a maximum of 15 min per direction
5–55Hz and amplitude of $0.7mm_{p-p}$ and 4g max acceleration
Unit mounted on vibration table without shock absorbing material

Recovery time
Operates within 30 minutes coming from −10°C soak, going into 60% relative humidity at +20°C room conditions

Electromagnetic interference
Meets VDE, 0871 and VDE 0875
Grenzwertklasse B

Safety
Safety class I according to IEC 348

ACCESSORIES SUPPLIED

Front cover with storage space
Operating and service manual
BNC-Banana adapter
Contrast filter
2×10:1 attenuator probe
Collapsible viewing hood
Cal terminal – BNC adapter

OPTIONAL ACCESSORIES

PM 8921	Passive probe 1:1 (1.5m)
PM 8921 L	Passive probe 1:1 (2.5m)
PM 8935	Passive probe 10:1; 11pF (1.5m)
PM 8935 L	Passive probe 10:1; 14pF (2.5m)
PM 8932	Passive probe 100:1; max. voltage 5600V; 2pF (1.5m)
PM 8940	High voltage isolation amplifier for floating measurements at $650V_{RMS}$
PM 8943	FET probe 650MHz, 1:1/10:1/100:1
PM 8960	19-in rackmount adapter
PM 9355/01	Current probe 12Hz...70MHz
PM 9381	Oscilloscope camera
PM 8976	Camera adapter for stationary use
PM 9366	Collapsible viewing hood
PM 8980	Long type viewing hood
PM 8994	Set of accessories for probes
PM 8991	Oscilloscope trolley
PM 8901	Battery pack for 3 hours continuous operation
PM 8910	Polaroid anti-glare filter
PM 8992	Accessory pouch

100MHz transfer storage oscilloscope PM 3266

100MHz/5mV

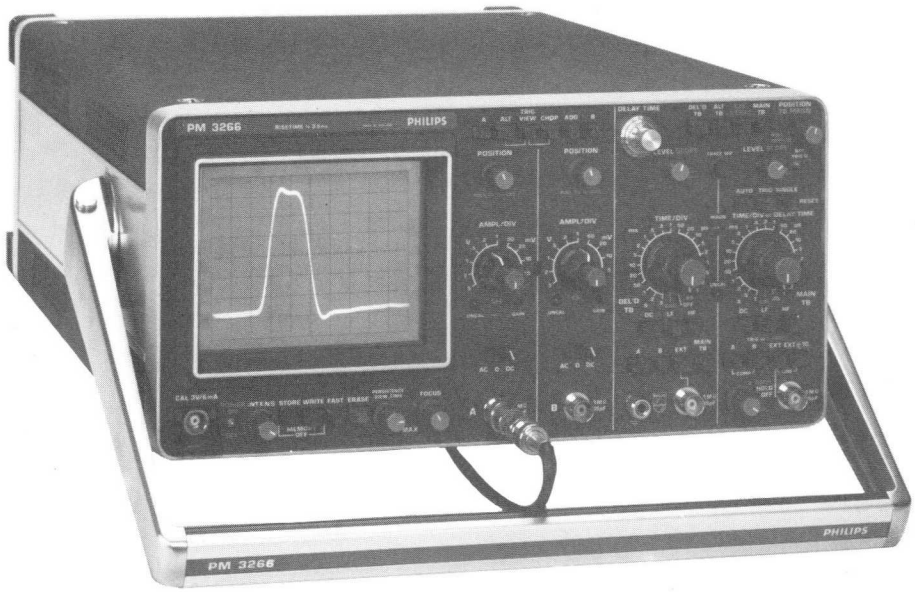
1000div/μs writting speed over full screen

Auto erase with variable viewing times

Storage times up to 1h

Alternate time base display

Trigger view useable as a third channel



The PM 3266 will capture repetitive or single high-speed events and store them for viewing, for up to 1 hour. Storage time is continuously variable from 15 seconds minimum. The two different storage modes include a **fast** mode utilizing a writing speed of 1000div/μs, and a **write** mode with a 0.25div/μs writing speed. A **max. write** position is included in the write mode circuit having à 2.5 div/μs writing speed.
In fast mode for repetitive signals, an auto erase facility refreshes the signal being observed allowing variable viewing times between 3 and 8 seconds.
Typical applications include observation, using the single shot mode of, e.g., various phenomena in discharge tubes, relays, etc. Also, in digital systems the PM 3266 will capture glitches which occur randomly as interference signals. Measurement accuracy has been increased to a high order by the extremely sensitive storage system combined with full screen display. Moreover operation of the various facilities have been made very easy. Controls are reduced to one variable control plus a single pushbutton for each function (i.e. four pushbuttons only).

Other facilities include alternate time base display plus composite triggering capability to allow the display of non time-related signals; the wide band trigger circuit operates well beyond the 100MHz vertical bandwidth.

The trigger view system can also be used as a third display channel and vertical sensitivity ranges from 2mV (up to 35MHz) through 5mV to 5V (at 100MHz).

TECHNICAL SPECIFICATION

CRT

Type
Philips high speed image transfer storage tube with scan magnification in vertical direction.
Rectangular tube face, post accelerator and metal-backed phosphor.

Screen
P31 (GH) phosphor

Acc. voltage
10kV

Useful screen area
8 × 10div, each div equals 0.9cm.

Graticule
Internal with subdivisions along central axes. 10% and 90% lines are indicated.

Writing speed
Fast: 1000div/μs
Max. write: 2.5div/μs
Write: 0.25div/μs
(measured after erasure)

Storage time
Up to 1 hour, in store mode depending on intensity setting.
At max. intensity: fast: 15sec
max. write: 15sec
write: 60sec

Auto erase
In Fast mode.
View time continuously variable between 3 and 8sec

Persistence
In Write mode, continuously variable between 0.3 and 60sec

Erasure time
1.3s in Write mode
1.6s in Fast mode

VERTICAL OR Y-AXIS

Response
DC: 0Hz...100MHz (35MHz at 2mV)
AC: 7Hz...100MHz

Risetime
3.5ns

Deflection coefficients
2mV...5V/div. in steps in 1-2-5 sequence. Uncalibrated continuous control between steps 1: > 2.5.

Accuracy
± 3%

Display modes
Channel A only
Channel B only
Alternate
Chopped at approx. 1MHz
Channels A and B added
Trigger view
Trigger view with channels A and B alternate
Trigger view with channels A and B chopped

Channels A and B can be inverted

CMRR
> 100:1 up to 2MHz
> 20:1 at 50MHz

Input impedance
1MΩ ±2% in parallel with 15pF approx.
RC time, AC coupled: 22ms

Maximum input voltage
400 $V_{DC+AC\ pk}$, derating above 500kHz

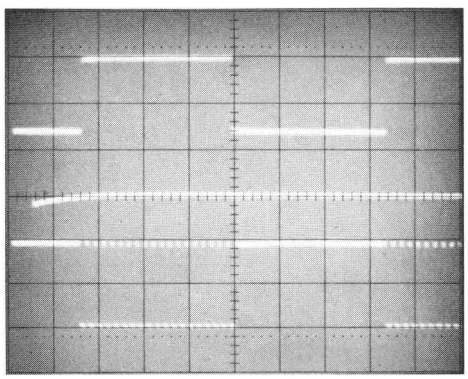
Maximum deflection
Undistorted deflection of 24div up to 35MHz
Shift range 16div

Signal delay
15ns visible delay

Trigger view
Display: External or internal trigger signal
External: 100mV/div
External ÷ 10: 1V/div
Trigger point: Screen centre ±0.3div
Time delay between vertical input and external input: 3ns.

HORIZONTAL OR X-AXIS

Horizontal deflection can be obtained from either the main timebase or the delayed timebase or a combination of the two, or from the signal source selected for X-deflection. In this case X-Y diagrams can be displayed using Y_A, Y_B, the Ext connector or the Line as a signal source.



Oscillogram demonstrates trigger view facility. The external trigger signal is displayed simultaneously with channel A and channel B.

Horizontal display modes
Main timebase
Main timebase intensified by delayed timebase
Delayed timebase
Main timebase and delayed timebase simultaneously displayed (alternate)
X–Y of X–Y//Y operation with X-deflection by Y_A, Y_B, Line or Ext source.

HORIZONTAL AMPLIFIER

Response
DC ≥2MHz (−3dB)

Deflection coefficient
50mV/div using Ext connector and 500mV/div in Ext ÷ 10 switch position. Uncalibrated continuous control 1: > 3. When Y_A or Y_B are used, sensitivities are 2mV...5V/div

Measuring accuracy
±3%

Phase error
3° at 100kHz

MAIN TIME BASE

Modes
Auto, RC time 100ms
Triggered
Single shot

Time coefficients
1s...50ns/div in 23 calibrated steps, in 1-2-5 sequence. Uncalibrated continuous control between steps, (with UNCAL warning lamp should main timebase be set out of calibration). ×10 magnifier extends max. sweep rate to 5ns/div

Accuracy
±2% (+20°C...+30°C)
±3% (+ 5°C...+40°C)
Additional error for magnifier ±1%.

Variable hold-off
Sweep hold-off time can be increased by a factor of 10.

DELAYED TIME BASE

Modes
Delayed timebase starts, either immediately after the delay time or, upon arrival of the first trigger pulse after the delay time.

Time coefficients
0.5s...50ns/div in 22-calibrated steps, 1-2-5 sequence. Uncalibrated continuous control between steps (with UNCAL warning lamp should delayed timebase be set out of calibration). ×10 magnifier extends max. sweep rate to 5ns/div

Accuracy
±2% (+20°C...+30°C)
±3% (+ 5°C...+40°C)
Additional error for magnifier ±1%

Calibrated sweep delay
Continuous calibrated control between 0 and 10× main timebase setting.

Incremental delay time accuracy
0.2% typical

Delay time jitter
Better than 1:30000

MAIN TIME BASE TRIGGERING

Trigger source
Internal Y_A, Y_B, Composite, Line, External, External ÷ 10

Slope
+ or −

Level range
Internal: 24div
External: +1.2V to −1.2V
External ÷ 10: +12V to −12V

Trigger sensitivity

	30MHz	100MHz	150MHz
Int	0.5div	1.5div	2div
Ext	50mV	150mV	200mV
Ext ÷ 10	500mV	1.5V	2V

Trigger coupling
DC: DC...full bandwidth
HF: 30kHz...full bandwidth
LF: internal 0...30kHz
external 7Hz...30kHz

Ext. trigger input impedance
1MΩ ±2% in parallel with 15pF approx.

Maximum allowable input
$400V_{DC+ACpk}$

Trigger jitter
Better than 0.5ns

DELAYED TIMEBASE TRIGGERING

Trigger source
Internal: Y_A or Y_B
External
Other characteristics are identical to TRIGGERING OF THE MAIN TIMEBASE

CALIBRATION

Calibrated voltage
$3V_{p-p}$ ±1% square wave

Calibrated current
$6mA_{p-p}$ ±2% square wave

Z-MODULATION

Input
DC-coupled, TTL compatible, 'HIGH' level blanks the display

Input impedance
10KΩ

Maximum input voltage
50V

Response time
35ns

POWER

Line voltages : AC 100...127V
AC 220...240V
DC 250...350V
Line frequency : 46...440Hz
Power consumption: 50W

DIMENSIONS AND WEIGHT

(w × h × d) 316 × 154 × 460mm
(12.4 × 6.1 × 18-in)
10.9kg (23.8lb)

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organization in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use: +5°C to +40°C
Limits for operation: −10°C to +55°C
Storage and transport: −55°C to +75°C

Altitude
Operating: to 5000m (15000ft)
Non-operating: to 15000m (45000ft)

Humidity
21 days cyclic damp heat 25°C–40°C R.H. 95%

Shock
Operating: 30g, half sine, 11ms duration, 2 shocks per axis per direction for a total of 12 shocks

Vibration
Vibrations in three directions with a maximum of 15 min per direction
5–55Hz and amplitude of $0.7mm_{p-p}$ and 4g max acceleration
Unit mounted on vibration table without shock absorbing material.

Recovery time
Operates within 30min coming from −10°C soak, going into room condition of 60% RH at 20°C

Electromagnetic interference
Meets VDE, 0871 and VDE 0875
Grenzwertklasse B

Safety
Safety class 1 according to IEC 348

ACCESSORIES SUPPLIED

Front cover with storage space
Operating and service manual
BNC-Banana adapter
Contrast filter
2 × 10:1 attenuator probe
Collapsible viewing hood
Cal terminal – BNC adapter

OPTIONAL ACCESSORIES

PM 8921	Passive probe 1:1 (1.5m)
PM 8921L	Passive probe 1:1 (2.5m)
PM 8935	Passive probe 10:1; 11pF (1.5m)
PM 8935L	Passive probe 10:1; 14pF (2.5m)
PM 8932	Passive probe 100:1; max. voltage 5600V; 2pF (1.5m)
PM 8940	High voltage isolation amplifier for floating measurements at $650V_{RMS}$
PM 8943	FET probe 650MHz, 1:1/10:1/100:1
PM 8960	19-in rackmount adapter
PM 9355	Current probe 12Hz...70MHz
PM 9381	Oscilloscope camera
PM 8976	Camera adapter for stationary use
PM 9366	Collapsible viewing hood
PM 8980	Long type viewing hood
PM 8994	Set of accessories for probes
PM 8991	Oscilloscope trolley
PM 8901	Battery pack for 1.5 hours continuous operation
PM 8910	Polaroid anti-glare filter

150MHz/5 mV

Built- in 100MHz analog multiplier (PM 3265 only)

Simultaneous display of main and delayed time bases

20kV pda tube gives bright 8×10cm display

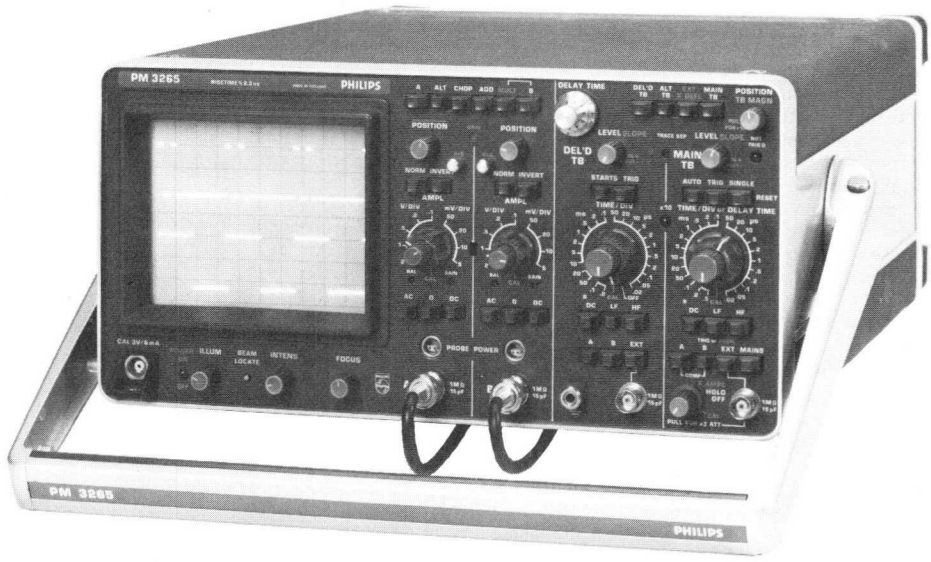
Built-in supply for active probes (PM 3265 only)

Automatic adaptation to all input voltage/frequency combinations, including DC

150MHz multiplier oscilloscope PM 3265 and economy version PM 3265E

The PM 3265 features a unique built-in analog 100MHz multiplier which opens up new measurement possibilities, e.g. dynamic power measurement on fast components and circuits.

The PM 3265E is an excellent 150MHz multipurpose instrument, designed to meet most laboratory applications that do not require a multiplying facility or an integral probe power supply. It is in all other respects, identical with the PM 3265, including the very useful alternative timebase facility.



Multiplier (PM 3265 only)

The four quadrant multiplier used allows a sign-correct multiplication of positive and/or negative signals and to display them in the correct way. It is based on a single monolithic chip. As the transistors and diodes used in the chip feature a bandwidth of more than 2GHz, multiplication is possible above 100MHz. The multiplier also has excellent stability and linearity. It is pushbutton operated. Besides the result of the multiplication, also one of the multiplicands (the signal of channel B) can be displayed. Thus the result of the multiplication is more easily understood.

Flexible triggering

The very high trigger sensitivity and bandwidth allows problem-free triggering of the oscilloscope well over 200MHz. Measurements on very fast circuits, such as ECL, can thus be performed without problems. Triggering is possible from each vertical channel separately or from both together. Mains and external triggering is also possible. Both time bases can be triggered independently of each other.

Switching of the horizontal sweep

In contrast to the 'mixed' time base featured on most portable oscilloscopes, the horizontal sweep can be switched to alternate on the PM 3265 and PM 3265E. Thus the brightened main time base and the delayed time base can be displayed simultaneously over the total screen width. It is therefore possible at all times, to see clearly which part of the pulse pattern is shown magnified.

Y output

The Y signals are also offered at the rear of the instrument. The output voltage is calibrated and is 50 or 100mV per screen division.
The result of a multiplication A × B is also available at the Y output. When integrating this output voltage by means of an integrator, it is possible to perform e.g. HF power measurements from the microwatt to the kilowatt range. Also available on the back panel of the PM 3265 are the sawtooth of the main time base and the gate pulse of the delayed time base. A TTL compatible Z-modulation is also possible.

TECHNICAL SPECIFICATIONS

CRT

Type
Philips rectangular domed mesh type tube, with 20kV acceleration potential and metal backed phosphor.

Screen type
P 31 (GH) phosphor standard
P 7 (GM) phosphor optional

Useful screen area
8 × 10 div. of full centimeters

Graticule
Internal graticule with centimeter divisions and 2 mm subdivisions along the central axes. 10% and 90% lines are indicated. Illumination continuously variable.

VERTICAL OR Y-AXIS

Response
DC: 0Hz...150MHz (−3dB)
AC: 10Hz...150MHz (−3dB)

Risetime: 2.3ns

Display modes
A only, normal and inverted
B only, normal and inverted
Chopped at 1MHz approx.
Alternate
Added (both channels normal and inverted)
Multiply (A × B)
A × B and B chopped or alternate depending on TB setting

Signal delay
16ns

Drift
20μV/°C typically

Y output
BNC socket at the rear of the instrument,
DC coupled:
Output voltage: 50mV/div into 50Ω
100mV/div into 10kΩ
Bandwidth: 150MHz (100MHz in A × B mode)

MULTIPLIER
(PM 3265 only)

Bandwidth
0...100MHz (−3dB)

Risetime
≈ 3.5ns

Multiplication factor
1 ± 0.02
The product of signal A with A cm and signal B with B cm is displayed with A × B cm ± 2%

Dynamic range
Signal A: 8cm
(± 4cm from centre of screen)
Signal B: 8cm
(± 4cm from centre of screen)
Product A × B: 8cm
(± 4cm from centre of screen)

Signal delay
6ns between product and signal B

Product offset
< 0.3cm at 23°C

Display modes
± A × ± B
± A × ± B chopped or alternated with signal depending on TB setting

HORIZONTAL OR X-AXIS

Horizontal deflection can be obtained from either one of the Main time base or the delayed time base or a combination of the two, or from the signal source selected for X-deflection. In this case X-Y diagrams can be displayed using Y_A, Y_B, the Ext. connector or the line as a signal source.

Display modes
Main time base
Intensified
Delayed time base
Main TB and delayed TB alternated
External X deflection

HORIZONTAL AMPLIFIER

Bandwidth
DC...3MHz (−3dB) over 8div.

Deflection coefficient
300mV/div. using Ext. connector
900mV/div. in Ext. ÷ 3 mode
Uncalibrated continuous control 1: > 3
Vertical attenuator coefficients apply when Y_A or Y_B is used for X-deflection

MAIN TIME BASE

Modes
Auto-Triggered-Single shot

Time coefficients
0.5s/div...20s/div., 1-2-5 sequence
Uncalibrated continuous control between steps.
× 10 magnifier extends max. sweep rate to 2ns/div.

Accuracy
± 2% + 20°C to + 30°C
± 3% + 5°C to + 40°C
Additional error for magnifier + 1%

Variable hold off
Sweep hold off time can be increased by at least a factor of 10

TB output
Sawtooth: 0... + 5V
Output impedance: 5kΩ
Short circuit proof

DELAYED TIME BASE

Time coefficients
0.2s/div...20ns/div. in 22 calibrated steps; 1-2-5 sequence
Uncalibrated continuous control between steps
× 10 magnifier extends max. sweep rate to 2ns/div.

Calibrated sweep delay
Continuous calibrated control between 0 and 10 × main time base setting

Delay time jitter
Better than 1 : 20000, typical 1 : 50000 to 1 : 100000

Delayed Gate Output
+ 6V...0V negative pulse
Signal delivered during intensified and delayed time base modes

Delay time accuracy
± 2%

MAIN TIME BASE TRIGGERING

Trigger source
Internal: Y_A, Y_B, Composite, Line, External,
External ÷ 3

Slope
+ or −

Trigger sensitivity
Internal: 0.5cm up to 100MHz typically, 1cm at 100MHz...150MHz
External: 150mV up to 150MHz

Coupling
DC: DC... > 200MHz
LF: DC...30kHz
HF: 30kHz... > 200MHz

Level range
Internal: 24div. typical
External: −3.6V to + 3.6V typical,
Ext. ÷ 3: −11V to + 11V typical

DELAYED TIME BASE TRIGGERING

Trigger source
Internal: Y_A, Y_B, External
Other trigger specifications of delayed time bases are identical to those of the main time base

CALIBRATION

Calibrated voltage: $3V_{p-p}$ ± 1% square wave
Calibrated current: $6mA_{p-p}$ ± 1%
Frequency: 2kHz ± 2%

Z-MODULATION

Input
DC coupled

Max. input voltage
$400V_{DC+ACpk}$

Bandwidth
10MHz

Input impedance
1MΩ // 15pF

Polarity
A positive voltage intensifies display

TTL compatible
+ 5V = max. intensity
0V = normal intensity
− 5V = min. intensity

POWER

Accepts any voltage between 100 and 240V ± 10%, and any frequency between 46 and 440Hz in one range, without switching
Accepts DC > 110V
Power consumption 55W

Probe power
Two sockets at vertical amplifiers providing + 24 and − 24V for active probes

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use + 5°C... + 40°C
Limits for operation − 10°C... + 55°C
Storage and transport − 40°C... + 70°C

Altitude
Operating: to 5000m (15000ft)
Non operating: to 15000m (45000ft)

Humidity
21 days cyclic damp heat 25°C-40°C, R.H. 95%

Bump
1000 bumps of 10g, ½ sine 6ms duration, in each of 3 directions

Vibration
30 minutes in each of three directions, 10-150Hz; $0.7mm_{p-p}$ and 5g max acceleration.
Unit mounted on vibration table with shock absorbing material

Recovery time
Operates within 30 minutes coming from − 10°C soak, going into 60% relative humidity at + 20°C room conditions.

Electromagnetic interference
Meets VDE, 0871 and VDE 0875
Grenzwertklasse B

Safety
Safety class 1 according to IEC 348

DIMENSIONS AND WEIGHT

(w × h × d) 316 × 154 × 410mm
(12.4 × 6.1 × 16.1-in)
9kg (20lb)

ACCESSORIES SUPPLIED

Front cover with storage space
Operating and service manual
BNC-Banana adapter
Contrast filter
2 × 10 : 1 attenuator probe
Collapsible viewing hood
Cal terminal – BNC adapter

OPTIONAL ACCESSORIES

PM 8921	Passive probe 1 : 1 (1.5m)
PM 8921 L	Passive probe 1 : 1 (2.5m)
PM 8935	Passive probe 10 : 1; 11pF (1.5m)
PM 8935 L	Passive probe 10 : 1; 14pF (2.5m)
PM 8932	Passive probe 100 : 1; max. voltage 4000V; 2pF (1.5m)
PM 8940	High voltage isolation amplifier for floating measurements at $650V_{RMS}$
PM 8943	FET probe 650MHz, 1 : 1/10 : 1/100 : 1
PM 8960	19 inch rackmount adapter
PM 9355/01	Current probe 12Hz...70MHz
PM 9381	Oscilloscope camera
PM 8976	Camera adapter for stationary use
PM 9366	Collapsible viewing hood
PM 8980	Long type viewing hood
PM 8994	Set of accessories for probes
PM 8991	Oscilloscope trolley
PM 8901	Battery pack for 3 hours continuous operation
PM 8910	Polaroid anti-glare filter
PM 8992	Accessory pouch

100MHz oscilloscope with microprocessor controlled timing PM 3263

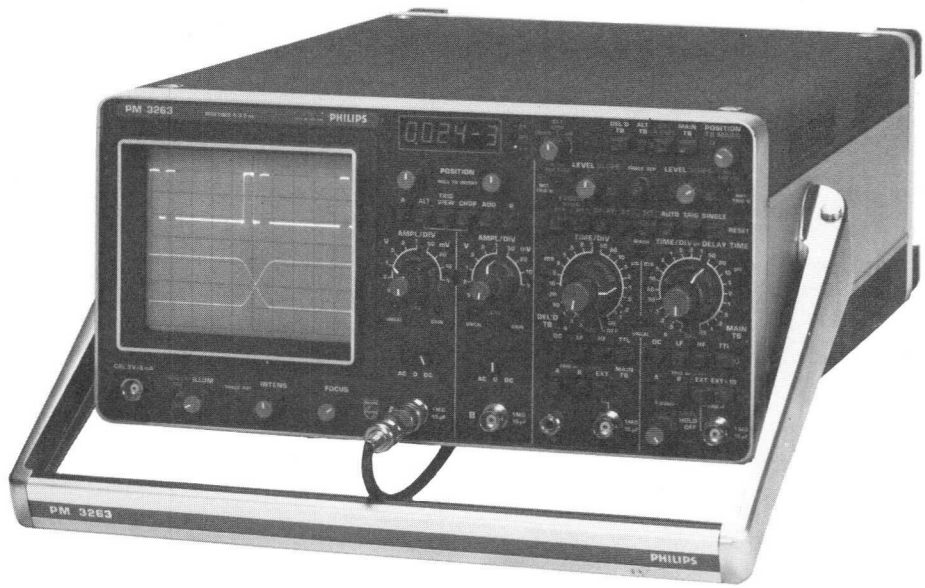
100MHz/5mV

Dual delay for time interval measurement

Delay by events

6-digit integral LED display

Alternate time base



The PM 3263 provides an easy solution for complex measurements in sophisticated R&D environments, or field situations where its compactness and portability are particularly beneficial.

The built-in microprocessor adds an extra dimension to everyday oscilloscope performance, being capable of undertaking fast mathematical calculations and which, with a precise control capability, introduces new and valuable features.

Prominent in these are the various time interval measuring facilities which include:

Dual delay which permits the precise measurement of the time interval between two signals on a single trace, or between two events on different traces, using the 'alternate' display mode. This facility also allows

Frequency measurement using markers located on the trace from which the microprocessor calculates the reciprocal value of the time interval to produce the frequency of the signal (1/T mode) which is shown on the LED display. In addition there is the facility of

Delay by events where any event in a series can be selected, using the integral 6-digit LED display, to start the delayed sweep. This facility can be introduced before either the delayed time base or the main time base. In addition, the delay-by-events feature, operated before the main time base, can also be combined with time interval or frequency measurements.

The LED display panel is also used as a warning device to advise the operator of situations involving out of calibration conditions or incorrect operating control settings and the words ERROR or UNCAL are indicated, as appropriate.

The integral microprocessor, as well as providing improved operational features by controlling timing functions, storing successive measurements in the combined delay-by-events mode, etc. performs other unique functions. These include the formatting of UNCAL/ERROR displays and an automatic, self-test routine for the microprocessor and LED display. Its use also allows very compact mechanical design and permits operator controls to be simplified.

TECHNICAL SPECIFICATION

CRT

Type
Philips rectangular domed mesh type tube with 17kV acceleration potential and metal backed phosphor

Screen type
P31 (GH) phosphor standard
P 7 (GM) or P11 (BE) phosphor optional

Useful screen area
8 × 10div of full centimeters

Graticule
Internal graticule with centimeter divisions and 2mm subdivisions along the central axes. 10% and 90% lines are indicated. Illumination continuously variable

VERTICAL OR Y-AXIS

Response
DC: 0Hz...100MHz (35MHz at 2mV)
AC: 7Hz...100MHz

Risetime
3.5ns

Deflection coefficients
2mV...5V/div in steps in 1-2-5 sequence.
Uncalibrated continuous control between steps 1: > 2.5

Accuracy
±3%

Display modes
Channel A only
Channel B only
Alternate
Chopped at approx. 1MHz
Channels A and B added
Trigger view
Trigger view with channels A and B alternate
Trigger view with channels A and B chopped
Channels A and B can be inverted

CMRR
> 100:1 up to 2MHz
> 20:1 at 50MHz

Input impedance
1MΩ ±2% in parallel with 15pF approx.
RC time, AC coupled: 22ms

Maximum input voltage
$400V_{DC+ACpk}$, derating above 500kHz

Maximum deflection
Undistorted deflection of 24div up to 35MHz
Shift range 16div

Signal delay
15ns visible delay

Trigger view
Display: External or internal trigger signal
External: 100mV/div
External ÷: 1V/div
Trigger point: Screen centre ±0.3div
Time delay between vertical input and external input: 3ns

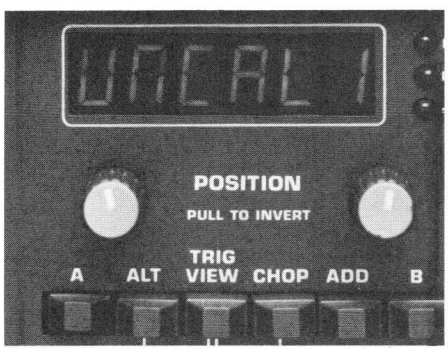
HORIZONTAL OR X-AXIS

Horizontal deflection can be obtained from either the main timebase or the delayed timebase or a combination of the two, or from the signal source selected for X-deflection. In this case X-Y diagrams can be displayed using Y_A, Y_B, the Ext connector or the Line as a signal source.

Horizontal display modes

Main timebase
Main timebase intensified by one or two delayed timebases
Delayed timebase(s)
Main timebase and delayed timebase(s) simultaneously displayed (alternate)
X–Y or X–Y//Y operation with X-deflection by Y_A, Y_B, Line or Ext source

Detail of front panel LED indicator showing UNCAL warning.



HORIZONTAL AMPLIFIER

Response
DC...2MHz (−3dB)

Deflection coefficient
50mV/div using Ext connector and 500mV/div in Ext ÷ 10 switch position. Uncalibrated continuous control 1: > 3. When Y_A or Y_B are used, sensitivities are 2mV...5V/div

Measuring accuracy
±3%

Phase error
3° at 100kHz

MAIN TIME BASE

Modes
Auto (RC time 100ms)
Triggered
Single shot

Time coefficients
1s...50ns/div in 23 calibrated steps, in 1-2-5 sequence. Uncalibrated continuous control between steps, (with UNCAL warning lamp should main timebase be set out of calibration). ×10 magnifier extends max. sweep rate to 5ns/div

Accuracy
±2% (+20°C...+30°C)
±3% (+ 5°C...+40°C)
Additional error for magnifier ±1%

Variable-hold-off
Sweep hold-off time can be increased by a factor of 10

DELAYED TIMEBASE

Time coefficients
0.5...50ns/div in 22 calibrated steps, 1-2-5 sequence. Uncalibrated continuous control between steps (with UNCAL warning lamp should delayed timebase be set out of calibration). ×10 magnifier extends max. sweep rate to 5ns/div

Accuracy
±2% (+20°C...+30°C)
+3% (+ 5°C...+40°C)
Additional error for magnifier ±1%

DELAY MODES

Delay
Time between start of MTB and start of DTB

ΔT
Time between start of two successive DTB's (in Y-ALT mode the second DTB on channel A and the first DTB on channel B is suppressed)

1/T
Reciprocal value of ΔT mode
Events before delayed timebase
Events before main timebase
6-digit LED display shows measured quantity in engineering notation. Non calibrated or faulty operation is indicated by UNCAL or ERROR display.

Delay, ΔT, 1/T
Variable between 0 and 10 × main timebase setting

Resolution
5.10^{-4} of 10 × main timebase setting

Jitter
1: 30.000

Accuracy

Delay	ΔT	1/T
±1% of range $-A\times10^{-3}$ of range + initial delay of 20ns	±1% of reading $-A\times10^{-3}$ of range $\pm0.25\times10^{-3}$ of range	±1% of reading $-A\times10^{-3}$ of range $\pm0.25\times10^{-3}$ of range

A depends on main timebase setting
A = 1.5 in settings starting at 5
A = 0.5 in settings starting at 1
A = 0 in settings starting at 2

Additional error in main timebase positions 50ns/div and 100ns/div resp. ±3% and ±1%
Minimum screen distance between measuring points in 1/T mode.
0.1div (magnifier × 1) or
1 div (magnifier ×10)

Events before DTB
LED-display shows number of events between triggering of main timebase and delayed timebase

Events before MTB
LED-display shows number of events between release of counter and triggering of the main timebase.
Events before MTB mode may be combined with delay, ΔT or 1/T modes.

Number of events
Continuously controllable between 0 and 99999

Display counter speed
Variable between 1 and 50pulses/s or between 100 and 5000pulses/s in steps of 100pulses

Pulse conditions
Max. rate: 125MHz
Min. pulse width: 4ns
Min. pulse space: 4ns

Set up time
10ns

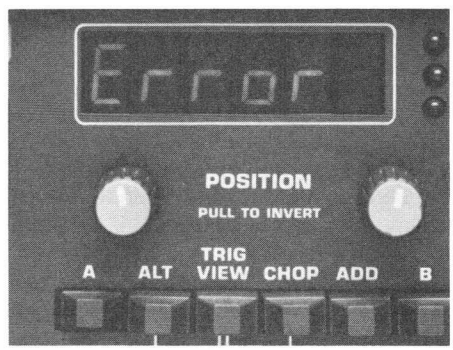
MAIN TIMEBASE TRIGGERING

Trigger source
Internal Y_A, Y_B, Composite, Line, External, External ÷ 10.

Slope
+ or −

Level range
Internal: 24div
External: +1.2V to −1.2V
External ÷ 10: +12V to −12V

In the event of uncorrect operator settings the LED panel displays the ERROR warning.



Trigger sensitivity

	30MHz	100MHz	150MHz
Int	0.5div	1.5div	2div
Ext	50mV	150mV	200mV
Ext÷10	500mV	1.5V	2V

Trigger coupling
DC: DC...full bandwidth
HF: 30kHz...full bandwidth
LF: internal 0...30kHz
external 7Hz...30kHz
TTL: INT: trigger window 1.2div
EXT: trigger window 1.2V (measured at the tip of 1:10 attenuator probe)

Ext Trigger input impedance
1MΩ ±2% in parallel with 15pF approx.

Maximum allowable input voltage
$400V_{DC+ACpk}$

Trigger jitter
Better than 0.5ns

DELAYED TIMEBASE TRIGGERING

Trigger source
Internal: Y_A or Y_B
External
Other characteristics are identical to TRIGGERING OF THE MAIN TIMEBASE

CALIBRATION

Calibrated voltage
$3V_{p-p}$ ±1% square wave

Calibrated current
$6mA_{p-p}$ ±2% square wave

Z-MODULATION

Input
DC-coupled, TTL compatible, 'HIGH' level blanks the display

Input impedance
10KΩ

Maximum input volt.
50V

Response time
35ns

MAIN TIMEBASE GATE

0 up to +5V

Output impedance
1KΩ

DELAYED TIMEBASE GATE

0 up to +5V

Output impedance
1KΩ

POWER

Line voltages : AC 100...127V
AC 220...240V
DC 250...350V
Line frequency : 46...440Hz
Power consumption : 60W

DIMENSIONS AND WEIGHT

(w×h×d) 316×154×460mm
(12.4×6.1×18-in)
10.7kg (23.5lb)

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organization in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use: +5°C to 40°C
Limits for operation: −10°C to +55°C
Storage and transport: −55°C to +75°C

Altitude
Operating: to 5000m (15000ft)
Non-operating: to 15000 (45000ft)

Humidity
21 days cyclic damp heat 25°C-40°C R.H. 95%

Shock
30g: half sine wave shock of 11ms duration: 2 shocks per direction for a total of 12 shocks.

Vibration
Vibrations in three directions with a maximum of 15min per direction; 5-55Hz and amplitude of $0.7mm_{p-p}$ and 4g max acceleration
Unit mounted on vibration table without shock absorbing material.

Recovery time
Operates within 30min, coming from −10°C soak, going into room condition of 60% RH at 20°C

Electromagnetic interference
Meets VDE, 0871 and VDE 0875
Grenzwertklasse B

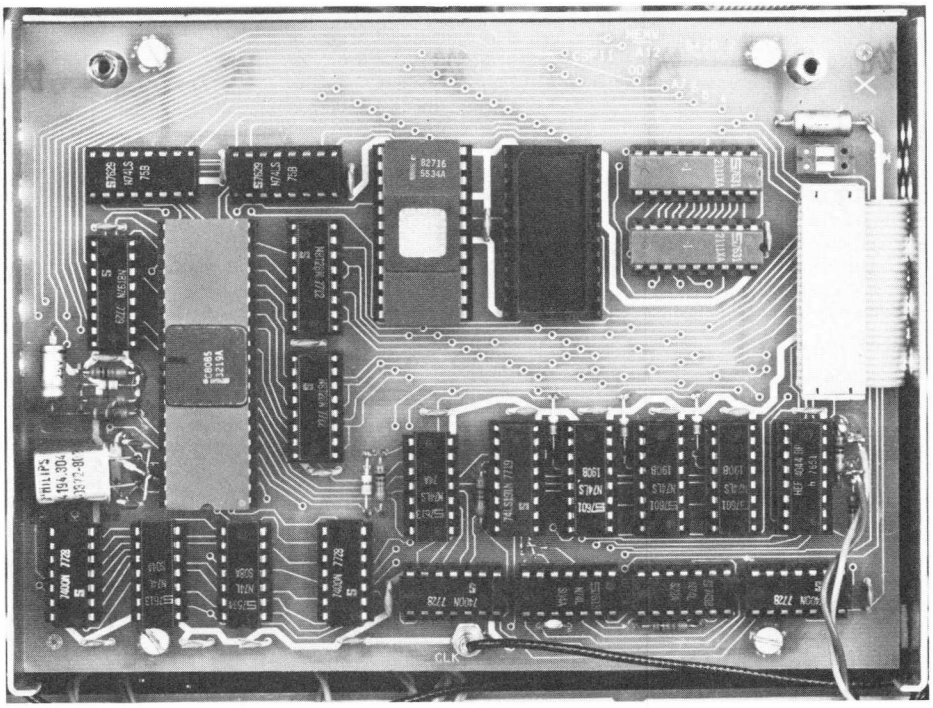
Safety
Safety class 1 according to IEC 348

ACCESSORIES SUPPLIED WITH THE INSTRUMENT

Front cover with storage space
Operating and service manual
BNC-Banana adapter
Contrast filter
2×10:1 attenuator probe
Collapsible viewing hood
Cal terminal – BNC adapter

OPTIONAL ACCESSOIRIES

PM 8921	Passive probe 1:1 (1.5m)
PM 8921L	Passive probe 1:1 (2.5m)
PM 8935	Passive probe 10:1; 11pF (1.5m)
PM 8935L	Passive probe 10:1; 14pF (2.5m)
PM 8932	Passive probe 100:1; max. voltage 4000V; 2pF (1.5m) .
PM 8940	High voltage isolation amplifier for floating mesurements at $650V_{RMS}$
PM 8943	FET probe 650MHz, 1:1/10:1/100:1
PM 8960	19 inch rackmount adapter adapter
PM 9355/01	Current probe 12Hz...70MHz
PM 9381	Oscilloscope camera
PM 8976	Camera adapter for stationary use
PM 9366	Collapsible viewing hood
PM 8980	Long type viewing hood
PM 8994	Set of accessories for probes
PM 8991	Oscilloscope trolley
PM 8901	Battery pack for 1.5 hours continuous operation
PM 8910	Polaroid anti-glare filter



View of the microprocessor chip with its associated circuit components.

Four-channel versatile portable oscilloscope PM 3244

50MHz/5mV

Four complete channels

Comprehensive triggering independently on each channel, plus composite

Display of differential inputs

Four channels with main and delayed timebases

Operates from almost any power source; runs for 5 hours on battery pack

X-Y measuring facilities

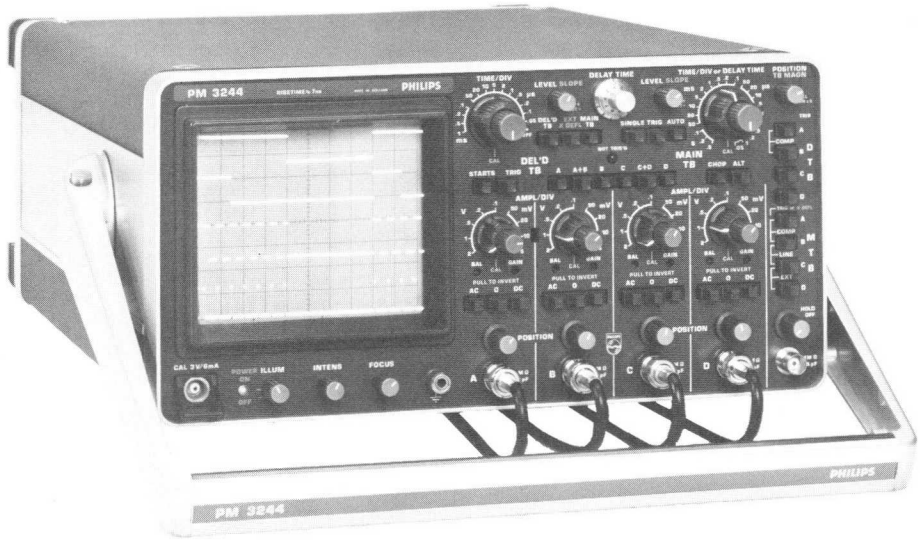
The PM 3244 represents a unique combination of four channels, compact size, true portability plus a new standard of price for performance.

Unequalled triggering

For sheer flexibility the triggering facilities are hard to beat. The PM 3244 offers the exclusive feature for any four-trace 'scope which

- accepts inputs from up to 7 different sources
- accepts up to 5 different sources for delayed time-base triggering
- offers selection of either of these facilities, independent from each other.

Because of its very low power consumption the PM 3244 is also unique in that it can be operated from batteries.



Why four channels?

There is a growing need for a portable 4-channel oscilloscope for the instantaneous observation of more than two timerelated events, for example,

- in memory systems
- in communication-lines
- for simultaneous checks on two twisted pairs of balanced lines
- examination of four parallel activities, etc.

Versatility is demonstrated by the capability of displaying channels A+B added, or C+D added or any modes A, B, C and D in any combination chopped or alternate.

TECHNICAL SPECIFICATION

CRT

Type
Philips rectangular meshtype tube with 10kV acceleration potential and metal backed phosphor.

Screen type
P31 (GH) phosphor standard
P7 (GM) phosphor optional.
Order number PM 3244G.

Useful screen area
8×10div of full centimeters.

Graticule
Internal graticule with centimeter divisions and 2mm subdivisions along the central axes. 10% and 90% lines are indicated. Illumination continuously variable.

VERTICAL OR Y-AXIS

Four identical vertical channels, each of which can be displayed individually, or in any combination up to four channels simultaneously, in alternate or chopped mode. Additionally the A+B and C+D signals can be displayed in any combination with the four channels. All channels can also be inverted.

Response
Freq. range DC:
0Hz...50MHz (−3dB)
Freq. range AC:
10Hz...50MHz (−3dB)

Risetime
7ns

Deflection coefficient
5mV/div...2V/div. in 1-2-5 sequence. Uncalibrated continuous control between steps 1: > 2.5

Accuracy
±3%

Display modes
Channel A only or
Channel B only or
Channel C only or
Channel D only or
Channels A+B added or
Channels C+D added
or any of these modes in any combination, chopped or alternate. Each channel can also be inverted. Chopping frequency approx. 1MHz.

CMRR in A-B and C-D modes
100:1 at 1MHz with 8div of common mode signal (after adjusting one vernier for optimum rejection of common mode).

Input impedance
1MΩ//15pF
RC time AC coupled 22ms
Coupling AC-0-DC

Maximum input voltage
$400V_{DC+ACpk}$

Maximum deflection
Undistorted deflection up to 24div for sinewave signals with frequencies of up to 15MHz.
Shift range 16div

Signal delay
⩾ 20ns

HORIZONTAL OR X-AXIS

Horizontal deflection can be obtained from either the main time base or the delayed time base, or a combination of the two, or from any of the signal sources selected for X-deflection. For X-Y displays Y_A, Y_B, Y_C or Y_D can be employed or the signal be applied to the external triggering input. The signal source for horizontal deflection can also be Line.

Horizontal display modes
Main time base
Main time base intensified by delayed time base
Delayed time base
Up to four trace X-Y displays using Y_A, Y_B, Y_C or Y_D for horizontal deflection or external or line.

HORIZONTAL AMPLIFIER

Response
DC...1MHz (−3dB)

Deflection coefficient
≤ 450mV/div using the Ext connector. Vertical deflection coefficients when Y_A, Y_B, Y_C or Y_D is used for horizontal deflection.

Measuring accuracy
±10% using Y_A, Y_B, Y_C or Y_D input.

Phase error
< 3° at 100kHz

MAIN TIME BASE

Time coefficients
0.5s/div...50ns/div in 1-2-5 sequence. Uncalibrated continuous control between steps 1: > 2.5

Accuracy
±3%

DELAYED TIME BASE

Modes
The delayed time base starts immediately after the selected delay or can be triggered after the delay time by any of the base-trigger sources.

Time coefficients
1ms/div...50ns/div in 1-2-5-sequence. Uncalibrated continuous control between steps 1: > 2.5

Accuracy
±3%

Time base magnifier
Magnification: ×5
Highest effective sweep speed: 10ns/div.
Additional tolerance: ±2%

MAIN TIME BASE TRIGGERING

Trigger source
Internal, Y_A, Y_B, Y_C, Y_D.
Composite, Line, External.

Slope
+ or −

Bandwidth
DC...50MHz

Modes
Auto: 10Hz...50MHz
Level: DC...50MHz
Single: DC...50MHz

Trigger sensitivity
Internal: 0.5div
External: 150mV

Level range
24div for internal sources.
From −5 to +5V for external sources.

Input impedance
1MΩ//15pF

Maximum input voltage
$400V_{(DC+ACpk)}$

DELAYED TIME BASE TRIGGERING

Trigger specifications are the same as those of the main time base with the following exception

Trigger source
Internal, Y_A, Y_B, Y_C, Y_D
Composite.

Sweep delay
In steps and continuously variable between 50ns and 5s after the start of the main time base sweep.

Incremental delay time accuracy
0.5%

Delay time jitter
1: > 20000

CALIBRATION

Calibrated voltage
$3V_{p-p}$ ±1% square wave

Calibrated current
$6mA_{p-p}$ ±1%

POWER

Line voltage and frequencies
$90V_{AC}...270V_{AC}$
46Hz...440Hz
(without switching)

DC Power source
$100V_{DC}...200V_{DC}$

Power consumption
29W at nominal line voltage

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are suplied on request by the PHILIPS organisation in your country or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use +5°C...+40°C
Limits for operation −10°C...+55°C
Storage and transport −40°C...+70°C

Altitude
Operating: to 5000m (15000ft)
Non-operating: to 15000 (45000ft)

Humidity
21 days cyclic damp heat 25°C-40°C, R.H. 95%.

Bump
1000 bumps of 10g, ½ sine, 6ms duration, in each of 3 directions.

Vibration
30 minutes in each of three directions, 10-150Hz; $0.7mm_{p-p}$ and 5g max acceleration.
Unit mounted on variation table with shock absorbing material.

Recovery time
Operates within 30 minutes coming from −10°C soak, going into 60% relative humidity at +20°C room conditions.

Electromagnetic interference
Meets VDE, 0871 and VDE 0875
Grenzwertklasse B

Safety
Safety class 1 according to IEC 348.

DIMENSIONS AND WEIGHT

(w × h × d) 316 × 154 × 410mm
(12.4 × 6.1 × 16.1-in)
9.6kg (21lb)

INSTRUMENT OPTIONS

The following are available as service modifications. Contact your local Philips office for details.
- Main time base sweep output
- Main time base gate output
- Delayed time base gate output

INSTRUMENT VERSIONS

PM 3244 is the standard version
PM 3244G has the long persistence type phosphor (P7)

ACCESSORIES SUPPLIED

Front cover
Operating and service manual
BNC-Banana adapter
Contrast filter
2 × 10:1 attenuator probe

OPTIONAL ACCESSORIES

PM 8921	Passive probe 1:1 (1.5m)
PM 8921L	Passive probe 1:1 (2.5m)
PM 8927	Passive probe 10:1; 11pF (1.5m)
PM 8927L	Passive probe 10:1; 14pF (2.5m)
PM 8932	Passive probe 100:1; max. voltage 400V; 2pF (1.5m)
PM 8940	High voltage isolation amplifier for floating measurements at $650V_{RMS}$
PM 8943	FET probe 650MHz, 1:1/10:1/100:1
PM 8960	19-in rackmount adapter
PM 9355/01	Current probe 12Hz...70MHz
PM 9381	Oscilloscope camera
PM 8976	Camera adapter for stationary use
PM 9366	Collapsible viewing hood
PM 8980	Long type viewing hood
PM 8994	Set of accessories for probes
PM 8991	Oscilloscope trolley
PM 8901	Battery pack for 5 hours continuous operation
PM 8910	Polaroid anti-glare filter
PM 8992	Accessory pouch

50MHz storage oscilloscope with multiplier PM 3243

5mV sensitivity at 50MHz

Built-in 40MHz multiplier

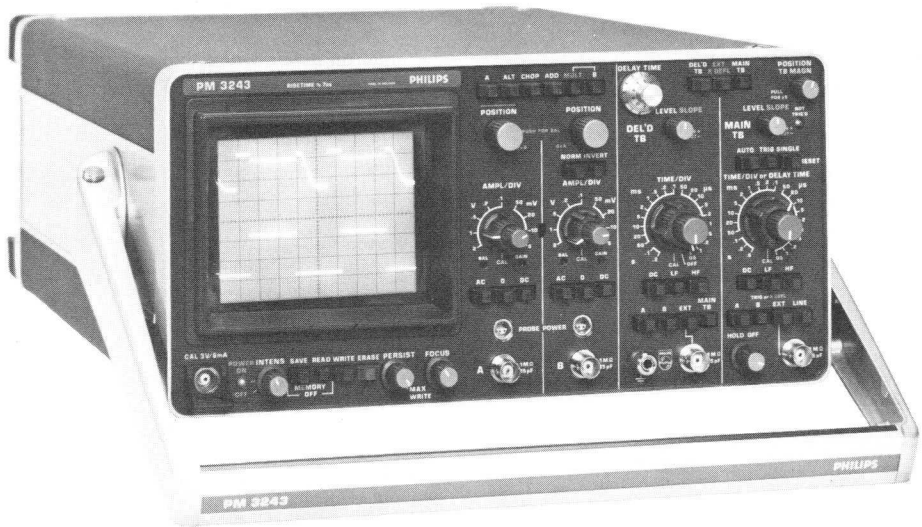
Simultaneous display of product and one of the factors

Variable persistence and storage

Advanced ergonomic design

Operation from almost any voltage/frequency supply, including DC, without voltage switching

This compact, dual-trace, dual-timebase instrument offers in addition to general-purpose facilities, special features of interest to users wanting to measure once-only instantaneous phenomena such as
– power measurements
– destructive testing
– drop testing
– mechanical measurements
and similar events.
Recordings are made possible by using the storage and variable persistence capability, and/or the built-in analog multiplier. These two features can be used individually or in combination.



Multiplier feature

To display the product of two input signals a single button has to be depressed. The multiplier facility also allows one of the multiplicands to be displayed for easier understanding of the multiplication. Compensation of the DC components at the multiplier input is by means of two potentiometers. (The adjustment is rarely needed due to the inherently good drift compensation.)

TECHNICAL SPECIFICATION

CRT

Type
Philips rectangular post accelerator half tone storage tube.

Screen type
P31 phosphor

Total acceleration voltage
8.5kV

Useful screen area
8×10div, 1div equalling 0.9cm

Graticule
Internal

Persistence
Normal: Natural persistence of P31 phosphor (10μs...1ms)

Variable: Continuously variable from 0.3s to 1.5 min

STORAGE

Storage time
In max. persistence mode: 1.5min
In 'read' mode: 3min
In 'save' mode: 15min

Writing speed
Normal: 200 div/ms
Max. write: 2div/μs

Erase
Push button operated, erasure takes approx. 600 ms

VERTICAL OR Y-AXIS

Response
DC: 0Hz...50MHz
AC: 10Hz...50MHz
Risetime: 7ns

Deflection coefficient
5mV/div...2V/div 1–2–5–sequence
Uncalibrated, continuous control between the steps
1: > 2.5

Accuracy
±3%

Input impedance
1MΩ//15pF
RC time AC coupled 22ms

Display modes
A only
B only, normal and inverted
Chopped (1MHz)
Alternated
Added
Multiply (A×B)
A×B and B chopped

CMR
100:1 at 1MHz

Input impedance
1MΩ//15pF
RC time AC coupled 22ms

Maximum input voltage
$400V_{(DC+ACpk)}$

Maximum deflection
Undistorted deflection of 24div for sine wave signals with frequencies of up to 15MHz

Shift range
16div

Signal delay
20ns visible

MULTIPLIER

Bandwidth
0...40MHz (−3dB)

Risetime
9ns

Multiplication factor
1±0.02

The product of signal A with A cm and signal B with B cm is displayed with A×B cm ±2%

Dynamic range
Signal: A: 8cm
(±4cm from centre of screen)
Signal B: 8cm
(±4cm from centre of screen)
Product A × B: 8cm
(±4cm from centre of screen)

Signal delay
8ns between product and signal B

Display modes
A × ±B
A × ±B chopped with ±B

Multiplier output
BNC socket at the rear of the instrument, DC coupled:
Output voltage: 50mV/div into 50Ω
100mV/div into 10kΩ
Bandwidth: DC...40MHz (−3dB)

HORIZONTAL OR X-AXIS

Horizontal deflection can be obtained from either the Main time base or the Delayed time base or a combination of the two, or from the signal source selected for X-deflection. In this case X-Y diagrams can be displayed using Y_A, Y_B, the Ext connector or the line as a signal source for horizontal deflection.

Horizontal display modes
Main time base
Main time base intensified by delayed time base
Delayed time base
X-Y or X-Y/Y operation with X-deflection by: Y_A, Y_B, External or Line

HORIZONTAL AMPLIFIER

Response
DC...1MHz (−3dB) over 6div

Deflection coefficient
450mV/div using Ext connector
Vertical attenuator coefficients apply when Y_A or Y_B is used for X-deflection.

Measuring accuracy
±10% using Y_A or Y_B input

Phase error
3° at 100kHz

MAIN TIME BASE

Modes
Auto, Triggered, Single shot

Time coefficients
0.5s/div...50ns/div 1–2–5 sequence
Uncalibrated continuous control between steps 1: > 2.5
×5 magnifier extends max. sweep rate to 10ns/div.

Accuracy
±3%
Additional error for magnifier ±2%

Variable hold-off
Sweep hold-off time can be increased by at least a factor of 5

DELAYED TIME BASE

Modes
The delayed time base either starts immediately after delay time or is triggerable after delay time, by the selected delayed time base trigger source.

Time coefficients
0.2s/div...50ns/div 1–2–5 sequence
Uncalibrated control between steps 1: > 2.5
×5 magnifier extends max. sweep rate to 10ns/div

Accuracy
±3%
Additional error for magnifier ±2%

Sweep delay
In steps variable with main time base. Continuously variable with 10-turn potentiometer between 0.2× and 10× the time coefficient of the main time base.

Delay time jitter
1 : 20000

Incremental delay time accuracy
0.5%

MAIN TIME BASE TRIGGERING

Trigger source
Internal Y_A, Y_B, Line, External

Slope
+ or −

Trigger sensitivity
Internal: 0.5div typical
External: 150mV typical

External trigger input impedance
1MΩ//15pF

Max allowable input voltage
$400V_{DC+ACpk}$

Trigger modes and coupling
Auto: 10Hz...50MHz
DC: 0Hz...50MHz
LF: 0Hz...50kHz
HF: 50kHz...50MHz

DELAYED TIME BASE TRIGGERING

Trigger source
Internal: Y_A, Y_B; External
Other trigger specifications of delayed time base are identical to that of the main time base.

CALIBRATION

Calibrated voltage
$3V_{p-p}$ ±1% square wave

Calibrated current
$6mA_{p-p}$ ±1%

Frequency
2kHz ±2%

POWER

Line voltages: Accepts any voltage between 100 and 240V ±10% and any frequency between 46 and 440Hz in one range, without switching.
DC power source: Accepts any DC-voltage between 100V and 200V
Power consumption: 39W
Probe power: Two sockets at vertical amplifiers providing +24V and −24V for active probes

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use +5°C...+40°C
Limits for operation −10°C...+55°C
Storage and transport −40°C...+70°C

Altitude
Operating: to 5000m (15000ft)
Non operating: to 15000m (45000ft)

Humidity
21 days cyclic damp heat 25°C-40°C, R.H. 95%

Bump
1000 bumps of 10g, ½ sine, 6ms duration, in each of 3 directions.

Vibration
30 minutes in each of three directions, 10-150Hz; $0.7mm_{p-p}$ and 5g max acceleration
Unit mounted on vibration table with shock absorbing material.

Recovery time
Operates within 30 minutes coming from −10°C soak, going into 60% relative humidity at +20°C room conditions.

Electromagnetic interference
Meets VDE, 0871 and VDE 0875
Grenzwertklasse B

Safety
Safety class 1 according to IEC 348.

DIMENSIONS AND WEIGHT

(w × h × d) 316 × 154 × 460mm
(12.4 × 6.1 × 18-in)
10.6kg (23.5lb)

INSTRUMENT OPTIONS

– Main time base sweep output
– Main time base gate output
– Delayed time base sweep output
are available as service modifications.
Contact your local Philips field engineer for detailed information.

ACCESSORIES SUPPLIED

Front cover
Operating and service manual
BNC-Banana adapter
Contrast filter
2 × 10:1 attenuator probe

OPTIONAL ACCESSORIES

PM 8921	Passive probe 1:1 (1.5m)
PM 8921L	Passive probe 1:1 (2.5m)
PM 8927	Passive probe 10:1; 11pF (1.5m)
PM 8927L	Passive probe 10:1; 14pF (2.5m)
PM 8932	Passive probe 100:1; max. voltage 4000V; 2pF (1.5m)
PM 8940	High voltage isolation amplifier for floating measurements at $650V_{RMS}$
PM 8943	FET probe 650MHz, 1:1/10:1/100:1
PM 8960	19-in rackmount adapter
PM 9355/01	Current probe 12Hz...70MHz
PM 9381	Oscilloscope camera
PM 8976	Camera adapter for stationary use
PM 9366	Collapsible viewing hood
PM 8980	Long type viewing hood
PM 8994	Set of accessories for probes
PM 8991	Oscilloscope trolley
PM 8901	Battery pack for 3 hours continuous operation
PM 8910	Polaroid anti-glare filter

10MHz dual beam storage oscilloscope PM 3234

10MHz/2mV

True dual beam operation

Variable persistence and storage

Uninterrupted recordings and storage, even of single events

Signal delay in both vertical channels

Comprehensive triggering facilities (Auto, AC, DC and single-shot)

Line or 24V DC operation

PM 3234 combines true dual-beam operation and 'half-tone' storage including variable persistence, resulting in an advanced and versatile performance. The instrument can thus be used to advantage for a very wide range of applications, often replacing more complex and expensive oscilloscopes.

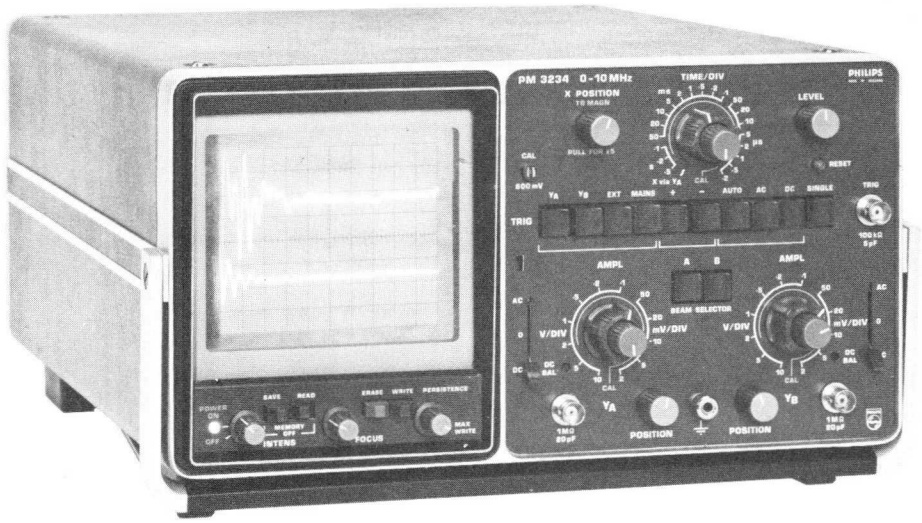
Dual beam storage provides continuous, uninterrupted displays, unlike the chopped or alternate displays of dual-trace instruments.

Dual beam display, combined with the storage facilities, ensures true displays and recordings, including single-shot phenomena. (See figs. 1 and 2).

Half-tone storage has also proven its value. The half-tone tube is about the same size as a conventional CRT with an equivalent screen size and provides a versatile control of the storage function. For example: the persistence can be varied continuously from 0.3s to 1.5min. It can also be switched from 'high' to 'low' intensity viewing positions giving either minimum brightness for 15min or maximum brightness for 3min. The PM 3234 is thus an extremely versatile instrument and of particular value for oneshot measurements which can be stored and subsequently analysed in detail.

As well as providing the unique combination of true dual-beam operation with halftone storage, the PM 3234 also has an excellent all-round performance.

The 'auto' triggering position is a particularly useful feature as the trigger level is derived from the signal itself. And in the absence of a signal the time base is free running and a quick, accurate check of the zero line reference is obtained. The trace is also easy to find under normal operating conditions.



TECHNICAL SPECIFICATION

CRT

Type
Philips rectangular dual beam postaccelerator half-tone storage tube

Screen type
P31 phosphor

Total acceleration voltage
8.5kV

Useful screen area
8 × 10div, 1div equalling 0.9cm

Overlap for the two beams
100%

Graticule
Internal

Persistence
Normal: Natural persistence of P31 phosphor (10μs...1ms)
Variable: Continuously variable from < 0.3s to ⩾ 1.5min

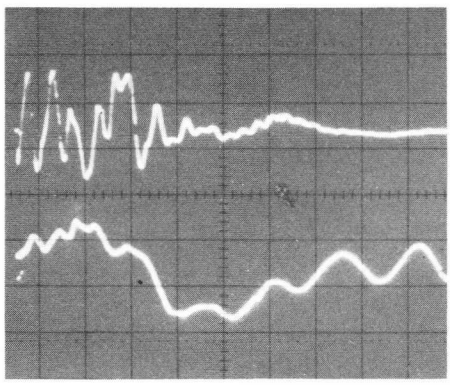
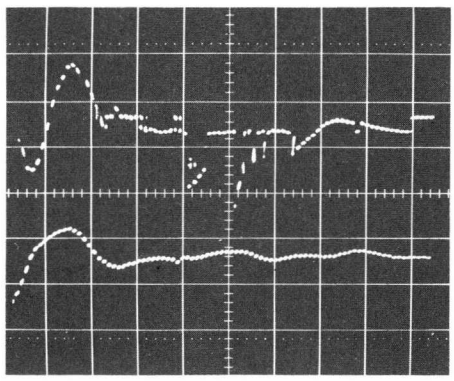


Fig. 1. This oscillogram shows a single-shot phenomenon accurately displayed and recorded on the PM 3234.

Fig. 2. This oscillogram was taken on a dual-trace instrument recording a same single-shot signal. The error and ambiguity that the chopped display mode has introduced is all too obvious.



Storage time
In maximum persistence mode: ⩾ 1.5min
In 'read' mode: ⩾ 3m
In 'save' mode: ⩾ 15m

Writing speed
Normal: ⩾ 100div/ms
Max. write': ⩾ 1div/μs

Erase
Push button operated, erasure takes approx. 600ms

VERTICAL OR Y-AXIS

Two identical amplifiers, one for each deflection system. The input stages are provided with an active drift-feedback circuit, giving an extremely stable display.

Response
DC: 0Hz...10MHz (−3dB)
AC: 2Hz...10MHz (−3dB)

Risetime
35ns

Deflection coefficients
2mV/div...10V/div in twelve steps in 1-2-5 sequence. Uncalibrated, continuous control between the steps.

Accuracy
3%

Over- (under-) shoot
⩽ 2% (with a test pulse of 10ns risetime for 6div of deflection at 1MHz)

Input impedance
1MΩ//20pF
Input RC time when AC coupled
100ms

Maximum input voltage
$400V_{DC+ACpk}$

Maximum deflection
For sinewave signals with frequencies of up to 3MHz, the vertical deflection will be undistorted for a total amplitude of 24div. With the aid of the positioning controls, the peaks of such a signal can be displayed.

Signal delay
150ns total, 80ns visible

DC-drift at maximum sensitivity
< ¼div/hour

HORIZONTAL OR X-AXIS

Horizontal deflection can be obtained from an internally generated, triggered time-base, or from an external signal, connected to the Y_A input. In this case X–Y diagrams can be displayed with full sensitivities for both directions.

HORIZONTAL AMPLIFIER

Response
DC: 0Hz...1MHz (−3dB)
AC: 2Hz...1MHz (−3dB)

Deflection coefficients
2mV/div...10V/div in twelve calibrated steps in 1-2-5 sequence. Uncalibrated continuous control between steps

Measuring accuracy
5%

Phase error
5° at 100kHz

TIME BASE

Time coefficients
0.5s/div...0.2μs/div in twenty calibrated steps in 1-2-5 sequence. Uncalibrated continuous control between steps

Measuring accuracy
5%

Time base magnifier
5×, giving a display equivalent to 50div every 10div of which can be made visible by using the horizontal positioning control. The measuring accuracy with magnified sweep is 7%

Time base output
$6V_{p-p}$ (from −2 to +4V open output voltage)
$300mV_{p-p}$

Time base output into 50Ω

Internal resistance
1kΩ
The time base output may be short-circuited without affecting the accuracy of the time coefficients

TRIGGERING

The time base generator operates in the triggered mode with adjustable level and slope when an input signal is applied. An auto-circuit can be switched in, providing a bright zero line at an adjustable trigger level, the level automatically being limited to the peak-peak amplitude of the signal.

Trigger source
Internal: Y_A
Y_B
Line
External

Trigger slope
+ or −

Trigger mode
Auto: 20Hz... ⩾ 10MHz
AC: 10Hz... ⩾ 10MHz
DC: 0Hz... ⩾ 10MHz
Single

Trigger sensitivity
Internal: 1div up to 10MHz
External: 1V up to 10MHz

Input impedance
100kΩ//5pF

Maximum input voltage
$400V_{DC+ACpk}$

Level range
Internal: 24div (with continuous attenuator in 'CAL' position)
External: 24V. In the automatic mode, the level range is automatically adjusted to the signal amplitude.
The trigger level is *not* influenced by the vernier controls of the vertical deflection factors.

CALIBRATION

Calibrated voltage: 600mV ±1% square wave
Frequency: 2kHz approximately

POWER

Line voltages: 90V...140V and 180V...265V, 46...440Hz
DC-22V...30V
Power consumption: *AC:* 61VA at 220V
DC: 1.4A at 24V

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organization in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use +5°C... +40°C
Operating −10°C... +55°C
Storage and transport −40°C... +70°C

Altitude
Operating: to 5000m (15000ft)
Non-operating: to 15000m (45000ft)

Humidity
21 days cyclic damp heat 25°C–40°C R.H. 95%

Bump
1000 bumps of 10g, ½sine, 6ms duration, in each of 3 directions

Vibration
30 minutes in each of three directions, 10–150Hz; $0.7mm_{p-p}$ and 5g max. acceleration.
Unit mounted on vibration table with shock absorbing material.

Recovery time
Operates within 30 minutes coming from −10°C soak, going into 60% relative humidity at +20°C room conditions.

Electromagnetic interference
Meets VDE, 0871 and VDE 0875
Grenzwertklasse B

Safety
Safety class 1 according to IEC 348.

DIMENSIONS AND WEIGHT

(w × h × d) 326 × 185 × 503mm
(12.8 × 7.3 × 19.8-in)
11.8kg (26lb)

ACCESSORIES SUPPLIED

Front cover
Operating and service manual
BNC-Banana adapter
Contrast filter

OPTIONAL ACCESSORIES

PM 9326	Passive probe 1:1/10:1 (1.1m)
PM 9327	Passive probe 1:1/10:1 (2.1m)
PM 9328	Set of two passive probes 1:1/10:1
PM 8921	Passive probe 1:1 (1.5m)
PM 8921L	Passive probe 1:1 (2.5m)
PM 8925	Passive probe 10:1; 11pF (1.5m)
PM 8925L	Passive probe 10:1; 14pF (2.5m)
PM 8932	Passive probe 100:1; max. voltage 4000V; 2pF (1.5m)
PM 8940	High voltage isolation amplifier for floating measurements at $650V_{RMS}$
PM 8943	FET probe 650MHz, 1:1/10:1/100:1
PM 9359	19-in rackmount adapter
PM 9355/01	Current probe 12Hz...70MHz
PM 9381	Oscilloscope camera
PM 8973	Camera adapter for stationary use
PM 9366	Collapsible viewing hood
PM 8980	Long type viewing hood
PM 8994	Set of accessories for probes
PM 8991	Oscilloscope trolley
PM 8901	Battery pack for 9 hours continuous operation

10MHz dual beam oscilloscope PM 3233

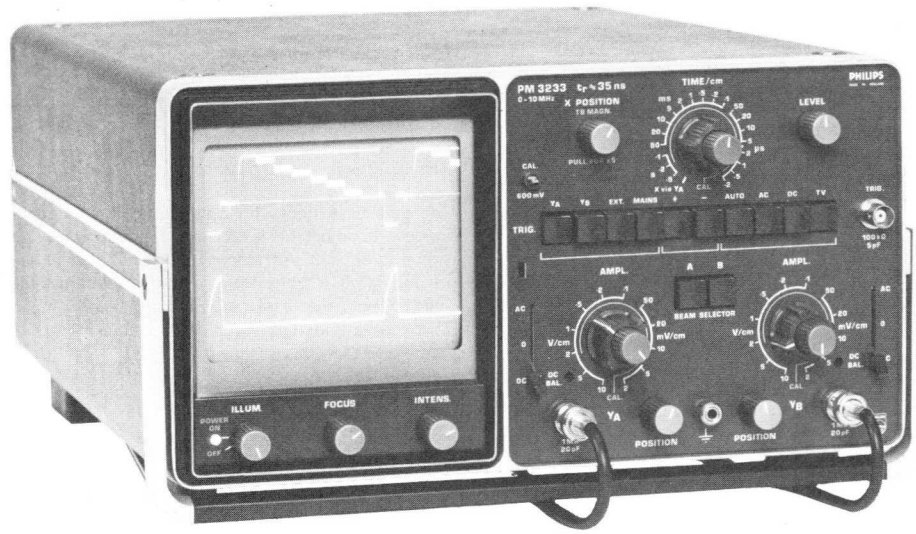
10MHz/2mV

True dual beam operation

Signal delay in both vertical channels

Comprehensive triggering facilities (Auto, AC, DC and TV)

The PM 3233 has a high 2mV sensitivity across the full bandwidth. It is a true dual beam instrument, so there is no possibility of phase errors as in time-shared oscilloscopes, and it has universal triggering facilities that include choice of source, DC coupling, automatic level and automatic TV line/frame positions.
The rectangular CRT has a large 8 × 10cm screen and excellent light output due to the 10kV post acceleration and the dual beam principle. This allows extremely low duty cycle signals to be displayed.
In the automatic position the time base is free running (in the absence of a signal) for quick zero line references at all sweep speed settings. In the automatic mode the triggering level is derived from the signal. The 'scope also has DC as well as AC coupling, plus the special TV position that gives fully automatic line or frame-derived triggering.
The whole screen area can be covered by both beams and displays are extremely bright due to the use of a 10kV mesh-type, dual-beam PDA tube.



TECHNICAL SPECIFICATION

CRT

Type
Philips rectangular mesh type splitbeam tube, with 10kV acceleration potential and metal backed phosphor.

Screen type
P31 (GH) phosphor standard. For P7 (GM) long persistence phosphor, order PM 3233G

Useful screen area
8cm × 10cm for both beams.

Overlap of the two systems
100%

Graticule
External with centimeter divisions and subdivisions of 2mm along the central axes. 10% and 90% lines are indicated.

Graticule illumination
Continuously variable.

VERTICAL OR Y-AXIS

Two identical amplifiers, one for each deflection system. The input stages are provided with an active drift-feedback circuit, giving an extremely stable display.

Response
DC: 0Hz...10MHz (−3dB)
AC: 2Hz...10MHz (−3dB)

Risetime
35ns

Deflection coefficients
2mV/cm...10V/cm in twelve steps in 1-2-5 sequence. Uncalibrated, continuous control between the steps.

Measuring accuracy
±3%

Over- (under-) shoot
≤ 2% (with a test pulse of 10ns risetime for 6cm of deflection at 1MHz).

Input impedance
1MΩ//20pF
Input RC time when AC coupled 100ms.

Maximum input voltage
$400V_{DC+ACpk}$

Maximum deflection
For sinewave signals with frequencies of up to 3MHz, the vertical deflection will be undistorted for a total amplitude of 24cm. With the aid of the positioning controls, the peaks of such a signal can be displayed.

Signal delay
150ns total, 80ns visible.

DC-drift at maximum sensitivity
¼cm/hour

HORIZONTAL OR X-AXIS

Horizontal deflection can be obtained from an internally generated, triggered time-base or from an external signal, connected to the Y_A input. In this case X–Y diagrams can be displayed with full sensitivities for both directions.

HORIZONTAL AMPLIFIER

Response
DC: 0Hz...1MHz (−3dB)
AC: 2Hz...1MHz (−3dB)

Deflection coefficients
2mV/cm...10V/cm in twelve calibrated steps in 1-2-5 sequence. Uncalibrated continuous control between steps.

Measuring accuracy
±5%

Phase error
5° at 100kHz

For all other specifications see vertical amplifiers

TIME BASE

Time coefficients
0.5s/cm...0.2μs/cm in twenty calibrated steps in 1-2-5 sequence. Uncalibrated continuous control between steps.

Measuring accuracy
±5%

Time base magnifier
5×, giving a display equivalent to 50cm, every 10cm of which can be made visible by using the horizontal positioning control. The measuring accuracy with magnified sweep is 7%.

Time base output
$6V_{p-p}$ (from −2V to +4V open output voltage).

Time base output into 50Ω
$300mV_{p-p}$

Internal resistance
1kΩ
The time base output may be short-circuited without affecting the accuracy of the timecoefficients.

TRIGGERING

The time base generator operates in the triggered mode with adjustable level and slope when an input signal is applied. An autocircuit can be switched in, providing a bright zero line at all sweep speeds under no signal conditions. In this automode, triggering is possible at an adjustable trigger level, the level automatically being limited to the peak-peak amplitude of the signal.

Trigger source
Internal: Y_A
Y_B
Line
External:

Trigger slope
+ or −

Trigger modes and coupling
Auto: 20Hz...10MHz
AC: 10Hz... ⩾10MHz
DC 0Hz... ⩾10MHz
TV: Fully automatic triggering on TV-video signals, selection of 'frame' and 'line' automatically being made with the time base speed.

Trigger sensitivity
Internal: 1cm up to 10MHz
External: 1V up to 10MHz

Input impedance
100kΩ//5pF

Maximum input voltage
$400V_{DC+ACpk}$

Level range
Internal: 24cm (with continuous attenuator in 'CAL' position)
External: 24V.
In the automatic mode, the level range is automatically adjusted to the signal amplitude. The trigger level is **not** influenced by the vernier controls of the vertical deflection factors.

CALIBRATION

Calibrated voltage: 600mV ±1%, square wave
Frequency: 2kHz approximately.

Intensity modulation
Blanking voltage: 20V
Input resistance: 47kΩ
Frequency range: 20Hz...1kHz
Maximum input voltage: $400V_{DC+ACpk}$

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organization in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use +5°C...+40°C
Operating −10°C...+55°C
Storage and transport −40°C...+70°C

Altitude
Operating: to 5000m (15000ft)
Non-operating: to 15000m (45000ft)

Humidity
21 days cyclic damp heat 25°C–40°C R.H. 95%

Bump
1000 bumps of 10g, ½ sine, 6ms duration, in each of 3 directions

Vibration
30 minutes in each of three directions, 10–150Hz; $0.7mm_{p-p}$ and 5g max. acceleration
Unit mounted on vibration table with shock absorbing material.

Recovery time
Operates within 30 minutes coming from −10°C soak, going into 60% relative humidity at +20°C room conditions.

Electromagnetic interference
Meets VDE, 0871 und VDE 0875
Grenzwertklasse B

Safety
Safety class 1 according to IEC 348.

POWER

Line voltages AC: 90V...140V and 180V...265V, 46...440Hz
DC: 22V...30V
Power consumption *AC*: 40VA at 220V
DC: 0.85A at 24V

DIMENSIONS AND WEIGHT

(w×h×d) 326×185×503mm
(12.8×7.3×19.8-in)
9.5kg (21lb)

ACCESSORIES SUPPLIED

Front cover
Operating and service manual
BNC-Banana adapter
Contrast filter

OPTIONAL ACCESSORIES

PM 9326	Passive probe 1:1/10:1 (1.1m)
PM 9327	Passive probe 1:1/10:1 (2.1m)
PM 9328	Set of two passive probes 1:1/10:1
PM 8921	Passive probe 1:1 (1.5m)
PM 8921L	Passive probe 1:1 (2.5m)
PM 8925	Passive probe 10:1; 11pF (1.5m)
PM 8925L	Passive probe 10:1; 14pF (2.5m)
PM 8932	Passive probe 100:1; max. voltage 4000V; 2pF (1.5m)
PM 8940	High voltage isolation amplifier for floating measurements are $650V_{RMS}$
PM 8943	FET probe 650MHz, 1:1/10:1/100:1
PM 9359	19-in rackmount adapter
PM 9355/01	Current probe 12Hz...70MHz
PM 9381	Oscilloscope camera
PM 8973	Camera adapter for stationary use
PM 9366	Collapsible viewing hood
PM 8980	Long type viewing hood
PM 8994	Set of accessories for probes
PM 8991	Oscilloscope trolley
PM 8901	Battery pack for 9 hours continuous operation

15MHz compact oscilloscopes PM 3225, PM 3226 and PM 3226P

15MHz: 2mV

Compact dimensions combined with 8×10 div screen

Comprehensive triggering facilities (Auto or manual, level and TV)

Functionally designed front panel

Single trace: PM 3225

Dual trace: PM 3226

Educational version PM 3226P

These oscilloscopes are ideal for a very wide range of applications – from the crowded bench tops of R&D laboratories through to TV service workshops and educational institutions.
All models employ advanced professional features with easy-to-use facilities like the Automatic 'Top' triggering and the automatic TV line or frame derived triggering. When precise control of the triggering parameters is needed, the 'Top' mode can be changed to 'Level' in order to trigger the instrument at an exact point in the input signal. In the absence of input signal the instrument displays a continuous trace. In the 'Top' mode triggering is automatic and amplitude independant. Even signals with very low duty cycles will be triggered automatically and narrow 100ns pulses with low duty cycle will trigger the timebase from the free-running to the triggered state.
For TV applications, triggering is completely automatic. Frame triggering occurs in the lower sweep speeds up to 0.5ms/div and is automatically switched over to line triggering from 0.2ms/div upwards.
PM 3226P is designed for educational applications.
It features inversion of channel A, the facility to add channel B to channel A for B+A and B-A displays plus the use of channel B for X input in order to make X-Y displays at full sensitivity. With this oscilloscope it is therefore possible to demonstrate to students the exact meaning of a wide range of phenomenae, since these display facilities are *in addition* to the specification of model PM 3226.

TECHNICAL SPECIFICATION

CRT

Measuring area
8×10div; 1div=7.5mm

Screen type
P31 (GH)
P7 (GH) optional

Acceleration voltage
1.5kV

VERTICAL OR Y-AXIS

Frequency range
DC: 0...15MHz
AC: 2Hz...15MHz

Risetime
25ns

Deflection coefficients
2mV...10V/div in 12 calibrated steps in 1–2–5 sequence

Accuracy
3% (PM 3225)
5% (PM 3226)

Vertical position
16div (8div each in upward and downward direction reckoned from the central horizontal graticule line).

Dynamic range
24div for sinewave signals with frequencies of up to 1MHz

Input impedance
1MΩ/25pF

Display modes
PM 3225: single beam one channel only
PM 3226 A only
B only
A and B chopper or alternate
B±A (PM 3226P only)

Chopper frequency:
200kHz

Max. permissible input voltage:
$\pm 400V_{DC+ACpk}$ Resistant against non-repetitive surges up to 1000V

HORIZONTAL AMPLIFIER

Response
DC...100kHz (PM 3225)
DC...500kHz (PM 3226)

Deflection coefficient
1V/div or 5V/div (±10%) (PM 3225 and PM 3226) as Y-input (PM 3226P)

Max. permissible input voltage
$400V_{DC+ACpk}$ Resistant against non-repetitive surges up to 1000V

Input impedance
1MΩ//25pF

TIME BASE

Time coefficients
0.2s/div...0.5µs/div
in 18 calibrated steps
Fastest sweep speed: 100ns/div
Continuous control 1: ≥2.5 (PM 3226 and PM 3226P only)

Accuracy
±5%

Magnifier
×5 calibrated, 1 step

Additional error
2%

TRIGGERING

Source
Internal (PM 3226: A or B)
External
Line

Trigger sensitivity
Int. ⩽ 1.5div at 15MHz typ. 0.75div at 1MHz
Ext. ⩽ 1.5V at 15MHz typ. 0.75V at 1MHz
Top: ⩽ 2div at 15MHz (⩽ 4V for PM 3226)
⩽ 2V at 15MHz (3V for PM 3226)
TV: 0.5div sync amplitude 0.5V sync amplitude (⩽ 1V for PM 3226)

Input impedance
1MΩ//25pF

Max permissible input voltage
400V $_{DC+ACpk}$
Resistant against non-repetitive surges up to 1000V

Trigger mode
The timebase generator runs free in absence of trigger signal
A. Trigger level adjustable over 12div or 12V. Lowest triggerable frequency for sinewaves is 10Hz.
B. Top

Trigger slope
+ or −

Triggering with TV signals
Frame, coupled with positions 0.5ms/div to 200ms/div
Line, coupled with positions 0.2ms/div to 0.5µs/div

Probe adjustment
Hook-on clip on front panel

POWER

Line voltages: 110, 127, 220, 240V$_{AC}$ (±10%)
Line frequency: 46...400Hz
Consumption: PM 3225:16VA
PM 3226: 18VA

DIMENSIONS AND WEIGHT

PM 3225	230×120×310mm (9×4.7×12.2-in) 3.8kg (8lb)
PM 3226(P)	275×120×320mm (11×4.7×12.5-in) 4.3kg (9.5lb)

PM 3226P allows the B-channel amplifier to be used as an X-input, X-Y displays can thus be obtained with full 2mV sensitivity.

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organization in your country or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use +5°C...+40°C
Operating −10°C...+55°C
Storage and transport −40°C...+70°C

Altitude
Operating: to 5000m (15000ft)
Non-operating: to 15000m (45000ft)

Humidity
21 days cyclic damp heat 25°C–40°C R.H. 95%

Bump
1000 bumps of 10g, ½ sine, 6ms duration, in each of 3 directions.

Vibration
30 minutes in each of three directions, 10–150Hz; 0.7mm$_{p-p}$ and 5g max. acceleration.
Unit mounted on vibration table with shock absorbing material.

Recovery time
Operates within 30 minutes coming from −10°C soak, going into 60% relative humidity at +20°C room conditions.

Electromagnetic interference
Meets VDE, 0871 and VDE 0875
Grenzwertklasse B

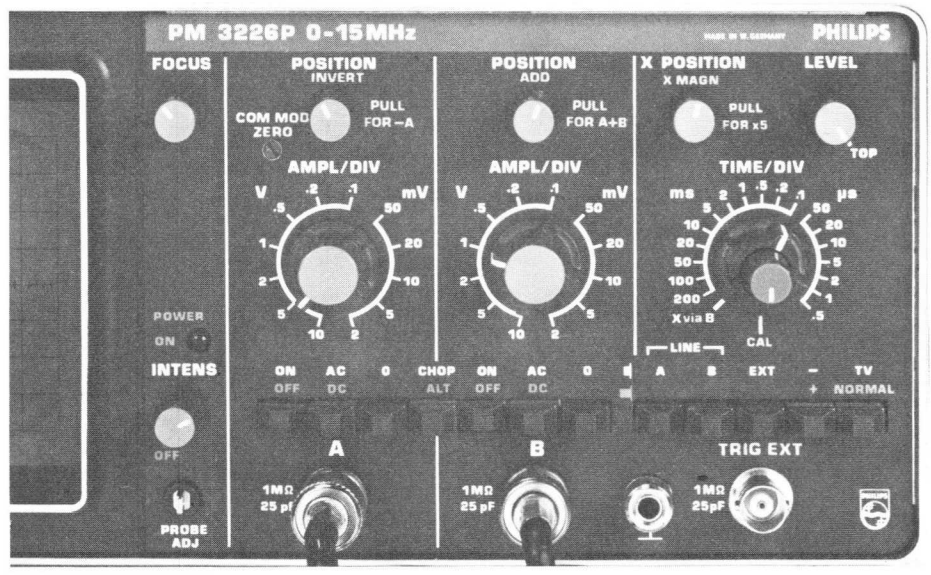
Safety
Safety class 1 according to IEC 348.

ACCESSORIES SUPPLIED

Operating and service manual
Front cover
BNC-Banana adapter

OPTIONAL ACCESSORIES

PM 9326	Passive probe 1:1/10:1 (1.1m)
PM 9327	Passive probe 1:1/10:1 (2.1m)
PM 9328	Set of two passive probe 1:1/10:1
PM 8921	Passive probe 1:1 (1.5m)
PM 8921L	Passive probe 1:1 (2.5m)
PM 8925	Passive probe 10:1; 11pF (1.5m)
PM 8925L	Passive probe 10:1; 14pF (2.5m)
PM 8932	Passive probe 100:1; max. voltage 4000V; 2pF (1.5m)
PM 8940	High voltage isolation amplifier for floating measurements at 650V$_{RMS}$
PM 8943	FET probe 650MHz, 1:1/10:1/100:1
PM 8962	19-in rackmount adapter
PM 9355/01	Current probe 12Hz...70MHz
PM 8994	Set of accessories for probes



NEW*

25MHz and 35MHz oscilloscopes PM 3212 and PM 3216*

3600.- 3950.-

PM 3212:

25MHz/2mV

Large 8×10 screen

Signal delay

Comprehensive triggering includes pk-pk Auto, DC-coupling, Auto TV

Double insulation

Double insulation

*

PM 3216:

35MHz/2mV plus all PM3212 features, and:

Max sweep speed 10ns/cm

External triggering sensitivity 200mV/2V

Variable trigger hold-off

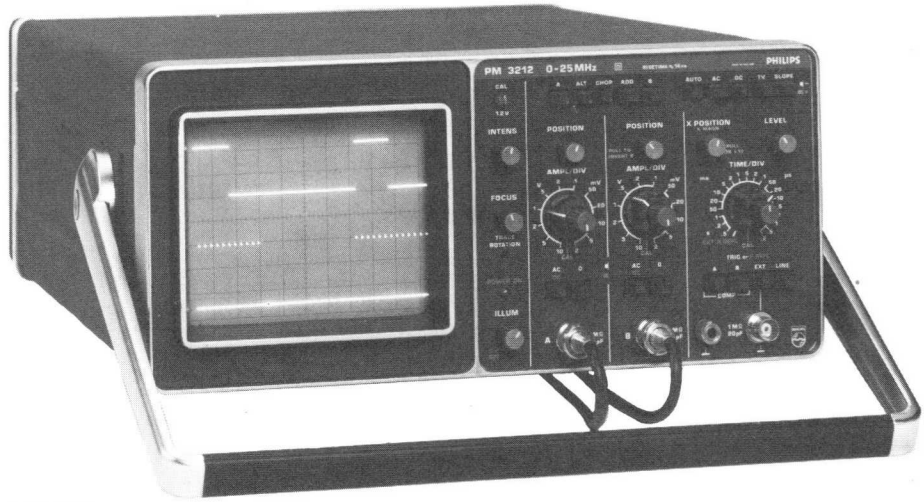
External Z-modulation input

A well-considered combination of facilities and features lift the PM 3212 and PM 3216 out of the usual general-purpose oscilloscope category into their own, exclusive, price/performance slot. For example the peak-to-peak auto triggering, Auto TV facility, DC-coupled triggering plus the choice of various trigger sources give more facilities for an economic price.

In addition to these common features, the PM 3216 has a wider bandwidth, variable triggering sensitivity and trigger hold-off: plus an extra 100ns/div position on the time base and an external Z-modulation facility.

The basic Philips attention to compact size, minimal weight, first-class ergonomic design allowing the user to concentrate on the measurement and not the controls, etc., have produced a really functional pair of oscilloscopes. (Battery-powered versions are available if required.)

To-days' preference for double insulation between an instrument and ground has not been overlooked and both units can be powered from a 2-wire source where earth loops need to be avoided or the main earth connection may become faulty during a series of tests.



PM 3212

TECHNICAL SPECIFICATION

CRT

Type
Philips rectangular mesh-type post deflection accelerator tube with 10kV acceleration voltage and metal backed phosphor.

Screen type
P31 (GH) phosphor standard
P7 (GM) phosphor optional

Useful screen area
8×10cm

Graticule
Internal graticule with centimetre divisions and 2mm divisions along the central axes. 10% and 90% lines are indicated.
Graticule illumination continuously variable

Y AXIS

Frequency response
PM 3212: DC 0Hz...25MHz (−3dB)
AC 2Hz...25MHz (−3dB)
PM 3216: DC 0Hz...35MHz (−3dB)
AC 2Hz...35MHz (−3dB)

Rise time
PM 3212: 14ns
PM 3216: 10ns

Deflection coefficients
2mV/div...10V/div. 1-2-5 sequence
Uncalibrated continuous control between the steps 1: >2.5

Accuracy
±3%

Display modes
Channel A, channel B, alternate, chopped at approx. 500kHz, added. Channel B can be inverted.

Input impedance
1MΩ//20pF

Maximum input voltage
400V (DC+AC peak)

Maximum deflection
Undistorted deflection of 24div.
Shift range 16div.

Signal delay
20ns visible

CMR-factor
100:1 at 1MHz
(A-B mode with 8div. common mode signal)

HORIZONTAL

Horizontal deflection can be obtained from the main time base, the delayed time base, a combination of both, or from an external source. In this case X-Y diagrams can be displayed using Y_A, Y_B, the EXT connector or the mains as signal source for horizontal deflection.

Display modes
X-Y or X-Y/Y operation with X-deflection by: Y_A, Y_B, External or Mains (line)

X-INPUT

Deflection coefficients
PM 3212: 500mV/div. using EXT connector
PM 3216: 200mV/div. using EXT connector
2 V/div. using EXT÷10 connector
Vertical attenuator coefficients apply when Y_A or Y_B is used for X-deflection

Measuring accuracy
±10%

Frequency response
DC...1MHz (−3dB)

Phase error
3° at 100kHz

TIME BASE

Mode
Automatic or triggered

Time coefficients
PM 3212: 0.5s/div...200ns/div.
PM 3216: 0.5s/div...100ns/div.
in 1-2-5 sequence
Uncalibrated continuous control between steps 1 : > 2.5 × 10 magnifier extends max. sweep rate to 20ns/div. for PM 3212 and to 10ns/div. for PM 3216.

Accuracy
±3%
Additional error for magnifier ±2%

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organization in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use +5°C...+40°C
Operating −10°C...+55°C
Storage and transport −40°C...+70°C

Altitude
Operating to 5000m (15000ft)
Non-operating to 15000m (45000ft)

Humidity
21 days cyclic damp heat 25°C–40°C, R.H. 95%

Shock
30g: half sine wave shock of 11ms duration: 3 shocks per direction for a total of 18 shocks.

Vibration
Vibrations in three directions with a maximum of 15min per direction; 5–55Hz and amplitude of 0.7mm_{p-p} and 4g max acceleration.
Unit mounted on vibration table without shock absorbing material.

Recovery time
Operates within 30 minutes coming from −10°C soak, going into 60% relative humidity at +20°C room conditions.

PM 3216

Electromagnetic interference
Meets VDE, 0871 and VDE 0875
Grenzwertklasse B

Safety
The isolation between PM 3212 and line fulfills the safety requirements of IEC 348 for class II instruments.

POWER

Line voltages and frequencies: 110, 127, 220 and 240V_{AC} ±10%, 46...440Hz
DC power source: 21–27V_{DC}, floating input, at 1.1A
Power consumption: 28W when powered from nominal line voltage

ACCESSORIES SUPPLIED

Front cover
Operating and service manual
BNC-Banana adapter
Contrast filter
2 × 10:1 attenuator probe

OPTIONAL ACCESSORIES

PM 8921	Passive probe 1:1 (1.5m)
PM 8921L	Passive probe 1:1 (2.5m)
PM 8925	Passive probe 10:1; 11pF (1.5m)
PM 8925L	Passive probe 10:1; 14pF (2.5m)
PM 8932	Passive probe 100:1; max. voltage 5600V; 2pF (1.5m)
PM 8940	High voltage isolation amplifier for floating measurements at 650V_{RMS}
PM 8943	FET probe 650MHz, 1:1/10:1/100:1
PM 8962	19-in rackmount adapter
PM 9355/01	Current probe 12Hz...70MHz
PM 9381	Oscilloscope camera
PM 8972	Camera adapter for stationary use
PM 9366	Collapsible viewing hood
PM 8980	Long type viewing hood
PM 8994	Set of accessories for probes
PM 8991	Oscilloscope trolley
PM 8901	Battery pack for 12 hours continuous operation
PM 8910	Polaroid anti-glare filter
PM 8992	Accessory pouch

25MHz and 35MHz oscilloscopes PM 3214 and PM 3218

PM 3214:

25MHz/2mV

Large 8×10cm screen

Signal delay

Comprehensive triggering facilities including pk-pk Auto, DC-coupling and Auto TV

Main and delayed time base

Alternate time base displays

Double insulated power supply

PM 3218:

35MHz/2mV plus all PM 3214 features, and:

Max sweep speed 10ns/cm

External triggering sensitivity 200mV/2V

Variable trigger hold-off

External Z-modulation input

The PM 3214 and PM 3218 offer all the basic facilities of models PM 3212 including peak-to-peak auto triggering, Auto TV facility, DC-coupled triggering and the choice of up to five trigger sources. In addition, there are more application possibilities to be derived from such facilities as:

- the delayed sweep which includes full independent functions for both main and delayed time bases
- alternate time base display which allows instantaneous display of main and delayed time bases
- the capability of triggering main and delayed time bases from separate sources.

In addition to these common features, the PM 3218 has a wider bandwidth, variable triggering sensitivity and trigger hold-off: plus and extra 100ns/div position on the timebase and an external Z-modulation facility.

TECHNICAL SPECIFICATION

CRT

Type
Philips rectangular mesh-type post deflection accelerator tube with 10kV accelerating voltage and metal backed phosphor

Screen type
P31 (GH) phosphor standard
P 7 (GM) phosphor optional

Useful screen area
8×10cm

Graticule
Internal graticule with centimetre divisions and 2mm divisions along the central axes. 10% and 90% lines are indicated. Graticule illumination continuously variable

Y-AXIS

Frequency response
PM 3214: DC 0Hz...25MHz (−3dB)
AC 2Hz...25MHz (−3dB)
PM 3218: DC 0Hz...35MHz (−3dB)
AC 2Hz...35MHz (−3dB)

Rise time
PM 3214: 14ns
PM 3218: 10ns

Deflection coefficients
2mV/div...10V/div 1-2-5 sequence
Uncalibrated, continuous control between steps
1 : > 2.5

Accuracy
±3%

Display modes
Channel A, channel B, alternate, chopped at approx. 500kHz, added. Channel B can be inverted

Input impedance
1MΩ//20pF

Maximum input voltage
400V (DC+AC peak)

Maximum deflection
Undistorted deflection of 24div.
Shift range 16div.

Signal delay
⩾2 divisions with fastest sweep speed

CMR-factor
100:1 at 1MHz
(A-B mode with 8div common mode signal)

HORIZONTAL

Horizontal deflection can be obtained from the main time base, the delayed time base, a combination of both, or from an external source. In this case X-Y diagrams can be displayed using Y_A, Y_B, the EXT connector or the mains as signal source for horizontal deflection

Display modes
X-Y or X-Y/Y operation with X-deflection by: Y_A, Y_B, External or Mains (line)

X-INPUT

Frequency response
DC...1MHz (−3dB)

Deflection coefficients
PM 3214: 500mV/div using EXT connector
PM 3218: 200mV/div using EXT connector
2 V/div using EXT ÷10 connector
Vertical attenuator coefficients apply when Y_A or Y_B is used for X-deflection

Measuring accuracy
±10%

Phase error
3° at 100kHz

MAIN TIME BASE

Mode
Automatic or triggered

Time coefficients
PM 3214: 0.5s/div...200ns/div
PM 3218: 0.5s/div...100ns/div
in 1-2-5 sequence.
Uncalibrated continuous control between steps 1 : > 2.5. ×10 magnifier extends max. sweep/rate to 20ns/div for PM 3214 and to 10ns/div for PM 3218.

Accuracy
±3%
Additional error for magnifier ±2%

DELAYED TIME BASE

The delayed time base either starts immediately after the delay time, or is triggerable after delay time by the selected delayed timebase trigger source

Time coefficient
PM 3214: 1ms/div...200ns/div
PM 3218: 1ms/div...100ns/div
in 1-2-5 sequence.
×10 magnifier extends max. sweep rate to 20ns/div for PM 3214 and to 10ns/div for PM 3218

Accuracy
±3%
Additional error for magnifier ±2%

Sweep delay
Variable in steps with main time base.
Continuously variable with 10-turn potentiometer between 0× and 10× the time coefficient of the main time base

Incremental delay time accuracy
0.5%

Delay time jitter
1 : >20000

MAIN TIME BASE TRIGGERING

Trigger source
Internal Y_A, Y_B, Composite, Line
External
External ÷10 (PM 3218 only)

Slope
+ or −

Trigger modes
Auto: 20Hz...50MHz
DC: 0Hz...50MHz
AC: 5Hz...50MHz
TVF: Ensures automatic and stable triggering on 'frame' frequency of composite TV-video signals
TVL: Ensures automatic and stable triggering on 'line' frequency of composite TV-video signals

Trigger sensitivity
PM 3214: internal 1div at 25MHz
external 500mV at 25MHz
PM 3218: internal 1div at 25MHz
external 200mV at 35MHz
ext ÷10 2V at 35MHz

Level range
PM 3214: internal 16div typical
external −4V to +4V typical
PM 3218: internal 16div typical
external −1.6 to +1.6V typical
ext ÷10 −16V to +16V typical
Automatically adjusted between limits of signal amplitude in position Auto

Variable hold-off (PM 3218 only)
Sweep hold-off time can be increased by a factor of 10

External trigger input impedance
1MΩ//20pF

Maximum allowable input voltage
400V (DC+AC peak)

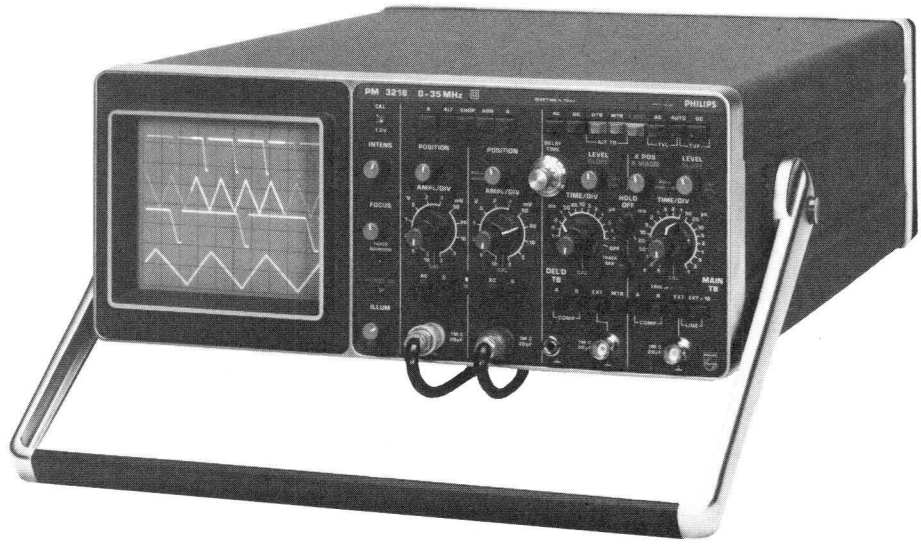
DELAYED TIME BASE TRIGGERING

Trigger source
Internal Y_A, Y_B, Composite; External
Other trigger specifications of the delayed time base are identical to that of the main time base with the exception of TV triggering

CALIBRATION

Voltage
$1.2V_{p-p}$ ±1% square wave

Frequency
2kHz approx



POWER

Line voltage and frequencies
110, 127, 220 and $240V_{AC}$ ±10% 46...440Hz

DC power source
$22\text{-}27V_{DC}$, floating input, 1.1A max

Power consumption
30W when powered from nominal line voltage.

Z-Modulation (for PM 3218 only)
TTL compatible; low level blanks the display

DIMENSIONS AND WEIGHT

(w×h×d) 33×13,5×42cm
8.4kg

ENVIRONMENTAL CAPABILITIES

The environmental data are valid if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use +5°C...+40°C
Operating −10°C...+55°C
Storage and transport −40°C..,+70°C

Altitude
Operating: to 5000m (15000ft)
Non-operating: to 15000m (45000ft)

Humidity
21 days cyclic damp heat 25°C–40°C R.H. 95%

Shock
30g: half sine wave shock of 11ms duration:
3 shocks per direction for a total of 18 shocks.

Vibration:
Vibrations in three directions with a maximum of 15min per direction;
5–55Hz and amplitude of $0.7mm_{p-p}$ and 4g max acceleration.
Unit mounted on vibration table without shock absorbing material.

Recovery time
Operates within 30 minutes coming from −10°C soak, going into 60% relative humidity at +20°C room conditions.

Electromagnetic interference
Meets VDE, 0871 and VDE 0875
Grenzwertklasse B

Safety
The insulation between both oscilloscopes and line fulfills the safety requirements of IEC 348 first edition for metal encased class II instruments

INSTRUMENT OPTIONS

- Main time base sweep output
- Main time base gate output
- Delayed time base gate output
- Intensity modulation input (standard in PM 3218)

Available as service modifications
Contact your local Philips field engineer for detailed information.

ACCESSORIES SUPPLIED

Front cover
Operating and service manual
BNC-Banana adapter
Contrast filter
2×10:1 attenuator probe

OPTIONAL ACCESSORIES

PM 8921	Passive probe 1:1 (1.5m)
PM 8921L	Passive probe 1:1 (2.5m)
PM 8925	Passive probe 10:1; 11pF (1.5m)
PM 8925L	Passive probe 10:1; 14pF (2.5m)
PM 8932	Passive probe 100:1; max. voltage 4000V; 2pF (1.5m)
PM 8940	High voltage isolation amplifier for floating measurements at $650V_{RMS}$
PM 8943	FET probe 650MHz, 1:1/10:1/100:1
PM 8963	19-in rackmount adapter
PM 9355/01	Current probe 12Hz...70MHz
PM 9381	Oscilloscope camera
PM 8972	Camera adapter for stationary use
PM 9366	Collapsible viewing hood
PM 8980	Long type viewing hood
PM 8994	Set of accessories for probes
PM 8991	Oscilloscope trolley
PM 8901	Battery pack for 12 hours continuous operation
PM 8910	Polaroid anti-glare filter
PM 8992	Accessory pouch

AVAILABLE VERSIONS

PM 3214, PM 3218: Standard model
PM 3214G, PM 3218G: With long persistence type phosphor (P7)
PM 3214B, PM 3218B: With built-in batteries plus charger
Contact your local Philips field engineer for detailed information.

NEW

15MHZ dual trace Oscilloscope PM 3207

15MHz/5mV
Large 8×10cm screen
Auto, TV triggering
Same sensitivity on X and Y channels
B-invert facility
Triggering from A or B channel
Double insulation

The PM 3207 exhibits many features associated with more sophisticated, expensive, oscilloscopes, yet remains an extremely compact and lightweight instrument. Whilst ideal for a very wide range of field applications, it is equally acceptable for workshop use, because of its small size.

The rectangular 8×10cm screen gives a bright, crisp display under all conditions of use, even in 'dirty' environments. Weak signals will be adequately handled by the 5mV sensitivity (e.g., even 1:100 and 1:10, at 50 or 500nV/div.). Moreover, sensitivity is the same for both directions in the X–Y mode, with X-deflection via the A input.

The B-invert switch allows signals with inverted polarity to be displayed in phase with the reference signal. It also operates in the X–Y mode, allowing direct comparison of traces by inverting the polarity of the Y signal.

Auto triggering ensures a stable trace, locked to the screen at all times, yet allows trigger level adjustment between the peaks of a signal. In addition, triggering is possible from either A or B channel to avoid frequent changing of input cables during a test.

Double insulation allows otherwise difficult measurements, where results can be seriously affected by the presence of hum from grounds loops. Electrical safety is also assured by the double-insulated power supplies.

The unit is fully environmentally tested for use in workshop, field or industrial environments.

TECHNICAL SPECIFICATION

CRT

Type
Philips rectangular tube with 1.5kV accelerating voltage

Screentype
P31 (GH) phosphor standard
P7 (GM) phosphor optional

Useful screen area
8×10div of 1cm

Graticule
External graticule with centimetre division and 2mm divisions along the central axes

VERTICAL OR Y-AXIS

Response
DC: 0Hz...15MHz (−3dB)
AC: 10Hz...15MHz (−3dB)

Risetime
23ns

Deflection coefficient
5mV...10V/div. calibrated steps, 1-2-5 sequence.

Accuracy
±5%

Display modes
A
A±B
A&±B
±B

Input impedance
1MΩ//35pF

Input coupling
AC, DC

Maximum input voltage
400V (DC+AC peak)

HORIZONTAL OR X-AXIS

Horizontal display modes
– Time base
– X-Y operation with X defelection via Y_A input

HORIZONTAL AMPLIFIER

Response
DC: 0Hz...2MHz (−3dB)

Deflection coefficients
See Y-axis

Phase error
3° at 10kHz

TIMEBASE

Time coefficients
0.2s/div...0.5μs/div in 2×9 calibrated steps in 1-2-5 sequence
×5 magnifier extends max sweep rate to 100ns/div

Accuracy
±5%
Additional error for magnifier: ±2%

TRIGGERING

Trigger source
Internal: Y_A or Y_B
External

Trigger coupling
AC, TV

Slope
+ or −

Trigger sensitivity
Internal: 0.75div at 100kHz
External: 0.75V at 100kHz

Automatic trigger
Adjustable between peaks of signal

External trigger input impedance
1MΩ//35pF

Max allowable input volt
400V (DC+AC peak)

CALIBRATION

Signal available for probe adjustment

POWER

Line voltage and freq.
110, 220 or 240V AC±10%, 45...66Hz

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organisation in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING INSTRUMENTS DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use: +5°C...+40°C
Limits for operating: −10°C...+45°C
Storage and transport: −40°C...+60°C

Altitude:
Operating: to 5000m (15000ft)
Non-operating: to 15000m (45000ft)

Humidity
21 days cyclic damp heat at 25°C–40°C, R.H. 95%

Shock
30g: half sine wave shock of 11ms duration:
3 shocks per direction for a total of 18 shocks.

Vibration
3g vibrations in three directions with a maximum of 15min per direction; 10 minutes with a frequency of 15-25Hz and amplitude of $1mm_{p-p}$. Unit mounted on vibration table without shock absorbing material.

Recovery time
Operates within 30 minutes coming from −10°C soak, going into 60% relative humidity at +20°C room conditions.

Safety
The insulation between PM 3207 and line fulfills the safety requirements of IEC 248 for Class II instruments.

POWER

Line voltage and freq.:
110, 220 oe 240V AC ±10%, 45...66Hz

Power consumption:
25W at nominal line voltage.

DIMENSIONS AND WEIGHT

(w×h×d) 300×130×370mm
(11.8×5×14.6-in)
4.7kg (10.4lb)

ACCESSORIES SUPPLIED

Operating manual

OPTIONAL ACCESSORIES

PM 9326	Passive probe 1:1/10:1 (1.1m)
PM 9327	Passive probe 1:1/10:1 (2.1m)
PM 9328	Set of two passive probes 1:1/10:1
PM 8921	Passive probe 1:1 (1.5m)
PM 8921L	Passive probe 1:1 (2.5m)
PM 8925	Passive probe 10:1; 11pF (1.5m)
PM 8925L	Passive probe 10:1; 14pF (2.5m)
PM 8932	Passive probe 100:1; max voltage 4000V; pF (1.5m)
PM 8940	High voltage isolation amplifier for floating measurements at $650V_{RMS}$
PM 8943	FET probe 650MHz, 1:1/10:1/100:1
PM 8967	19-in rackmount adapter
PM 9381	Oscilloscope camera
PM 9366	Collapsible viewing hood
PM 8980	Long type viewing hood
PM 8994	Set of accessories for probes

15MHz Dual trace oscilloscope PM 3211

15MHz/2mV

Large, bright 8×10cm screen

Comprehensive trigger and display facilities, including TV triggering

Double insulation avoids ground loop interference

A±B display

Designed for general-purpose, everyday, use in laboratories, service workshops and field applications the PM 3211, whilst of compact dimensions, features a full-size 8×10cm screen. The A and B channels can be added and the B channel inverted so that A+B or A−B can be displayed.

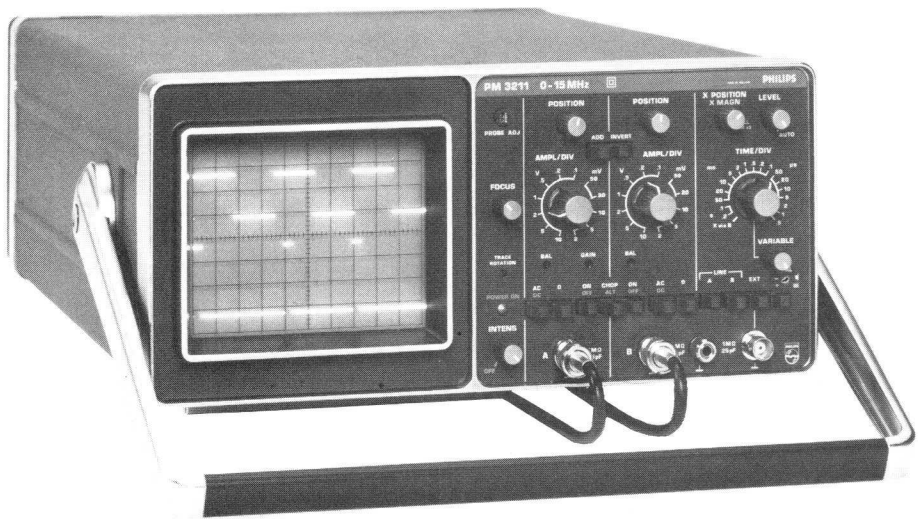
The comprehensive trigger and display facilities include multi-sourced 'Auto' or 'Level' set modes (no need to reverse the probes and TV triggering.)

Channel B can also be used as an X-input allowing X-Y displays to be made at all attenuation settings.

The continuously variable timebase simplifies such measurements as, for example, phase, or timing comparisons.

A ×5 magnifier extends the maximum sweep rate to 100ns/cm. Interference introduced by ground loops is eliminated by the double insulation technique, which allows a 2-wire line connection to be used. The unit will operate from 110... 240V_{AC} at 46...440Hz, supplies.

A sturdy carrying handle protects both the CRT and controls during transportation. This very versatile, compact instrument weighs only 7.5kg (16.5lb).



TECHNICAL SPECIFICATION

CTR

Type
Philips rectangular mesh-type post deflection accelerator tube with 4kV accelerating voltage

Screen type
P31 (GH) phosphor standard
P7 (GM) phosphor optional

Useful screen area
8×10div of 1cm

Graticule
External graticule with centimeter divisions and 2mm divisions along the central axes.

VERTICAL

Response
DC: 0Hz...15MHz (−3dB)
AC: 10Hz...15MHz (−3dB)

Risetime
23ns

Deflection coefficient
2mV...10V/div calibrated steps, 1-2-5 sequence.

Accuracy
±3%

Display modes
Channel A only
Channel B only
Alternate
Chopped at 250kHz approx.
Added
Channel B can be inverted

CMRR
100:1 at 1MHz
(A-B mode with 8div of common mode signal)

Input impedance
1MΩ//25pF

Input coupling
AC, DC, O

Maximum input voltage
400$V_{DC+ACpk}$

Maximum deflection
Display is undistorted for a maximum deflection of up to 24div for since wave signals with frequencies of up to 5MHz.
Shift range ±8div.

HORIZONTAL

Horizontal display modes
– Time base
– X-Y operation with X deflection via Y_B input

HORIZONTAL AMPLIFIER

Response
DC: 0Hz...1MHz (−3dB)

Deflection coefficients
See Y-axes

Phase error
3° at 50kHz

TIME BASE

Modes
– Auto-free-run with automatic top detection
– Triggered

Time coefficients
0.2s/div...0.5μs/div in 18 calibrated steps in 1-2-5 sequence. Uncalibrated continuous control between steps 1: ⩾ 2.5

Accuracy
±3%
Additional error for magnifier: ±2%

TRIGGERING

Trigger source
Internal: Y_A
Y_B
Line
External

Slope
+ or –

Trigger sensitivity
Internal: 0.75div at 5MHz
External: 0.4V at 5MHz

Trigger modes and coupling
AFR: 20Hz...15MHz
Normal: 10Hz...15MHz
: TV triggering

External trigger input impedance
1MΩ//25pF

Max. allowable input voltage
$400V_{DC+ACpk}$

CALIBRATION

Signal available for probe adjustment

POWER

Line voltages and frequencies
110, 127, 220 and $240V_{AC}$ ±10% 46...440Hz

Power consumption
20W at nominal line voltage

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by the PHILIPS organization in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperatures
Rated range of use: +5°C...+40°C
Limits for operating: –10°C...+55°C
Storage and transport: –40°C...+70°C

Altitude
Operating: to 5000 (15000ft)
Non-operating: to 15000m (45000ft)

Humidity
21 days cyclic damp heat 25°C–40°C R.H. 95%

Shock
30g: half sine wave shock of 11ms duration: 3 shocks per direction for a total of 18 shocks.

Vibration
Vibrations in three directions with a maximum of 15min per direction; 5–55Hz and amplitude of $0.7mm_{p-p}$ and 4g max. acceleration.
Unit mounted on vibration table without shock absorbing material.

Recovery time
Operates within 30 minutes coming from –10°C soak, going into 60% relative humidity at +20°C room conditions.

Electromagnetic interference
Meets VDE, 0871 and VDE 0875
Grenzwertklasse B

Safety
The insulation between PM 3211 and line fulfills the safety requirements of IEC 348 for metal encased Class II instruments

DIMENSIONS AND WEIGHT

(w × h × d) 300 × 135 × 445mm
(11.8 × 5.3 × 17.5-in)
7.5kg (16.5lb)

ACCESSORIES SUPPLIED

Operating and service manual
Front cover
BNC-Banana adapter

OPTIONAL ACCESSORIES

PM 9326	Passive probe 1:1/10:1 (1.1m)
PM 9327	Passive probe 1:1/10:1 (2.1m)
PM 9328	Set of two passive probes 1:1/10:1
PM 8921	Passive probe 1:1 (1.5m)
PM 8921L	Passive probe 1:1 (2.5m)
PM 8925	Passive probe 10:1; 11pF (1.5m)
PM 8925L	Passive probe 10:1; 14pF (2.5m)
PM 8932	Passive probe 100:1; max. voltage 5600V; 2pF (1.5m)
PM 8940	High voltage isolation amplifier for floating measurements at $650V_{RMS}$
PM 8943	FET probe 650MHz, 1:1/10:1/100:1
PM 8962	19-in rackmount adapter
PM 9355/01	Current probe 12Hz...70MHz
PM 9381	Oscilloscope camera
PM 8972	Camera adapter for stationary mounting PM 9381
PM 8992	Accessory pouch
PM 9366	Collapsible viewing hood
PM 8980	Long type viewing hood
PM 8910	Polaroid anti-glare filter
PM 8991	Oscilloscope trolley
PM 8994	Set of accessories for probes

INSTRUMENT OPTION

$-24V_{DC}$ input
is available as service modification.
Contact your local Philips field engineer for detailed information.

Accessory Selection chart

				PM 3207 15MHz dual trace oscilloscope	PM 3211 15MHz dual trace oscilloscope	PM 3212 25MHz dual trace oscilloscope	PM 3214 25MHz dual trace, dual time base oscilloscope	PM 3216 35MHz dual trace oscilloscope	PM 3218 35MHz dual trace, dual time base 'scope	PM 3225/PM 3226 15MHz general purpose single/dual trace	PM 3232/33/34 10MHz double beam oscilloscope	PM 3243 50MHz storage oscilloscope	PM 3244 50MHz four-channel oscilloscope	PM 3262 100MHz dual trace portable oscilloscope	PM 3263 100MHz dual trace with digital delay	PM 3265(E) 150MHz dual trace portable oscilloscope	PM 3266 100MHz dual trace	Page
Probes (passive)																		
PM 9326	1:1 and 10:1	15MHz 1:1m		×	×					×	×							46
PM 9327	1:1 and 10:1	15MHz 2:1m		×	×					×	×							46
PM 9328	Set of two probes	10:1/100:1		×	×					×	×							46
PM 8921(L)	1:1	25MHz 1.5 or	2.5m(L)	×	×	×	×	×	×	×	×	×	×	×	×	×	×	46
PM 8925(L)	10:1	25MHz 1.5m or	2.5m(L)	×	×	×	×	×	×	×	×							47
PM 8927(L)	10:1	50MHz 1.5m or	2.5m(L)									×	×					47
PM 8935(L)	10:1	250MHz 1.5m or	2.5m(L)											×	×	×	×	47
PM 8932	100:1 4000V	175MHz	1.5m	×	×	×	×	×	×	×	×	×	×	×	×	×	×	47
Probes (active)																		
PM 8940	Isolation amplifier			×	×	×	×	×	×	×	×	×	×	×	×	×	×	48
PM 8943	1:1, 10:1 and 100:1	650MHz FET-probe		×	×	×	×	×	×	×	×	×	×	×	×	×	×	49
PM 9355/01	Current probe 12Hz to	70MHz		×	×	×	×	×	×	×	×	×	×	×	×	×	×	50
Rack mount adapters 19-in																		
PM 9359											×							51
PM 8962					×	×		×										51
PM 8963							×		×									51
PM 8960												×	×	×	×	×	×	51
PM 8967				×														51
Sundries																		
PM 8994	Accessories for probes			×	×	×	×	×	×	×	×	×	×	×	×	×	×	51
PM 8992	Accessory pouche				×	×	×	×	×				×	×	×	×	×	51
Camera and camera adapters																		
PM 9381	Oscilloscope camera			×	×	×	×	×	×		×	×	×	×	×	×	×	52
PM 8973	Adapter for stationary use										×							52
PM 8972	Adapter for stationary use				×	×	×	×	×									52
PM 8974	Adapter for stationary use											×	×					52
PM 8976	Adapter for stationary use													×	×	×	×	52
Graticules and filters																		
PM 8910	Polaroid anti-glare filter				×	×	×	×	×			×	×	×	×	×	×	51
Viewing hoods																		
PM 9366	Collapsible viewing hood			×	×	×	×	×	×			×	×	×	×	×	×	51
PM 8980	Closed, long type viewing hood			×	×	×	×	×	×			×	×	×	×	×	×	51
Battery pack																		
PM 8901	Battery pack $24V_{DC}$ and $260V_{DC}$					×	×	×	×		×	×	×	×	×	×	×	51
Trolley																		
PM 8991					×	×	×	×	×		×	×	×	×	×	×	×	51

* no longer available

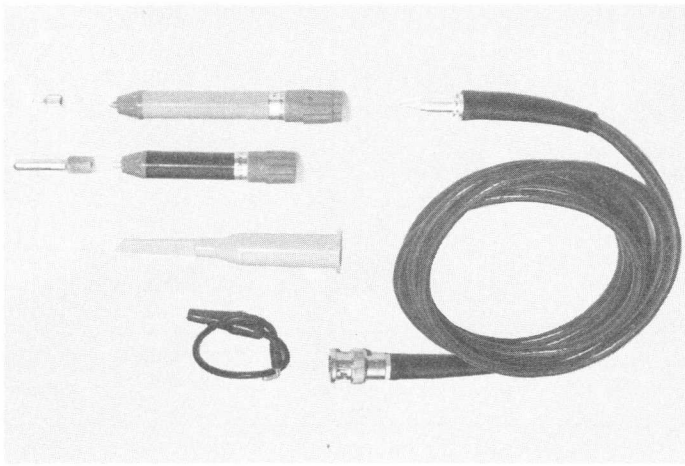
Survey of probes

Type	Atten.	Length (m)	Loading (MΩ)	Loading (pF)	Zero ref	DC_{max} (V)	Useful BW (MHz)	Probe only rise time ns	Scope C in pF
PASSIVE PROBES									
PM 9326	1× 10×	1.1 1.1	1 10	32[1] 8	no	1000 1000	15 15	20 7	any 10...55
PM 9327	1× 10×	2.1 2.1	1 10	58 8	no	1000 1000	15 15	35 7	any 10...30
PM 8921	1×	1.5	1	42[1]	no	500	15 15 10	17 20 26	15 and 15...20 and > 20
PM 8921L	1×	2.5	1	64[1]	no	500	10 10 10	25 29 37	15 and 15...20 and > 20
PM 8925	10×	1.5	10	11	yes	500	40	3 5	15...25 and 25...40
PM 8925L	10×	2.5	10	14	yes	500	40	3.5 5.5	15...25 and 25...40
PM 8927	10×	1.5	10	11	yes	500	80	1.7 2.3	14...17 and 17...21
PM 8927L	10×	2.5	10	14	yes	500	80	2 2.7	14...17 and 17...21
PM 8932	100×	1.5	20	2	yes	4000	175 60	1.2 3.5	10...21 and 21...30
PM 8935	10×	1.5	10	11	yes	500	250	0.6 0.9	10...11 and 11...16
PM 8935L	10×	2.5	10	14	yes	500	250	0.7 1.1	10...11 and 11...16
ACTIVE PROBES									
PM 8940 Isolation ampl.	–	2.3	10 1	9 45	–	$650V_{RMS}$	1.5	230	any
PM 8943 FET probe	1× 10× 100×	1.5	1 1 1	3.5 2.2 1.4	–	100 200 200	650	0.55	14...21
PM 9355 Current probe	–	1.5	–	–	–	–	12Hz...70MHz	8	any

1) Plus capacitance of oscilloscope

PM 9326 and PM 9328

General purpose passive probes — DC . . . 15MHz



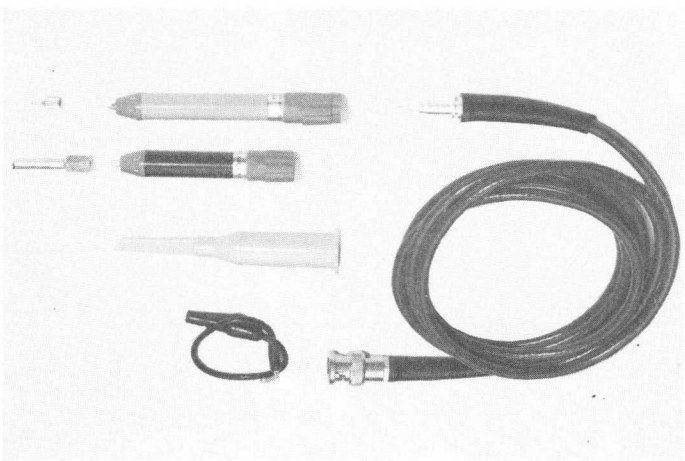
These probes are designed for use in the frequency range DC to 15MHz. The probe head is removable and can be selected to give an attenuation of either 1 :1 or 10:1
Included parts: Probe cable 1.5m; ground lead; probe heads; 10:1 and 1 :1 ; measuring hook.

TECHNICAL SPECIFICATION

With 1 :1 attenuator	PM 9326	PM 9328
Input resistance	1MΩ	Identical to
Input capacitance	32pF	PM 9326
Rise time (probe only)	20ns	but with
Max. input voltage	$1kV_{DC+ACpk}$	two probes
Cable length	1.1m	
With 10:1 attenuator		
Attenuation	10× ±3%	
Input capacity when connected to 20pF scope input	8pF	
Compensation range	10...55pF	
Rise time (probe only)	7ns	

PM 9327

General purpose passive probes — DC . . . 15MHz

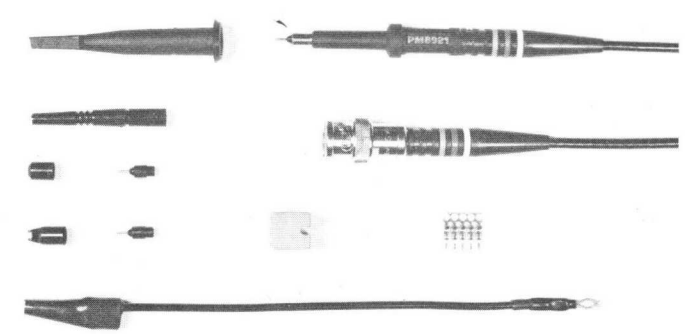


TECHNICAL SPECIFICATION

With 1 :1 attenuator	PM 9327
Input resistance	1MΩ
Input capacitance	58pF
Rise time (probe only)	35ns
Max. input voltage	$1kV_{DC+ACpk}$
Cable length	2.1m
With 10:1 attenuator	
Attenuation	10× ±3%
Input capacity when connected to 20pF scope input	8pF
Compensation range	10...30pF
Rise time (probe only)	7ns

PM 8921(L)

General purpose passive 1:1 probe — DC . . . 15MHz



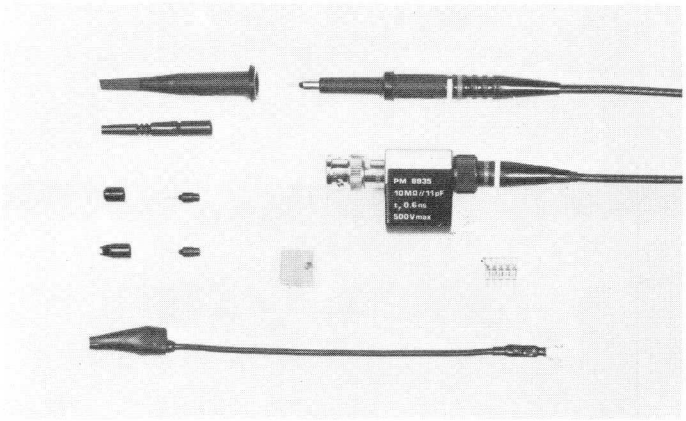
To be used with frequencies up to 15MHz, and with any measuring equipment having a BNC input connector
Included parts: Retractable hook tip; wire wrap adapter; dual in-line adapter; two spare tips; ground lead; protective cap; two insolating sleeve; probe holder; 5 contact clips.

TECHNICAL SPECIFICATION (for 1MHz//20pF scope)

	PM 8921	PM 8921L
Attenuation	1×	1×
Input resistance	1MΩ	1MΩ
Input capacity	42pF	64pF
Probe-only bandwidth	17MHz	12MHz
Probe-only rise time	20ns	29ns
Max. input voltage	$500V_{DC+ACpk}$	$500V_{DC+ACpk}$
Cable length	1.5m	2.5m

General purpose passive probes (with zero line reference)

PM 8925(L) DC . . . 40MHz
PM 8927(L) DC . . . 80MHz
PM 8935(L) DC . . . 250MHz



Included parts: Retractable hooktip, wire wrap adapter, dual in-line adapter, isolating sleeve, 2 spare tips, probe holder, 5 contact clips, ground lead.

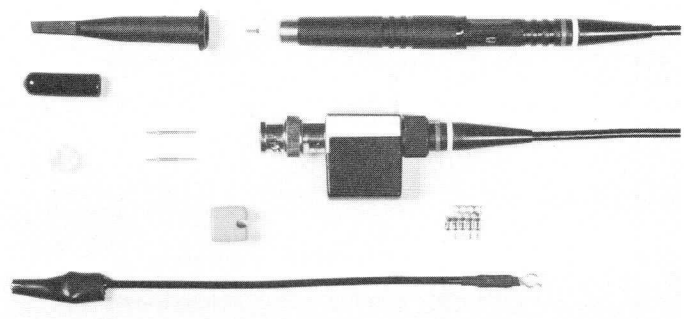
TECHNICAL SPECIFICATION

	PM 8925	PM 8925L	PM 8927	PM 8927L	PM 8935	PM 8935L
Attenuation	10×	10×	10×	10×	10×	10×
Input resistance	10MΩ	10MΩ	10MΩ	10MΩ	10MΩ	10MΩ
Input capacity	11pF	14pF	11pF	14pF	11pF	14pF
Probe only rise time	3ns	3.5ns	1.7ns	2ns	0.6ns	0.7ns
Compensation range	15... 40pF	15... 40pF	14... 21pF	14... 21pF	10... 16pF	10... 16pF
Max. input voltage (DC+ACpk)	500V	500V	500V	500V	500V	500V
Cable length	1.5m	2.5m	1.5m	2.5m	1.5m	2.5m

PM 8932

High voltage passive 100 : 1 probe (with zero line reference)

DC. . .175MHz



TECHNICAL SPECIFICATION

Attenuation	: 100×
Input resistance	: 20MΩ
Input capacity	: 2pF
Probe-only risetime	: 1.2ns
Compensation range	: 10...30pF
Max. input voltage	: 4kV DC+AC_{pk}
(derating above 1MHz)	5.6kV AC_{pk-pk}

Isolation amplifier
PM 8940

Bandwidth: DC . . . 1.5MHz
Max. common mode voltage: 650V_{RMS}
Max. differential input voltage: 650V_{RMS}
Deflection coefficient: 5mV/div

This isolation amplifier has been specially designed to facilitate accurate measurement of small signals floating on high potentials, without risk to the operator. It will handle signals from a few millivolts, superimposed on voltages up to a maximum amplitude of 650V_{RMS}.
A 15-step attenuator covers the range between 5mV and 200V per division to allow maximum use of the oscilloscope screen. This feature plus the high common mode rejection of 1:800,000 in the 5mV/div setting allows easy observation of minute details in complex waveforms. The combination of the characteristic input capacitance of the unit and its low input impedance with respect to ground ensures good, reliable oscillograms of floating signals at frequencies up to 1.5MHz.
The unit consists of two parts, the pre-amplifier and the attenuator. This allows the probe to be used as close as possible to the circuit under test but allows the attenuator to be operated at a safe distance from the area where a high potential is present.
Connection of the measuring cables to the pre-amplifier is by means of a screw terminal recessed within the pre-amplifier housing. Disconnection thereafter demands the use of a screwdriver, alerting users to the presence of high voltages and motivating them to remove the high voltage source before proceeding further.
The two amplifier inputs cover the ranges 5 to 20mV and 50mV to 200V per division.
The amplifier is part-powered by batteries ('front' end to opto-coupler) with an automatic switch-off after 10 mins, option, and a line voltage step-down unit contained inside the line plug (opto-coupler and 'back' end).
The high voltage cable used to interconnect the sub units will withstand up to 250°C max to avoid damage should it come into contact with high temperature apparatus.

TECHNICAL SPECIFICATION

		Input I	Input 2
Bandwidth:	DC:	0...1.5MHz	0...1.5MHz
	AC:	3Hz...1.5MHz	3Hz...1.5MHz
Abberations:		⩽ ±3%	⩽ ±3%
Max. wire diameter:		2mm	2mm
Defl. coefficient:		50mV...200V/div	5mV...20V/div
Defl. accuracy:		⩽ ±3%	⩽ ±3%
Max. diff. inp. voltage:		650V_{RMS}	30V_{RMS}
Diff. inp. impedance:		10MΩ//9pF	1MΩ//40pF
Common mode rejection (For 650V_{RMS} sine wave, common mode voltage; DC to 60Hz)		⩽ 0.5div (500mV...200V/div)	⩽ 0.5div
Max. common mode inp. volt:		650V_{RMS}	650V_{RMS}
Input capacitance to ground:		60pF	25pF

OUTPUT:

Load:	1mΩ//±10...40pF	
Dynamic range:	20div	*
Output offset:	⩽ 0.25div	*
Drift:	⩽ 0.05div/°C	*
Noise:	⩽ 0.05div	*

*Oscilloscope at 20mV/div and DC coupling.

POWER SUPPLY:

AC supply:	220V (−10%/+20%)
Frequency:	50...400Hz (±10%)
Power consumption:	10VA max
DC supply:	two 9V batteries. (Giving two hours operating time)

FET probe
PM 8943

DC to 650MHz Bandwidth

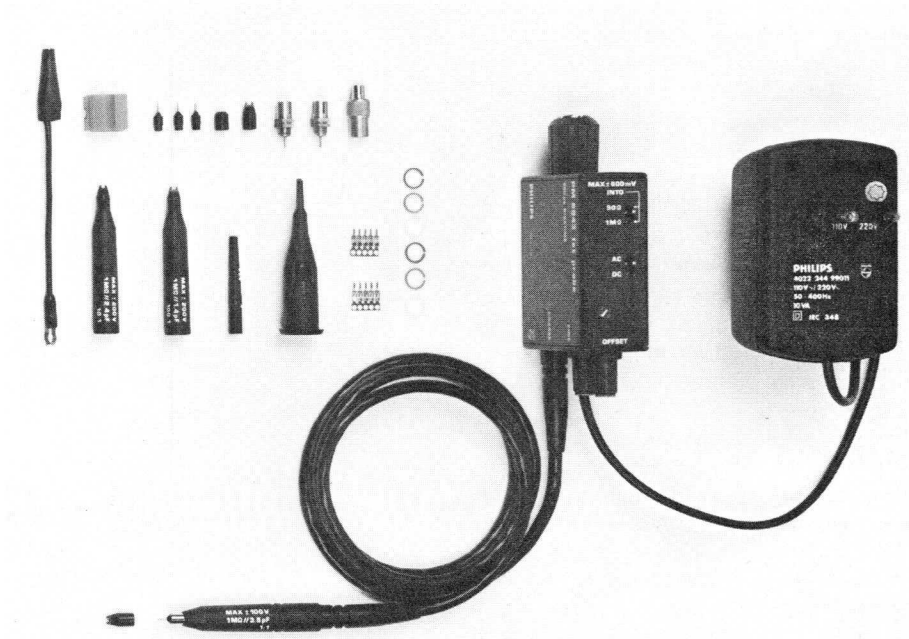
Transmission factor 1:1

Input impedance 1MΩ//3.5pF

DC offset

DC-AC coupling switch

For 50Ω and 1MΩ systems



The PM 8943 is designed for the measurement of low level, high frequency signals. Using the probe makes it possible to measure high frequency signals with a 1:1 gain still having a good frequency response and a minimum loading of the circuit under test. The plug-on attenuator heads offer higher maximum input voltages and give an extra reduction of the input capacitance. DC–AC coupling can be selected by a switch without having to change the probe. The PM 8943 is invaluable for use in 50Ω and 1MΩ systems having a BNC input, such as oscilloscopes, counters, analyzers etc.

TECHNICAL SPECIFICATION

Gain
1×

Bandwidth
DC to 650MHz
1Hz to 650MHz

Rise time
⩽ 0.55ns

Input resistance
1MΩ

Input capacitance
3.5pF

Dynamic range
0.6V

Offset voltage
±5V

Noise (tangential)
250μV

Max. input voltage
$100V_{DC+ACpk}$

Power supply
220, 100V +20%/−10%

Signal delay
8.5ns

Output load
50Ω or 1MΩ

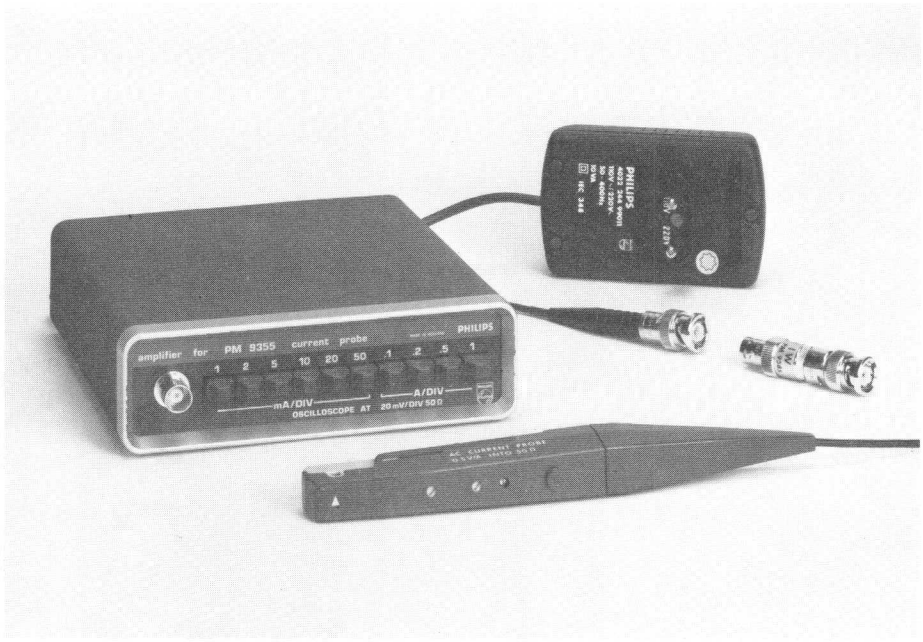
Attenuator 10×
Input resistance: 1MΩ
Input capacitance: 2.2pF
Dynamic range: 6V
DC offset: ±50V

Attenuator 100×
Input resistance: 1MΩ
Input capacitance: 1.4pF
Dynamic range: 60V
DC offset: ±200V

AC current probe PM 9355/01

12Hz . . . 70MHz
High 1mA/div sensitivity
Low circuit loading
Low noise level: 150μV

The PM 9355 AC current probe and amplifier combination is ideal for measuring currents from 12Hz to 70MHz. The clip-on current transformer allows measurements on wires up to 3mm in diameter without disconnection. The 100 : 1 transformer gives signal measurements with minimum loading (0.005Ω//2.5μH).
The low 150μV noise level combined with a sensitivity of 1mA/mV (with scope set to 50mV/div) ensures accurate, clear reading of low-amplitude signals. Selection of the required sensitivity is done by means of a calibrated switch on the amplifier.
Main applications for the current probe include measurements of currents from 12Hz to 70MHz without unsoldering wires. There is minimum loading on the circuit, and the construction of the probe virtually eliminates the chance of an accidental short circuit during attachment of the probe to the conductor. The insulated transformer even allows measurements on uninsulated wires.
Common mode rejection ratio measurements are possible if the currents through two conductors are in opposite directions, giving zero flux in the transformer.



PM 9355/01 comprises

1. Current probe
2. Current probe amplifier
3. 50Ω BNC feedthrough termination
4. Earth lead
5. Carrying case
6. Manual

TECHNICAL SPECIFICATION

Sensitivity
1mA/div to 1A/div in 10 steps with oscilloscope set at 20mV/div. Accuracy ±3%.

Bandwidth
5mA/div to 1A/div 12Hz to 70MHz;
1mA/div to 1A/div 12Hz to 45MHz.

Risetime
5mA/div to 1A/div, 5ns;
1mA/div to 1A/div, 8ns.

Dynamic range
approx 6 divisions.
(oscilloscope set at 20mV/div)

Output load
50Ω (50Ω termination included for 1MΩ systems).

Maximum Voltage
$600V_{DC+ACpk}$ (probe closed)

Maximum current
$12A_{p-p}$

Noise
150μA (referred to input)

Capacitive load
0.5pF to 2pF depending on wire diameter

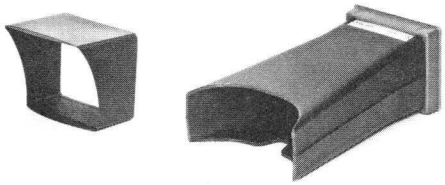
Power
220, 100V (+20%, −10%)

Temperature range
+ 5°C to +40°C within specification,
−10°C to +55°C operating,
−40°C to +70°C storage and transport.

Accessories

Viewing hoods

PM 9366 Collapsible viewing hood for PM 3207, PM 3211/12/14/16/18, PM 3240(X), PM 3243/44, PM 3261*, PM 3262, PM 3263, PM 3265E, PM 3266.



PM 8980 Closed, long type viewing hood PM 3207, PM 3211/12/14/16/18, PM 3240(X), PM 3243/44, PM 3262, PM 3263, PM 3265E, PM 3266.

Miscellaneous

PM 8994 Set of probe accessories
1 × ground cable 30cm
1 × ground cable 15cm for wire-wrap
1 × ground cable 30cm for wire-wrap

Graticules and filters

PM 8910 Polaroid anti-glare for PM 3211/12/14/16/18, PM 3240(X), PM 3243/44, PM 3262, PM 3263, PM 3265(E), PM 3266.

Battery packs and supply units

PM 8901 330V/24V battery pack. Sealed lead acid batteries giving 180Wh from full charge. Charging time 10h. Protected against overload, short-circuit and excessive discharging.
Operation time:

PM 3232*/33:	9h
PM 3234:	5.5h
PM 3240(X):	7.5h
PM 3212/16:	12h
PM 3214/18:	10h
PM 3243:	3h
PM 3244:	5h
PM 3262:	3h
PM 3266	2.5h

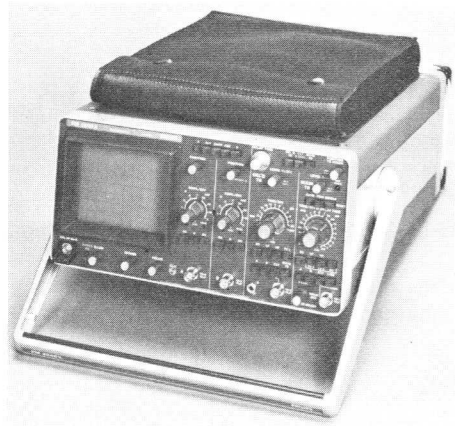
* no longer available

PM 8991 Trolley
To make an optimum use of the lab features of the light weight oscilloscopes, a trolley is available for the following type numbers: PM 3211/12/14/16/18, PM 3232*/33, PM 3240(X), PM 3243/44, PM 3262, PM 3263, PM 3265(E), PM 3266

The oscilloscope tray can be positioned from −15° downwards to 70° upwards. This possibility together with the solid wheels (2 × 20cm and 2 × 8cm ∅) offers good mobility of your scope under all lab and service conditions.

Carrying cases and accessory pouches

PM 8992/01 Accessory pouche for PM 3211/12/14/16/18, PM 3240(X), PM 3244, PM 3262, PM 3265(E).



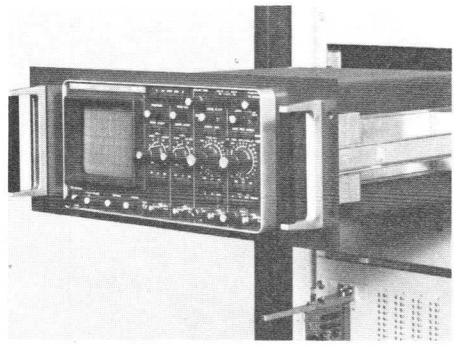
19-in rack mount kits

A wide range of 19-in rack mount kits is available.

The following kits are available:

PM 9359	for the PM 3232*, PM 3233 and PM 3234 with slide-out assembly
PM 8960	for the PM 3240(X), PM 3243, PM 3244, PM 3262, PM 3263, PM 3265(E), PM 3266 with slide-out assembly shown
PM 8962	for the PM 3211 and PM 3212
PM 8963	for the PM 3214
PM 8967	for the PM 3207

* no longer available



Cables and adapters

PM 9581	50Ω termination 3W
PM 9585	50Ω termination 1W
PM 9067	T-piece adapter 1 × BNC (male) 2 × BNC (female)
PM 9051	Adapter BNC (male) - Banana (female)
PM 9053	Adapter BNC (female) – Banana (male)
PM 9061	Adapter BNC (female) – BNC (female)
PM 9071	Cable (135Ω) Banana-banana
PM 9072	Cable (135Ω) BNC-banana
PM 9074	Cable (50Ω) BNC-BNC
PM 9075	Cable (75Ω) BNC-BNC

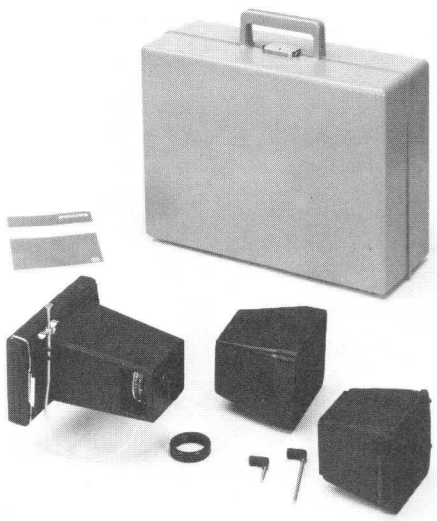


Fig. 1. PM 9381 kit which gives the user the option of a handheld or fixed arrangement.

Fig. 2. PM 9381 shown fitted to an oscilloscope.

Camera

CAMERA PM 9381 FOR INSTANT OSCILLOGRAMS

If photos of oscilloscope waveforms have to be taken, one operator likes to have the camera permanently fitted to the oscilloscope, whilst another may prefer not to have this disturbing object on his measuring instrument.
With the PM 9381 both preferences can be met. The PM 9381 is delivered as a handhold camera together with those extra tools necessary for modifying it into a stationary camera (Fig. 2). Separate adapters for different type of oscilloscopes fit the camera to the required instrument (Fig. 1). The camera with the adapter for handhold operation is supplied in an attractive case which also offers storage space for the separate adapters for stationary use plus two extra film packs.

TECHNICAL SPECIFICATION

Oscilloscope camera including adapter for hand hold use.

Camera Body	: High quality ABS moulding with attached Polaroid 101 series film back.
Lens	: Moulded two element f3.5 70mm focal length with aperture control down to f32.
Shutter	: Self cocking, mounted between lens. Speeds from 1 second to 1/125th inclusive, with 'B' for time exposures. Built in 'X' contact for event triggering. Shutter actuated by cable release.
Focus	: Fixed by method of mounting for correct distance.
Object to Image Ratio	: Up to 8 × 10cm displays 1 < 0.85 fixed.
Film	: Polaroid Black and White 8 exposure film packs Type 107C 3000 ASA Type 665 75 ASA Pos./Neg.

Adapters for stationary use:
PM 8972 for PM 3211, 3212, 3214, 3216, 3218
PM 8973 for PM 3232, 3233, 3234
PM 8974 for PM 3243, 3244
PM 8976 for PM 3260 fam. + PM 3240

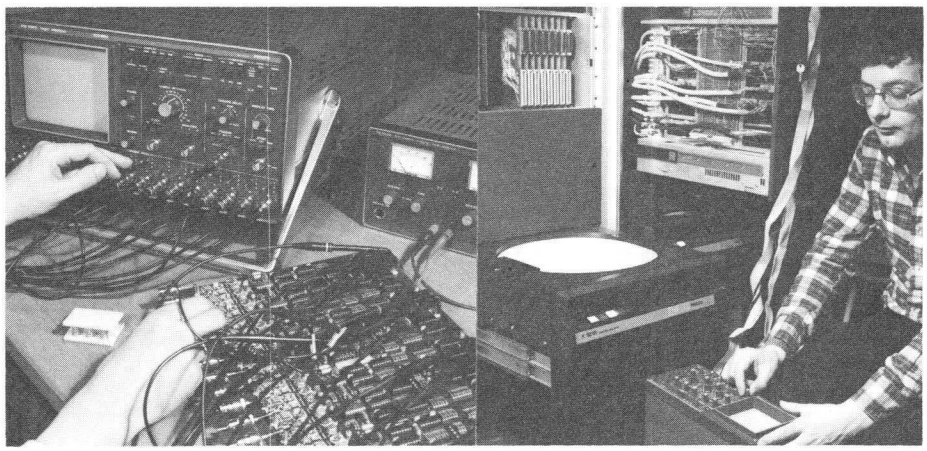
Data test equipment

Introduction

The world of electronics is changing rapidly from analog to digital techniques. This can be seen in many areas – from professional to consumer products. The result has been new test demands which will not be adequate using analog methods.

Digital circuitry requires digital test equipment both for locating faults and for analyzing the cause. In fact, it is impractical to separate these two aspects (for the same reason that it is also impractical in the analog case). However, logic analyzers, with their capacity for simultaneous observation of lines of data can simplify otherwise complex measurements.

Philips' logic analyzers are designed to provide for the location *and* analysis of digital faults in a single package. The two currently available instruments provide both timing and state facilities to tackle software, or hardware or compounded faults, allowing the user to solve all his problems with a single instrument. The two instruments have also been designed for ease of use. In particular, the design concepts of the PM 3500 and PM 3540 have been aimed at achieving a smooth transition from analog to digital test equipment. Moreover, the feature of simplified operation has been achieved by concentrated attention to ergonomic design aspects.



Covering the whole spectrum of applications from laboratory to the factory and field servicing with Philips logic analyzers.

Two-ended approach

Logic analyzers are needed at all levels of digital testing – between the extremes of design/research and development to field servicing. For this reason, Philips has approached this wide span of requirements with these and other application areas in mind.

The resulting instruments therefore, combine timing and state analysis facilities for maximized analyzing capability. While the PM 3500 provides full logic timing and state analysis up to 100MHz, the PM 3540 provides oscilloscope timing capabilities to follow up problems located by an integral logic state analyzer.

Both instruments are built around microprocessors to provide maximum flexibility. This means that for example in the PM 3500 it is possible to switch instantaneously from timing to state analysis; also a wide choice of state formatting is possible – binary, hexadecimal, octal or mapping to enable easy cross-referencing.

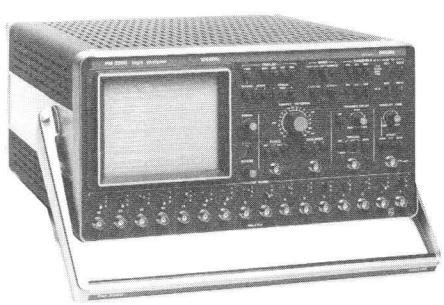
Continuously-displayed summaries show the status of each instrument and simplify setting up of measurements. Attention to details such as ensuring that the trigger word is displayed – and can be set – in the same format as displayed data means that the instruments are very easy to use.

To help the user to understand exactly why Philips has produced these two instruments, it is perhaps a useful exercise to examine digital testing in more detail in order to appreciate how Philips' logic analyzers can help meet these special needs.

Digital test requirements

While analog circuits can be tested by checking voltage levels and signals at several points, digital circuitry depends on states and complex, interacting, time-relationships. Trouble-shooting on digital circuitry is therefore inherently more complex than in purely analog situations. Faults in digital circuitry can be either software or hardware based – or a combination of the two and the capability of being able to check both types of problem is a *must* for simple testing. A general-purpose logic analyzer can do just this.

Reduced to basic terms, logic analyzers simply handle timing and state measurements. A timing analyzer will provide a timing diagram to allow the examination of time relationships in hardware. Logic state analyzers provide state displays – in binary or other formats for software debugging and hardware fault location.



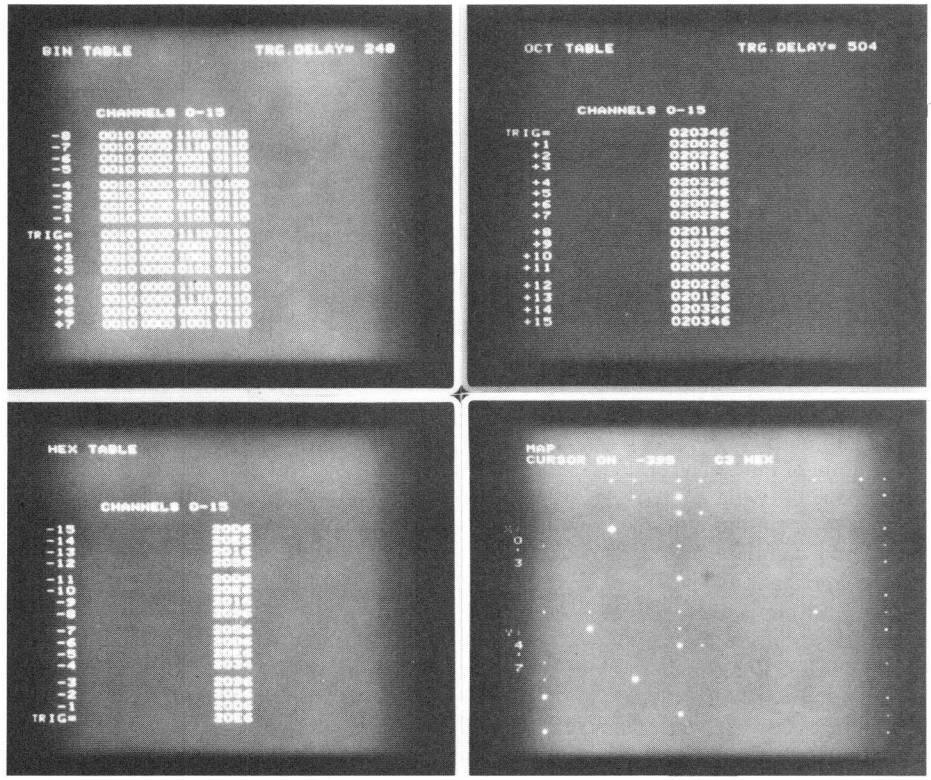
The PM 3500 logic analyzer functions in both state and timing modes.

Philips' analyzers provide both timing *and* state facilities, being designed as general purpose instruments capable of handling both hardware and software work.

In many ways, the logic analyzer is the digital equivalent of the oscilloscope. Of course it cannot be considered as a replacement but rather as an ancillary device capable of viewing many lines of data simultaneously.

A logic analyzer has completely separate acquisition and display processes to allow data patterns to be frozen and stored for analysis. Unlike an oscilloscope, it *stops* when it reaches a trigger point.

This allows the observation of the relationship between a number of logic signals either before or after a defined condition has triggered the instrument. A major benefit is the provision of a most convenient examination facility, allowing detailed study of the events leading up to a particular fault.



Use of a microprocessor in the PM 3500 analyzer allows simple switching between display formats for state analysis, providing binary, octal and hexadecimal tables with the added facility of a mapping mode.

Logic analyzer operation

Any logic analyzer is made up of four basic components: a data acquisition section; a storage section; a control section with interpretation capability; and a display section.

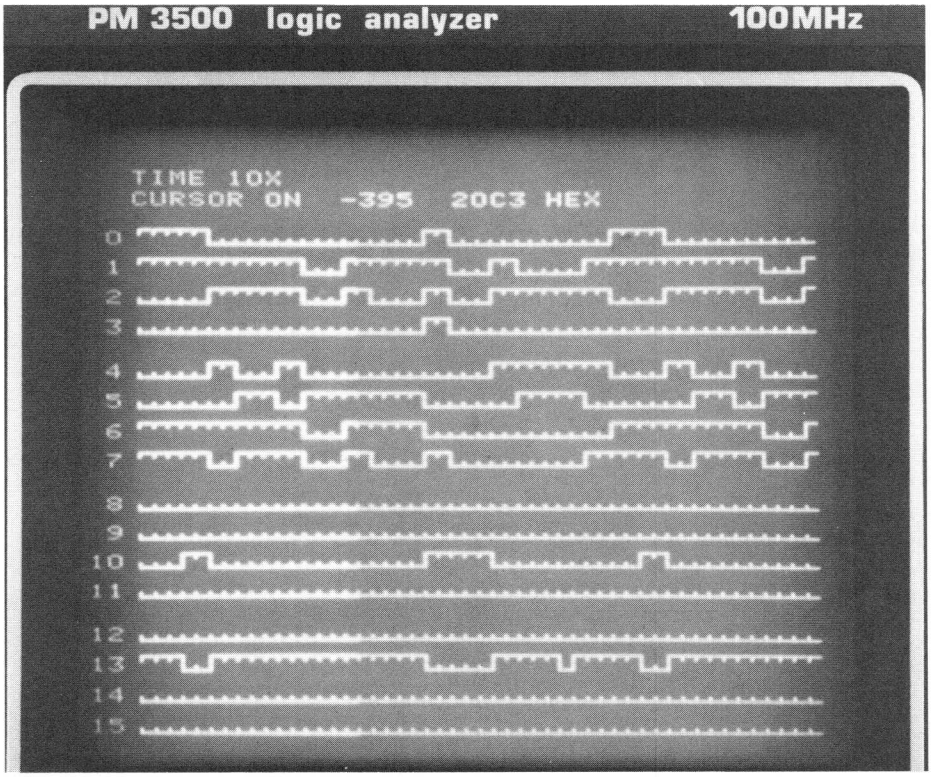
The data acquisition section receives parallel data simultaneously from the circuit being tested. The number of channels can vary. While eight may be adequate for timing analysis, trouble-shooting is simplified using extra channels. Microprocessors or minicomputers with multiple data lines often require even more. The PM 3500 and PM 3540 are optimized with 16 channels, this being adequate for general work. (For an operator to absorb more than 16 channels at one time can be difficult – especially for timing display).

Triggering on even more channels simplifies analysis however, so Philips' logic analyzers provide trigger word expansion. The incoming data is converted to 'ones' and 'zeros' using a voltage threshold adapted to the logic family being tested. Fixed, switch – selectable or continuously – variable settings allow work with several families – TTL, ECL, CMOS and so on. The PM 3500 can handle two different logic families at the same time – useful for checking microprocessors and associated circuitry, for example.

Data is sampled at set intervals and stored in a memory. Two types of sampling are possible: synchronous or asynchronous. In the synchronous mode the sampling intervals depend on the clock rate of the system being tested. Asynchronous sampling allows a much higher clock rate by using an independant clock.

Synchronous sampling results in a sequence of status signals allowing a step-by-step check of software action, that is, state analysis. Sampling at a higher clock rate – asynchronous analysis – means that timing behaviour can be studied for debugging control and interface hardware, for example.

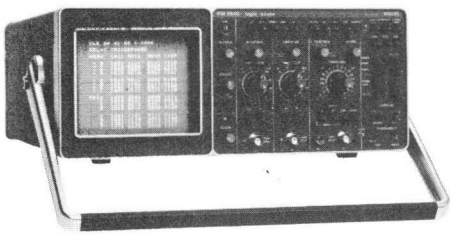
In the PM 3500 timing mode the display can be expanded more easily to simplify detailed examination.



Matching clock rates

Sampling speed depends on the application. Synchronous analysis on microprocessors is satisfied by a nominal 4MHz

while minicomputers need higher speeds. For this reason, the PM 3540 analyzer section operates at up to 10MHz, while the PM 3500 is considerably faster.
As a 'rule-of-thumb', asynchronous sampling needs to be five or ten times faster than circuit clock rates to allow, say, for pulse widths and delays between channels to be examined in detail. This is why the PM 3500 operates at 100MHz.
A useful facility is a glitch catching mode. Such as latch system allows glitches shorter than the sampling period to be captured. The latch mode on the PM 3500 allows glitches as short as 3ns to be captured.
The kernel of the analyzer is the memory. This must be wide enough to store the parallel data input and fast enough to handle the sampling rate used depending on the application.
In asynchronous timing work, memory depth needs to be long enough to store a couple of instructions – making a connection between speed and depth. The PM 3500, 100MHz instrument therefore, provides in the order of 1/2 k words of 16-bits of memory.
Memory depth for state analysis is less critical. The main criterion is storing enough steps of the program being tested for analysis. The memory depth of 64 words of 16-bits in the PM 3540, for example, is adequate for most a purposes.



PM 3540 logic scope.

In addition, memory depth can be used more effectively by exploiting extra trigger facilities and clock qualifiers. Clock qualification is used to gate the sampling clock. This gives a selective sampling possibility which enables the user to determine which precise state he wishes to analyze. (E.g. it may be required only to read statements from selected peripherals). It thus optimizes the use of total memory capacity.

Word recognition triggering

Data is acquired in a continuous stream and stored until a trigger pulse occurs. The most common form of triggering in logic analyzers is word recognition. This compares the incoming data with a specific word preset by the operator – matching of word and input results in a trigger pulse.

The triggering rate of a logic analyzer should be at least equal to that of the device being tested. The PM 3500 in fact can trigger on even faster transients, using its glitch-catching mode.
External triggering is provided in the Philips' analyzers using a separate trigger input. This external input can also be used to provide additional trigger qualification – that is, it provides additional conditions that must be met before triggering can take place.
While the trigger pulse normally stops data acquisition, it is also possible to display data *after* a chosen trigger point by introducing trigger delay.
In this case the initial trigger starts a preset counter on the analyzer and eventually stops the data acquisition and display. Which effectively 'stretches' the memory capacity.

Display format choice

Data can be displayed in several ways. Output for the Philips' logic analyzers is through a cathode ray tube. This was preferred because of the high definition possible. The ideal – as with the Philips' instruments – is to have the display built in.
The two main types of display are timing and state. The PM 3540 provides a real time oscilloscope display while timing display of the PM 3500 provides a pseudo waveform. So both give state and relative timing information. The state display provides data in a truth table format or as data 'map'.
Again flexibility is added in Philips' analyzers by providing a choice of state display formats to meet user requirements. While binary display provides a standard logic output, many microprocessor users prefer the hexadecimal format display. Octal display is often favoured by minicomputer users.
The mapping facility of the PM 3500 provides a useful overview of a logic system. Each stored logic word is shown as a separate dot. The vertical position of the dot depends on the most significant half of the word, while the horizontal position is proportional to the least significant half of the word. The result is a unique data 'signature' for fast detection of logic errors.
A blanking facility provides the opportunity to blank out irrelevant data. Using two memories provides the facility of a 'compare' mode where one memory is used for storage reference and the other is refreshed either as required, or automatically. The contents of both memories are compared and any inequalities are indicated by a message in the heading also, in more detail, by an intensified digit in the captured data block. In the automatic mode, an inequality stops further acquisition.

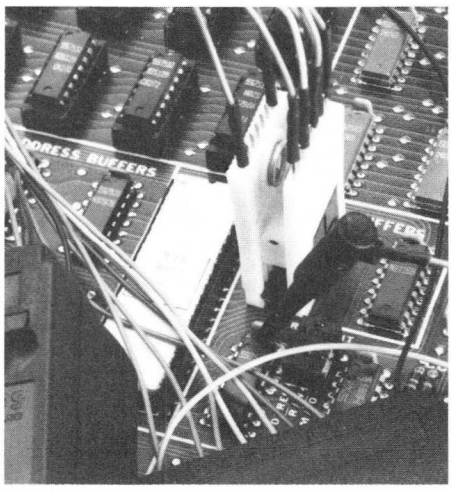
Microprocessor provides versatility

Provision of a variety of display modes requires a microprocessor for display control. The microprocessor also handles basic logic analyzer control functions in both the PM 3500 and the PM 3540. In addition to the data, status display are made possible.
Availability of the microprocessor also facilitates self-testing of instrument circuitry. The micro-processor self-test routine is automatically triggered at switch-on. In addition, comprehensive diagnostic service routines are provided, which automatically check the whole instrument at functional level.

Probe design is important

The importance of probes in logic analysis cannot be stressed too highly. Electrically they must must not interfere with the system under test, nor must they exercise any mechanical strain on the test points. Nor should they require adjustment, since logic signals are detected, not measured. Philips probes meet all these basic criteria. Of microminiature construction, the probe ends are flexible, allowing inaccessible points to be reached with minimal drag in the circuitry. Probe tips may be touch, wire-wrap or hook and are colour-coded for easy identification.
Digital test equipment promises to be one of the important areas for instrumentation in the future. Philips many years experience in the test and measuring field have already proved themselves equal to solving both current and future problems likely to be encountered in digital testing.

Probe tips may be wire wrap, or hook for use with the PM 3540. Illustration shows a 'pod' connector which allows multipoint connections to be made. The desired connection is selected by switching from the instrument front panel.



16 display channels and 504-word memory

100MHz clock rate

Easy changeover from state to time domain

Good ergonomic design for ease of use

Glitch-catching on events as short as 3ns

Comprehensive automatic diagnostic routines

Threshold selection of TTL, ECL, CMOS, etc., on any two groups simultaneously

Display formats in binary, hexadecimal, octal, mapping

Compare mode facilities

NEW

Logic analyzer PM 3500

The Philips PM 3500 logic analyzer provides logic timing and state checking up to 100MHz with built-in display for 16 channels. Memory depth is 505 words and a choice of thresholds matches any logic family. Considerable attention has been paid to ergonomic design aspects producing a very easy-to-use instrument. The PM 3500 is designed to provide one instrument both to locate and analyze digital faults – in fact it is impracticable to separate these two aspects in most situations. Instantaneous changeover from timing to state analysis allows instant comparison of software commands and hardware results.

Versatile general purpose analyzer

Provision of both timing and state facilities makes the PM 3500 a versatile general purpose analyzer. Up to 16 channels can be displayed at any time – with additional channels for triggering.
The input threshold is either fixed at TTL or ECL levels or continuously variable to match any other logic family being tested. The first set of eight input channels can have a different threshold from the second set. This simplifies working with different logic families (e.g. checking microprocessors and associated circuitry).
Asynchronous sampling is possible up to 100MHz – a variable divider allows setting of the clock rate from 20ms to 10ns. This rate is more than sufficient for microprocessor, minicomputer and even mainframe testing.
Detecting transients shorter than the sampling period is also possible using a glitch-catching mode. This allows glitches as short as 3ns to be caputed. They are then displayed as full clock width pulses over the following interval. As a result of the fast circuits used in every channel, it is also possible to trigger on these glitches. A separate input allows external triggering. Trigger qualification is also possible – providing additional trigger conditions. This effectively produces a 17th input. Triggerprobes can be added to extend the triggering conditions.

Economic use of memory

Incoming data is stored in a 16-bit wide memory which is 504 words deep. Use of clock qualifiers and trigger delay is provided. Trigger delay is operated by a single control that allows the captured block of data to be moved smoothly and continuously along the data stream.
With the trigger delay, the initial trigger pulse starts a presettable delay counter. This effectively stretches the memory capacity by 9999 words – the number of digits by which the counter can be preset. Analysis of the display is made simple using the cursor control. The cursor is intensified 16 word block which can be positioned anywhere along the captured data block. This format provides a simple reference when switching from time to state.
The position of the cursor word – the first word of the cursor block – is indicated in the status display this also applies to the digital delay. The cursor word will be presented in whatever format the display is set to show. State display in fact can be hexadecimal, octal or binary as well as in mapping form. While the binary display provides a standard logic format, many microprocessor users prefer hexadecimal output and octal display is often preferred by minicomputer users.

Comparison facility eases analysis

Instrument flexibility is encreased using the compare mode. This effectively splits the instrument into two separate analyzers by splitting the memory into two 249 word parts. Typically a reference table can be sorted in one half while the other part functions as normal for manual or automatic comparisons.
For ease of use a search mode is provided. This examines the total captured data block continuously bit by bit and stops automatically at any inequality – the result showing up as intensified digits as well as being indicated in the status heading.

Considerable effort has gone into the design of the PM 3500 in order to make it easy to use. A user is primarily interested in his design problems rather than the instrument being used to solve them. By simplifying all controls Philips have made it possible for the operator to virtually 'forget' his test instrument and concentrate fully on his problems. Operation of the PM 3500 is therefore restricted to pushbuttons and carefully located control knobs providing direct access to each function. This is simpler than, for example, complex keyboard-style controls.

Expand facilities allow data to be examined in more detail – displaying 504, 50 or 20 samples on the screen. Blanking of groups of data leads to automatic readjustment of remaining information for full screen display.

The status heading provides a wealth of information to ease interpretation of the data displayed. All trigger information is shown, including delay. Other relevant status information on the continuously-displayed summary includes mode, compare, expand and cursor word and position. Additional information provided includes the number of search counts and displayed messages (such as, 'no trigger', 'inequality', 'no/slow clock'.)

The use of a microprocessor increases flexibility. For instance the display formatting in the PM 3500 has been designed such that each point dot on the integral CRT is the result of a software instruction.

To meet the high speed requirements that such a circuit design demands, the fast Signetics 8 × 300 microprocessor is used.

Self test incorporated also

A big advantage of microprocessor control is the possibility of providing self-test facilities. This is utilized in the PM 3500 to provide both 'power-on' and comprehensive diagnostic service routines.

Power-on checks provide complete tests of the microprocessor and its environment. These cover RAMs, ROMs and all input and output circuitry.

Service routines are called up using an internal switch; five tests are provided which allow the operator to check the whole instrument at functional level.

The microprocessor also handles basic logic analyzer control functions. Among other advantages is the simple addition of status headings to make displayed data more meaningful.

Matched miniature probes

Input to the PM 3500 is through miniature five-to-one probes. Careful design ensures that data is not affected by loading – either electrical or mechanical. Dedicated logic detection capability with no adjustment required for use and matching to 100MHz operation is assured.

Threshold selection – ECL, TTL or variable – applies to levels at the probe tips and not at the instrument. Tips can be touch, wire-wrap or hook. The probe end can be made flexible for difficult-to-reach points and to reduce the mechanical loading on circuits being tested.

Conventional resistor notation colour coding aids identification of the probes. Depending on the application, earthing can be separate or grouped – with up to nine probes sharing a common earth connection. Probes can be used separately or grouped in blocks of four as required. The use of individual probes having sufficiently long leads allows connections to be made to widely separated test points.

TECHNICAL SPECIFICATION

DATA INPUT

All values specified at 5:1 probe tip.

Number
16 data channels via BNC connectors.

Impedance
5MΩ//13pF

Max voltage
−500V... +500V transient
−250V... +250V continuous

Threshold
Channels 0-7 and 8-15 can be set independently.
Push button selection of TTL, ECL and Variable levels
TTL: +1.4V
ECL: −1.3V
VAR −10V to +10V continuously adjustable, front panel monitor point

Max sensitivity
500mV$_{p-p}$ swing for 100MHz recording

Set up and hold times
1ns set up time, 2ns hold time, with respect to internal active clock edge

Pulse width
3ns min with a signal swing of 400mV.
To ensure correct recording in sample mode *at al times* the pulse width must be one sample interval plus 3ns e.g. 13ns for 100MHz

Skew
< 2ns channel-to-channel data skew

CLOCK

Source
Internal or external

Internal clock
X-tal controlled
10ns...20ms sample interval via front panel 20-position rotary switch in 1-2-5 sequence

External clock
Input via front panel BNC connector
Parameters same as for data input
Clock rate 80MHz max
Threshold selection same as for channels 0-7
Minimum clock pulse width 5ns
Sampling on positive or negative going clock edge
Delay between external clock input and data input 13ns (typical)

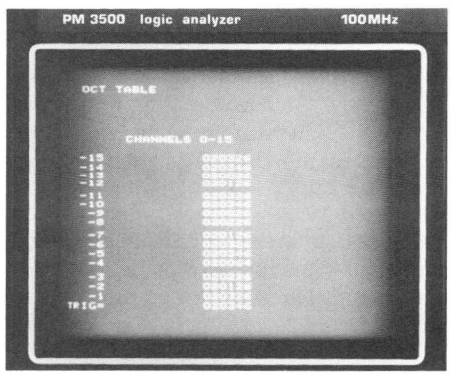
Clock qualifier
Input via front panel BNC connector
Parameters same as for data input
Clock rate 80 MHz max
Threshold selection same as for channels 0-7
Sampling only occurs when qualifier input is 'True' at the clock edge. 'True' is selected for high '1' or low '0' level.
In the 'X' position the qualifier is not used, 4ns set up time and 3ns hold time with respect to actual clock edge at probe tip

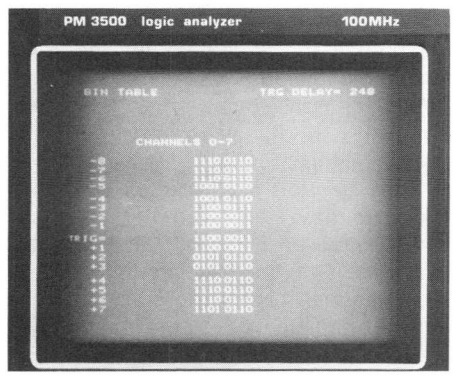
TRIGGER

Source
Internal, external or manual

Triggering
In Sample mode on signals having pulse widths of one sample interval plus 3ns
In Capture mode on glitches ⩾3ns
Using trigger probes on signals with a clock rate of 20MHz

Hexadecimal display.





Octal and binary displays. At all times heading gives clear indication of display mode, cursor word and delay. The position of displayed words relative to the trigger word are given.

Internal
Trigger word recognition on 16 channels and trigger qualifier (when employed)
Direct display and 100MHz triggering on 16 channels
Trigger word determined by channel switches having positions '1', '0' and 'X' (don't care)
Triggering occurs when there is a match between selected trigger word and data stream

External
Input via front panel BNC connector
Parameters same as for data input
Threshold selection same as for channels 0-7
Triggering on positive or negative going clock edge

Manual
Via front panel push button

Trigger qualifier (17th channel)
Identical to external triggering, but used with internal triggering
Selected via front panel push buttons 'INT' and 'EXT'
Triggering only occurs when trigger qualifier input is 'True' at clock edge.
'True' is selected for high '1' or low '0' levels
In the 'X' position the qualifier is not used

Trigger extension
17th trigger channel can be used with trigger probes to extend the trigger word in multiples of eight

Trigger delay
Triggering can be delayed by 0...9999 clock pulses via a single control to give center- and post-triggering plus delayed triggering of the captured data block. It can be continuously set to 'walk' or run through the data stream.

START

Source
Automatic, external or manual

Automatic
The instrument starts itself automatically after a display time that is adjustable from 1...10s. In combination with the 'walking' facility of trigger delay this gives pseudo real-time paging

External
Start request given by pulse on the front panel BNC 'External' input having TTL level and negative going edge

Manual
Via front panel push button

MEMORY

The memory format is 504 serial bits ×16 parallel channels. In the 'Compare' mode the PM 3500 is divided into two instruments, each having a memory capacity of 248 × 16 bits

OPERATING MODES

Sample mode
Input signals are simultaneously clocked into the memory at the sample clock transitions with respect to the selected threshold level(s).
Minimum pulse width that is *always* recorded is one sample interval plus 3ns with a signal swing over the threshold level of 250mV

Capture mode
Used to capture glitches of less than one sample interval and down to 3ns having signal swing of 400mV (4ns with 250mV)
Glitches are captured until the next clock edge and displayed for one sample interval

Compare mode
Half the memory is used to store reference data i.e. 248 × 16 bits. The other is then used to capture a second data block. When displayed in logic form, the 16-word table from the reference half is displayed together with the equivalent table from the second or trace data block. Any unequality between the two captured data blocks is indicated in the heading by the message 'UNEQ' and in the table by intensified digits.

Store ref
Reference data is acquired, stored and displayed until the Compare mode is reset.

Search mode
Used to make continuous comparisons between the 248 bit reference and trace data blocks.
When an unequality occurs, it is immediately indicated in the heading together with the number of comparisons made before unequality occured.
The two 16-word tables are displayed from the first unequality onwards, intensified digits indicating the unequalities in detail.

DISPLAY

Tube
Philips 10 × 12cm 10kV tube with electrostatic deflection.
Focus and intensity controls on front panel.
In the top part of the screen a continuous summary is given of the essential parameters and when relevant, of the instrument's status

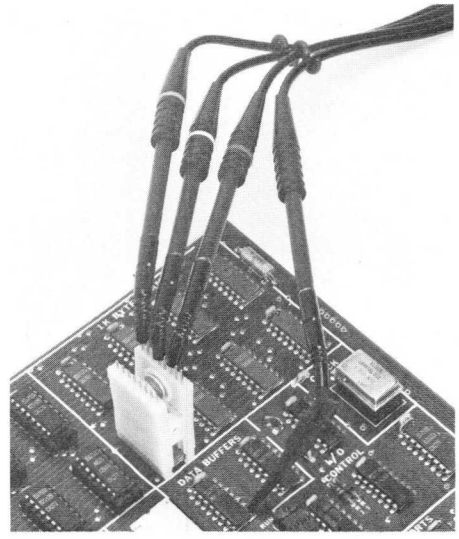
Cursor
The cursor is 16 intensified serial words across all displayed channels. The cursor word is the first of the 16 words and it is displayed in the summary heading in binary, octal or hexadecimal form together with its position relative to the trigger word. It is positioned using three push buttons: two to determine the direction in increments of one sample interval or continuously, the third for fast positioning in the captured data block.

Display modes
Timing, state tables and mapping

Time
16 channels grouped in 4 groups of 4 with a horizontal time axis

Expand
Time axis can be expanded 10× to display 50 serial bits or 25× to display 20 serial bits. Samples are indicated by markers
The cursor word serves as the starting word in expanded time displays

State
Binary, octal or hexadecimal
The 16-word cursor is displayed in tabular form and all words are identified by their relative position to the trigger word



The colour-coded micro-miniature probes are supplied in touch, wire-wrap or hook styling. They can be used singly or in groups of four. Common earth connections may be used with up to nine probes.

Mapping
Each word is represented as a unique dot on the screen by displaying the least significant word half along the horizontal axis and the most significant word half along the vertical axis.
The cursor is indicated by an intensified circle and is read out in the summary.
The brightness of the dots indicates the frequency of occurrence within the captured data.

Blank
Channels can be suppressed in sequence starting with channel 15 by pushing the blanking '+' button.
Recalling is done with the blanking '−' pushbutton.
In Time mode the remaining channels are regrouped in units of 4 channels over the entire display.
In the state modes blanking results in suppression columns from left (CH 15) to right (CH 0).
In the MAP mode blanking shrinks the map in steps from 8 by 8 bits, 7 by 8, 7 by 7, etc... Because the entire screen is used an expanded map view is obtained.

OUTPUTS

Via BNC connectors at rear side.

Trigger out
ECL level, low-high transition at trigger moment.

Start out
TTL level, low-high transition at start moment after initialisation.

POWER SUPPLY

Power consumption
100W

Line voltages and frequencies
90-150V_{AC} ±10%
150-242V_{AC} ±10%
48-440Hz

Safety requirements
According IEC 348 standards.

ENVIRONMENTAL

The environmental data are valid only if the instrument is checked in accordance with the official checking procedure. Details on these procedures and failure criteria are supplied on request by PHILIPS organization in your country, or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.

Ambient temperature
−10°C... +40°C operating
−40°C... +70°C storage and transport

Humidity
21 days cyclic damp heat 25°C-40°C R.H. 95%.

Shock
30g: half sine wave shock of 11ms duration: 3 shocks per direction for a total of 12 shocks.

Vibration
3g vibrations in three directions with a maximum of 15min per direction; 10 minutes with a frequency of 15-25Hz and amplitude of 1mm_{p-p}: 5min with a frequency of 25-55Hz and an amplitude of 0.5mm_{p-p}.

DIMENSIONS AND WEIGHT

Height: 200mm
Width: 386mm
Depth: 470mm
Weight: 14kg

ACCESSORIES SUPPLIED

- Five PM 8800 probe sets each containing 4 mini-probes
- Operating-Service manual

OPTIONAL ACCESSORIES

Trigger probe PM 8810

NEW

Logic scope PM 3540

Unique combination of logic analyzer and oscilloscope

Scope:

Full 2mV sensitivity over full 25MHz bandwidth

Trigger sources, A, B, Composite, Ext and from logic analyzer

Analyzer:

16 display channels with 64-word memory

10MHz synchronous clock rate

Clock qualifiers

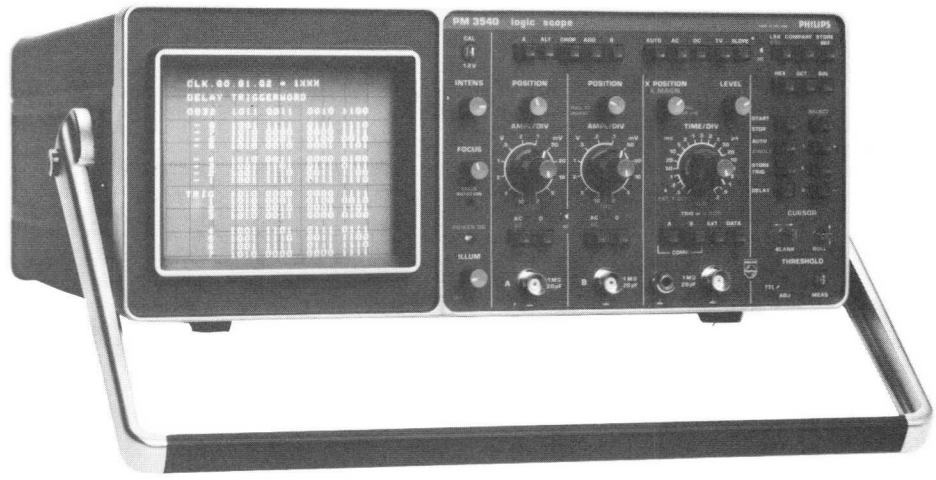
Good ergonomics for easy operation

Display formats in binary, hexadecimal, octal

Compare mode facility

Built-in diagnostic routines

The PM 3540 logic scope combines a 16-channel 10MHz logic analyzer with a versatile two-channel 25MHz oscilloscope to ensure complete, true logic testing.
Fault location is achieved by the logic analyzer section and the realtime oscilloscope display enables faults to be analyzed and corrected.
The result is a compact, portable, test and service instrument, capable of handling both software and hardware problems.



Operation as a logic analyzer

The instrument will work either as a logic analyzer with integral display, as an oscilloscope or as a powerful combination of the two. The logic analyzer section is a 10MHz state analyzer – with microprocessor control to provide maximum display versatility and minimum hardware.
It acquires data simultaneously over 16 channels. This data is stored in the 64-word memory and then displayed independently of the acquisition process. The trigger system stops data acquisition-freezing data present in the memory at that instant.
The data is obtained using specially designed probes for connection to the circuit being tested. Input to the logic sections of the PM 3540 is through three multi-lead probe pods PM 8820 each providing for eight inputs plus one earth connection. Two probe pods are used for the data and are for the clock and clock qualifiers. They are of dedicated digital design with high impedance and capacitance to cut interference and loading.
Miniature probes allow easy connection to the circuit being tested and each is colour-coded using resistor code for easy identification. Difficult access points can be reached with a flexible probe to ensure minimum mechanical strain. Each probe can be split from the stackable pods and left in the system being tested. A wide variety of probe terminations is available with wire-wrap or hook tips.

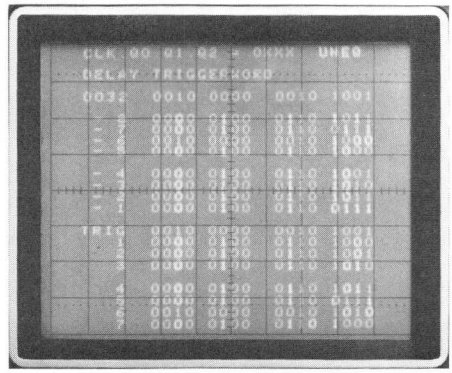
Choice of threshold levels

In the PM 3540 the incoming signal passes through a threshold level selector into an input latch. This provides a choice of threshold levels either fixed TTL or variable from −3V up to 10V to allow matching to a variety of logic families.
Sampling is synchronous and thus, dependent on the clock rate of the circuit being tested. This is used to look at the series of states present in the circuit under test. Such state analysis is mainly used to check through system software.
The PM 3540 can handle rates up to 10MHz and clock qualifiers allow conditioned sampling. For example, using a read signal from the system can ensure that only read statements will be recorded. This ensures optimum use of the memory.
Data storage is in a 64 word memory. Versatility can be increased by using a 'compare' mode. A second 64-word memory is used as a reference memory. New, incoming data is compared with the total contents of the reference memory. Any inequalities thus identified are indicated by a message in the display heading plus intensified digits in the table. In the automatic mode the refresh cycle is stopped automatically when an inequality occurs.

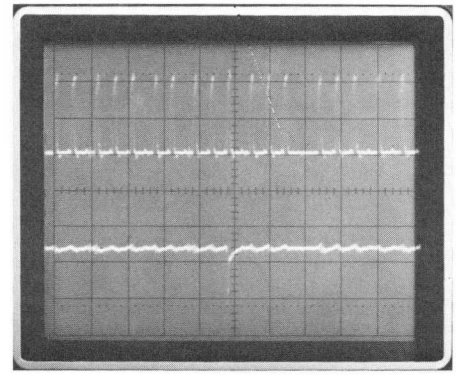
Word recognition triggering

The sampling process is stopped by a trigger pulse which causes the flow of data passing through the data memory to be halted. The pulse can be supplied in several ways but the most common is wordt recognition triggering.
Word recognition consists of defining a certain association of binary states required in the incoming parallel data. When the incoming signals match the word set, the trigger circuit puts out a trigger pulse.
The trigger word is normally made up the number of channels being displayed. Data acquisition can be made more selective by increasing the trigger word using additional trigger probes.
Trigger delay facilities allow examination of the data stream after the trigger point. Triggering can be internal, using word recognition, or manual, from the front panel. The trigger word is set using the front panel controls, in any format preferred by the operator.
The trigger pulse can be delayed by up to 999 samples or events by selecting an internal delay counter. Trigger word expansion is also possible using additional trigger probes. It is also possible to select a word from the data display for storage as a new trigger point. Selec-

Logic display in binary, octal or hexadecimal



Logic comparisons for quick and convenient fault analysis



Real-time displays for meaningful fault detection and correction.

tion of this as a new trigger word allows examination of a new block of captured data down or upstream. This paging facility can, for instance, be easily incorporated into a programmed service fault-finding system.
An automatic mode allows the instrument to retrigger periodically to update the display, providing a pseudo realtime display.

Integral display

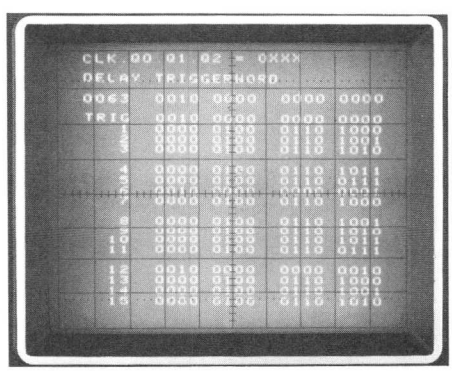
Several ways exist of displaying the data frozen in the memory. The ideal as with the PM 3540 is display on an integral screen to allow the analyzer to be completely self contained. The use of microprocessor control allows display flexibility by simplifying formating of data on the oscilloscope screen.
Three types of state table formating are provided, binary, hexadecimal and octal. The microprocessor is also responsible for all logic control. This allows simple ergonomic instrument control: for example pushbutton setting and continuously-displayed status information on the display.
A two-dimensional cursor is provided to simplify parameter setting. The cursor can be moved both vertically and horizontally. A special roll function allows paging through the entire 64 word data store – only 16 words are displayed at a time.

Matching analyzer to oscilloscope

The logic analyzer/oscilloscope combinaton in Philips logic scope provides state analysis together with oscilloscope timing display. Considerable attention has been paid to matching the two sections to achieve precise cross-referencing between data- and timing-analysis.
The oscilloscope section is a sophisticated service instrument providing high 2mV sensitivity up to 25MHz. It has two vertical inputs separate from those of the logic analyzer.
Trigger sources can be either vertical input, composite, external or the logic analyzer section.
The design of the instrument ensures that when the oscilloscope is triggered from the analyzer, the signal delay is reduced to a minimum. This ensures that the selected channels of the trigger word itself is displayed.
The edge of the signal on which the analyzer is triggered is displayed in the timing mode which provides an exact and easy cross-reference between state and timing analysis. This is a necessity in digital testing and cannot be achieved by separate oscilloscope and logic analyzer.
Apart from simplifying control and reducing the hardware requirement the microprocessor also provides comprehensive selftest facilities. These ensure functional operation at every switch-on and provide a set of switch-selectable service tests for routine maintenance and trouble-shooting.
There are nine different tests covering all main operating functions in the logic analyzer section to identify faults down to functional level. The result is maximum reliability and minimum downtime.

A unique trouble-shooting tool

The combination of logic analyzer and versatile oscilloscope in one portable instrument provides a unique instrument for a wide range of digital trouble-shooting problems in design and research laboratories, production environments and in the field.



TECHNICAL SPECIFICATION

STATE ANALYZER

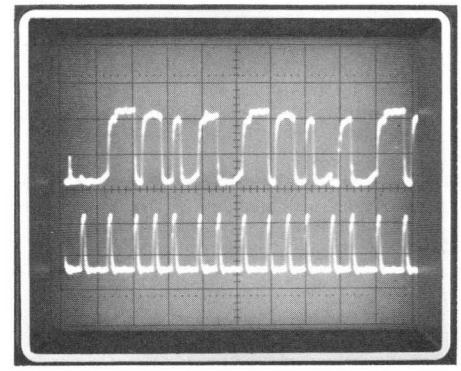
All values specified at probe tips of PM 8820

Data input
16 data channels via two multi-lead probes PM 8820 connected at right hand side of instrument.
Impedance
4MΩ//6pF
Max. voltage
−50...+50V
Threshold
TTL fixed +1.4V
Variable: up to +10V continuously adjustable, front panel monitor point.
Max. sensitivity
500mV$_{p-p}$ signal swing
Set up and hold times
30ns set up time, 2ns hold time with respect to external active clock edge at probe tip
Clock
Input via third multilead probe PM 8820. Threshold selection same as for data inputs. External sampling clock rate 10MHz max. Minimum clock pulse with 20ns. Sampling selectable on positive or negative going clock edge.
Clock qualifiers
Numbers: 3 clock qualifiers. Input via clock probe (3rd PM 8820). Sampling only occurs when qualifier input is 'True' at the clock edge.
'True' is selected for high '1' or low '0' level.
In the 'X' position the qualifier is not used. 5ns set up time and 2ns hold time with respect to actual clock edge at probe tip.

TRIGGER

Source
Internal, external or manual

Exact cross-reference between state and time analysis is provided by the PM 3540 logic scope. The real time oscillogram (upper signal) shows channel No. 0 (the right-hand data channel) and the corresponding clock signal. The negative-going edge of the clock signal (the trigger point) is itself displayed.



Internal
Triggerword recognition on 16 channels and trigger qualifier.
Triggerword determined
- by specifying directly from the captured data by operating STORE TRIG control. The first word of the display will become new trigger word.
- be selection via CRT display, cursor and controls 1/+, X and 0/− in the required formats (Hex, Oct, or Bin)

External, trigger qualifier
Choise external or trigger qualifier depends on trigger word selection.
EXT. trigger BNC connector when Logic Scope is in DATA and EXT. mode. Triggering only occurs when trigger qualifier input is TRUE at clock edge. TRUE is at high level (not connected is high level).
Manual
Via front panel push button
Trigger extension
The trigger qualifier can be used with trigger probes PM 8810 to extend the trigger word in multiples of eight.
Trigger delay
Triggering can be delayed by 0...9999 clock pulses controlled via CRT and selection buttons + and − ON/OFF switching of trigger delay by push button

START

Source
Automatic or manual
Automatic
The instrument starts itself automatically after a display time of approx. 1s to allow pseudo real time observations.
Manual
Via front panel push button
Memory
The memory format is 64 serial bits ×16 parallel channels. In the compare mode a second memory of the same size is used.

OPERATING MODES

Logic analyzer mode
By activating push button LSA/OSC the input signals are simultaneously clocked into the memory at the sample clock transitions with respect to the selected threshold level.
Oscilloscope mode
Logic scope is acting as an oscilloscope in its own right, plus selectable triggering from logic state analyzer
Compare mode
A second 64 word memory is used to store reference data. A captured data block is compared with the reference data block. Any inequality between the two blocks is indicated in the heading by the message 'UNEQ' and in the input table by intensified digits. In the HEX and OCT mode both the input and reference table are displayed. In the BIN mode only the input data is displayed.
Store ref.
Data is transferred from input memory into reference memory
Select
In the select mode the parameters can be specified using the cursor and selection controls 1/+, X and 0/−
Display
CRT of oscilloscope. In the top part of the screen a continuous heading is given containing the parameters and the status of the instrument.
Display modes
Hexadecimal, octal or binary. State tables of 16 words are displayed in 4 groups of 4 words. All words are identified by their relative position to the trigger word. The continuously displayed trigger word can be specified in the selected format.
Cursor
In the select mode the cursor is identified by an intensified digit and is positioned by the controls in horizontal or vertical directions.
Roll
When the instrument is not in the select mode, the vertical cursor control is used as a roll function to provide paging through the entire 64-word memory.
Blank
The horizontal cursor control is used to suppress channels. In the sequence starting with channel 15.

OSCILLOSCOPE

CRT

Type
Philips D 14-125 rectangular mesh-type post deflection accelerator tube with 10kV accelerating voltage and metal backed phosphor.
Screen type
P 31 (GH) phosphor standard
P 7 (GM) phosphor optional
Useful screen area
8×10cm
Graticule
Internal graticule with centimeter divisions and 2mm divisions along the central axes. 10% and 90% lines are indicated. Graticule illumination continuously variable.

Y-AXES

Frequency response
DC: 0Hz...25MHz (−3dB)
AC: 2Hz...25MHz (−3dB)
Risetime
14ns
Deflection coefficients
2mV/div...10V/div 1-2-5 sequence. Uncalibrated, continuous control between steps 1 : > 2.5
Accuracy
±3%
Display modes
Channel A, Channel B, Alternate. Chopped at approx. 500kHz, Added, Channel B can be inverted.
Input impedance
1MΩ//20pF
Maximum input voltage
400V (DC+AC peak)
Maximum deflection
Undistorted deflection of 24div. Shift range 16div
Signal delay
40ns visible
CMR-factor
100:1 at 1MHz (A-B mode with 8div common mode signal)

HORIZONTAL

Horizontal deflection can be obtained from either the time base or from the signal source selected for X deflection. In this case X-Y diagrams can be displayed using Y_A, Y_Y, the Ext. connector as a signal source for horizontal deflection
Display modes
X-Y or X-Y/Y operation with X-deflection by: Y_A, Y_B, External

X-INPUT

Frequency response
DC...1MHz (−3dB)
Deflection coefficient
500mV/div using Ext. connector. Vertical attenuator coefficients apply when Y_A, or Y_B is used for X-deflection
Measuring accuracy
±10%
Phase error
3° at 100kHz

TIME BASE

Modes
Auto-triggered
Time coefficients
0.5s/div...200ns/div 1-2-5 sequence. Uncalibrated continuous control between steps 1 : > 2.5; ×10 magnifier extends max. sweep rate to 20ns/div.
Accuracy
±3%. Additional error for magnifier ±2%

TRIGGERING

Trigger source
Internal: Y_A, Y_B, Composite, Data (via logic analyzer)
External
Slope
+ or −
Trigger mode
Auto: 20Hz...50MHz
DC : 0Hz...50MHz
AC : 5Hz...50MHz
TV
Fully automatic triggering on TV video signals, automatic selection of 'frame' and 'line' via time base speed selector
Trigger sensitivity
Internal 1div or word triggering. External 500mV
Level range
Internal 16div typical. External −4V to +4V typical. Automatically adjusted between limits of signal amplitude in position Auto
External trigger input impedance
1MΩ//20pF
Maximum allowable input voltage
400V(DC+AC peak)

CALIBRATION

Calibrated voltage
1.2V_{p-p} ±1% square wave
Frequency
2kHz approx

POWER SUPPLY

Line voltages and frequencies
110, 127, 220 and 240V_{AC} ±10%, 46...440Hz. The insulation between PM 3540 and line fulfils the safety requirements of IEC 348 for metal encased class II instruments.
DC power source
22-27, V_{DC} floating input, 1.1$A_{max.}$
Power consumption
40W

ENVIRONMENTAL CAPABILITIES

The environmental data are valid only if the instrument is checked in accordance with the official checking procedures. Details on these procedures and failure criteria are supplied on request by the Philips organisation in your country or by N.V. PHILIPS' GLOEILAMPENFABRIEKEN, TEST AND MEASURING DEPARTMENT, EINDHOVEN, HOLLAND.
Ambient temperatures
+ 5°C...+40°C rated range of use
−10°C...+55°C operating
−40°C...+70°C storage and transport
Altitude
to 5000m (15000ft) operating
to 15000m (45000ft) not operating
Humidity
21 days cyclic damp heat 25°C-40°C R.H. 95%
Bump
1000 bumps of 10g, ½sine, 6ms duration, in each of 3 directions.
Vibration
3g vibrations of 15min in three directions. 0.5mm_{p-p} displacements with 10Hz-55Hz one minute cycle
Electromagnetic interference
Meets VDE, Grenzwertklasse B
Recovery time
Operates within 15 minutes coming from −10°C soak, going intp 60% relative humidity at +20°C room conditions

DIMENSIONS AND WEIGHT

Height: 150mm incl. feet
Width: 330mm
Depth: 445mm
Weight: 8kg (17.6lb) approx

ACCESSORIES SUPPLIED WITH THE INSTRUMENT

Front cover. BNC-banana adapter. Operating and service manual. Two probes PM 8925. Three multilead probes PM 8820

OPTIONAL ACCESSORIES

Extension kit PM 8819.
Trigger probe PM 8810.

Philips microcomputer development system

Introduction

Economic aspects

Organizations with experience in the development of software combined with new hardware know that design costs can easily exceed budget expectations. A common cause is lack of proper system analysis, and therefore lack of a well-defined system specification. Another important cost-increasing factor is gross underestimation of the importance of adequate design tools. Today's microcomputer-based systems cannot be debugged efficiently with tools intended for a different technology. In the system integration phase in particular, debugging time and costs can rise atronomically if the right tools are not available. Many members of a project team may then have to be involved in locating the source or an error.

All these factors call for a powerful microcomputer development system. Companies who are new to microprocessor technology, in particular, must rationalize their total design efforts if they are to survive economically.

In an organization employing highly-paid software and hardware development engineers, the capital invested in the right microcomputer development system will be recovered very quickly indeed – often in a single project.

The Philips PM 4421 PMDS is a very powerful aid to economic success in microcomputer applications. The fact that it is a true universal system, unlike many other development systems available today, means that it will support future microcomputer-based projects, even if different microprocessors are selected for price, supply or performance reasons.

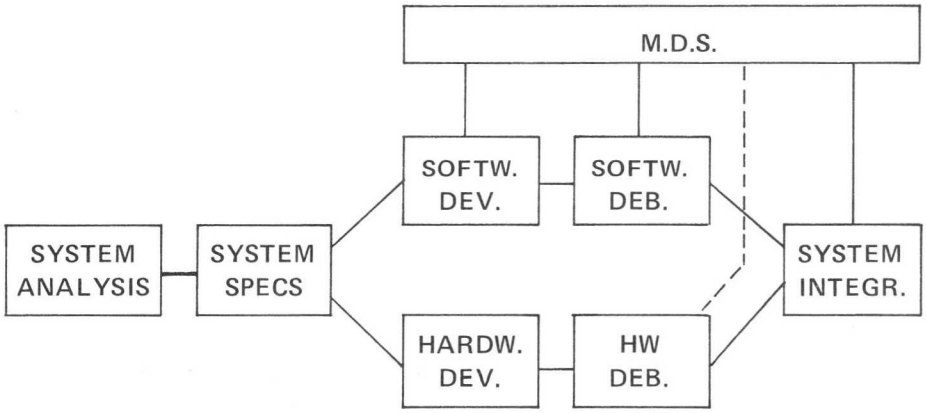
Powerful tool

The PM 4421 microcomputer development system is a powerful tool to increase efficiency in the design of microprocessor- and microcomputer-based systems. Development of such systems is split at an early stage into separate hardware and software elements which later must be integrated into a complete system after both have been debugged separately.

The PMDS can provide significant time and cost savings throughout the development process – both in the development of the separate hardware and software elements, and later in the system integration phase.

The PM 4421 provides the software designer with important development aids such as a text editor, assemblers and high level languages. The hardware designer is supported by techniques like real-time in-circuit emulation, tracing and state analysis.

During the system integration phase, the PM 4421's true real-time emulation capability can functionally exercise the complete system under actual operating conditions before final production committments are made. The often difficult problem underlying an error in either hardware or software can quickly be solved using the PMDS. The block diagram shows the project phases during which the PMDS can provide valuable development support.



Fully integrated system for development and debugging of hardware, software and system integration

Universal system for microprocessors, microcomputers and PROMs

Designed for both present and future developments

Multiprocessor (target) system debugging capability

Extensive breakpoint and trace facilities

PASCAL high-level language

Electronic design automation facility

NEW

Philips microcomputer development system PM 4421

Essential features of the PM 4421 PMDS

The PM 4421 is a complete development system. It offers advanced software development facilities and a true real-time emulation capability. The PMDS is also a universal development system, supporting the 8085, the Z80 and the 6500 family initially, and other important microprocessors in the near future. Its universal capability means that only a minimum of retraining is required on changeover to different microprocessors, and that such a changeover can be effected at minimum investment in hardware and software.

PMDS was designed with the ability to handle future systems, as well as today's. The first support for a 16-bit machine will be available shortly. And PMDS will support multi-microprocessor systems with up to four parallel debuggers, able to emulate a mixture of microcomputer architectures in parallel.

PMDS ensures portability of software between microcomputers by means of the high-level language PASCAL.

And since PMDS is based on the highly versatile Philips PM 4400 Compact Computer system, it is not only an excellent design tool for microcomputer-based systems, but can also be used for engineering analysis and administrative functions. In addition, an add-on option allows the sytem to act as an instrumentation controller via the widely standardized IEC-625 (IEEE-488) interface facility.

The whole PMDS concept is designed to protect the user's investment in both hardware and software by greatly reducing the risk of obsolescence.

PMDS Software System

PMDS offers 'state-of-the-art' software for highly efficient software development. Software design and specifications reflect years of experience in the Philips Concern in both mini- and medium-size computer programming and debugging techniques.

The software package contains a disk-based monitor controlling:

- control-command interpreter
- text editor
- cross-assemblers for the 8085, the Z80, the 2650, the TMS 1000 and the 8048 and 6500 family; and more to follow
- high-level language PASCAL
- linker
- PROM processor

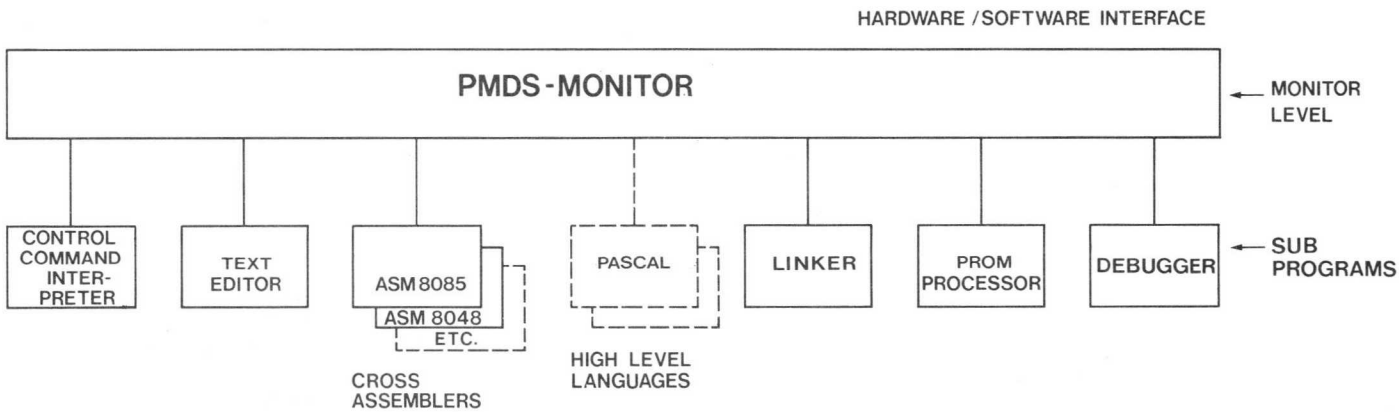
To control the run-time environment during emulation, a powerful debugger is already available for the 8085, the Z80 and the 6500 family microprocessors. This range will be extended shortly. Only the assemblers, compilers, and to a limited extent the debugger, are target-system dependent. Even so, target-system dependence is kept to an absolute minimum. All the software features offered work together to help the user design, test and correct programs in the easiest, most efficient possible way. Wherever possible, they also facilitate the use of ready-made codes such as library modules. An explanation of the functions and benefits codes such as library modules. An explanation of the functions and benefits provided by the PMDS software processors is given in the following description.

Text editor

The text editor allows an assembler language module to be entered via the keyboard and stored on floppy disks. The module can then act as input for a PMDS assembler.

If errors are found during assembly and need to be corrected, or if the module needs to be modified for any other reason, than the text editor provides many powerful commands to:

- insert or delete any number of lines at any point in the module
- move or copy sections of code from one part of the module to another
- insert into the module any selected part (or all) of another module
- correct errors in a program line without having to key-in the whole line again



– examine any part of the module
– find the line(s) of the module with a specified text string
– replace any text string by another in one or many lines of the module with a single command
– replace one string by another within a pre-defined column range over more than one line. This is a very powerful feature that allows a misspelt mnemonic, for example, to be replaced throughout the module with a single text editor command. It will not cause unwanted changes to other parts of the line.

Cross-assemblers

Cross-assemblers translate assembly-language modules into object modules that are acceptable as input for the universal linker. As microprocessor architectures and instruction sets vary between models, it is necessary to provide a range of different assemblers. Philips can provide cross-assembler support for a wide range of microprocessors. Special generation methods allow new cross-assemblers to be produced quickly and at low cost. The large number of common features in different cross-assemblers facilitates retraining on changeover to a new microprocessor type. A few of the many advanced features common to all PMDS assemblers are:

– conditional code generation
– MACRO facility
– memory type specification
– error messages
– cross-reference listing
– modular support
– paging support

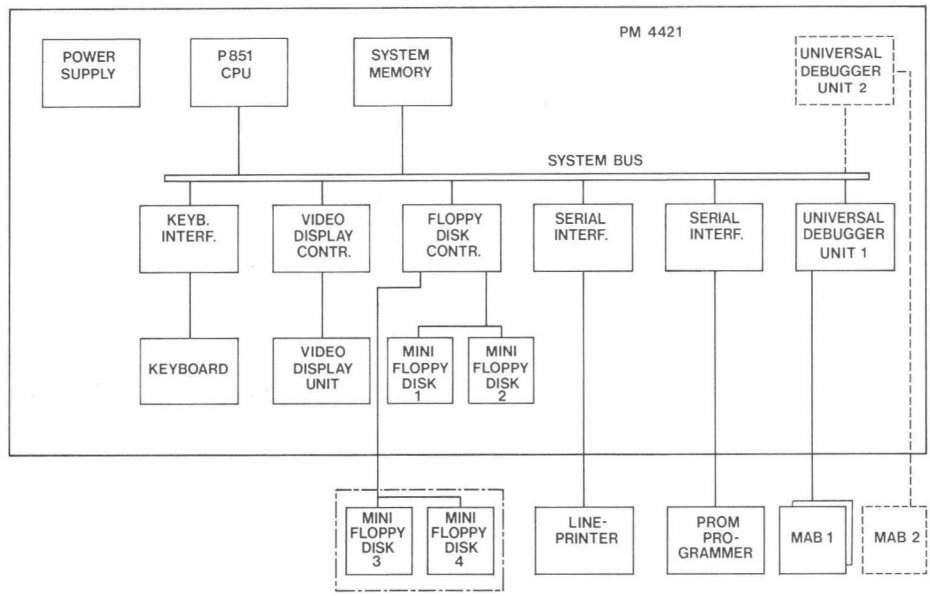
More information about these facilities is given in the appropriate data sheets.

Linker

The linker joins user modules together with any ready-made modules required to form one machine-code program. The locations of the modules and the memory layout of the prototype are entered into the linker or together with the necessary object-code modules. The PMDS linker is able to:

– change the memory layout at any time without the need to reassemble any modules
– check that all modules are being loaded into the right memory type (RAM or ROM)
– check prototype memory definitions for logical errors
– find and multiply defined externals in user modules
– optionally search up to four floppy-disk drives for modules required to satisfy external references

SYSTEM STRUCTURE MASTER SYSTEM



– allow user to control the start address of a module or sequence of modules, whenever necessary
– carefully check prototype specification for logical errors such as overlapping memory areas
– help debugging and program documentation by providing:
– a memory map which describes the memory layout of the prototype in a convenient reference form
– a load map showing the location of all program modules with their memory types and free areas
– a cross-reference table giving in alphabetical order the names and addresses of all externals and the places in the code they are referred to
– help in error correction by giving a large number of error messages in plain English, advising what errors have been detected and which control statements caused them.

Promloader control

The PM 4491 PROM Programmer works under remote control from the PM 4400 Compact Computer and its software. The software element which drives the programmer, the PMDS PROM processor, supports an interactive keyboard-command language via which the user specifies the required functions. These functions include a variety of operations involving machine-code programs on both floppy disk and PROMs. All data transfers dealt with by the PROM Processor take place via the PMDS system memory and can be in either direction: to or from floppy disk or to or from PROMs. The user can access and manipulate the code while it is held in memory. This flexible arrangement enables the performance of numerous different tasks with a relatively small range of commands.

Some applications of the PROM Processor are:

– PROM programming. A machine-code program can be loaded into PROMs from a microprocessor load file created with a linker, using a single command per PROM. The PROM Processor automatically verifies each data transfer and, on completion, displays a check sum of the transferred data which can be used to identify the programmed PROM
– PROM verification. The PROM contents are compared with the memory contents that may originate from a load file or from another PROM. Any differing bytes are displayed on the screen.
– blank checking. Any non-zero bytes in the PROM are displayed
– copying PROMs or reconstructing a floppy-disk load file from PROMs
– examining and patching machine-code programs. The memory contents originating from floppy-disk or PROM may be displayed line-by-line in hexadecimal format. The user can change the memory contents by retyping the affected characters on the display, and can store the changed version on floppy disk or PROM. Lines to be examined or changed can be accessed by referring to symbols used in the original source program
– creating machine code direct at the keyboard. The data may be typed in hexadecimal format and then stored on floppy disk in the UMDS microprocessor load-file format, or programmed direct into PROMs

– computing and inserting security-check sums. This is a useful facility in applications demanding high system integrity

Debugger

The debugger controls the universal debug unit and its options (emulation memories, trace memory, event counter etc.). This control is based on a set of commands to be given by the user. Five command classes of the debugger can be distinguished:

– general commands. These are the commands that are used only once during a debugging session, such as start and stop commands
– parameter setting commands. These commands are used to put the hardware debug unit into a particular position; they may be compared to the knobs on a conventional measuring device
– emulation control commands which control the emulation run
– debug commands, which are used to inspect and intervene in the target-processor operation results
– a load command to enter a load-module into the target and/or emulation memory

PMDS HARDWARE SYSTEM

Master system

The master system is built around the Philips P 851 16-bit micro-mini CPU, and incorporates the following functions packed in a single cabinet with detachable keyboard:

– a system memory of 64k bytes
– a video display for interfacing with the user
– a keyboard with extensive editing facilities
– a floppy disk subsystem
– control units for internal and external peripherals

All boards are of the double Euroboard format, while the system bus is based on the new Data Systems standard bus UPL (main characteristics: 24 address lines, 16 data lines and multi-master capability). The PMDS is designed in such a way that the system memory is completely isolated from the emulation memory. This gives full memory protection that is essential for a system designed to debug target systems.

Peripherals

The master system supports the following peripherals:

– a fast character printer (180 char/s): PM 4490
– a universal PROM programmer: PM 4491
– a digital cassette recorder: PM 4201

In addition, a direct serial link (V 24) allows communication with Intellec systems to transfer source files.

DEBUGGER

Universal debug unit

The PMDS has been designed from the beginning as a UNIVERSAL system. One of the features of the PMDS is the relatively low investment in hardware, software and training on switchover to a new microprocessor. Philips realized this by introducing a new concept: the universal debug unit. All the control logic, emulation memories and trace facilities are independent of the microprocessor architecture. The only change required is the simple, and therefore low-cost, Microcomputer Adaptor Box further referred to as MAB. The MAB is located outside the mainframe and attached to it via a dual flat cable. The mainframe cabinet offers space for two-universal debug units with associated options. The primary function of the universal debug unit is the control of the emulation process. The design ensures true real-time emulation for most microcomputers. The emulation process is stopped as soon as pre-defined break-point conditions are matched. The system has two trigger points of 48 bits wide. These bits are divided into an address group, a data group, a status/control group and a test probe group. The allocation of each group to the 48 bits can be programmed to bit level. Each trigger point has an associated match counter which allows counting up to 256 matches and a sync output to trigger an oscilloscope or a logic analyzer.
Moreover, a number of operating conditions of the target system may be checked, such as power failure, clock failure, prototype reset and access to 'non-existent' segments (see under 'mapping structure').

Multi-processor debugging

The PMDS is capable of supporting four universal debug units each of which is connected to its own microprocessor adaptor box (MAB). Every universal debug unit (UDU) can have an associated, dedicated emulation memory configuration and trace facility. During emulation of a multiprocessor system, each individual UDU performs its function of tracing and breakpointing independently. The UDUs may, however, be coupled for synchronization purposes.

MAPPING STRUCTURE

Mapping memory

The address space of the target system's memory is divided into 256 segments, each with a minimum of 256 bytes. The segment size depends on the address range of the target microcomputer. A 64k byte processor will have a segment size of 64k divided by 256 is 256 bytes. Each segment can be assigned to the target system's memory, the UDU's emulation memory, or can be given the 'non-existent' status. A segment can further have the status 'write-protected'.

Input-port mapping

The address space of the input is divided into 256 segments. Each segment must be assigned to the PMDS, the target system, or be given the 'non-existent' status. If the segment is assigned to the PMDS, input will be taken from the PMDS keyboard or disk file.

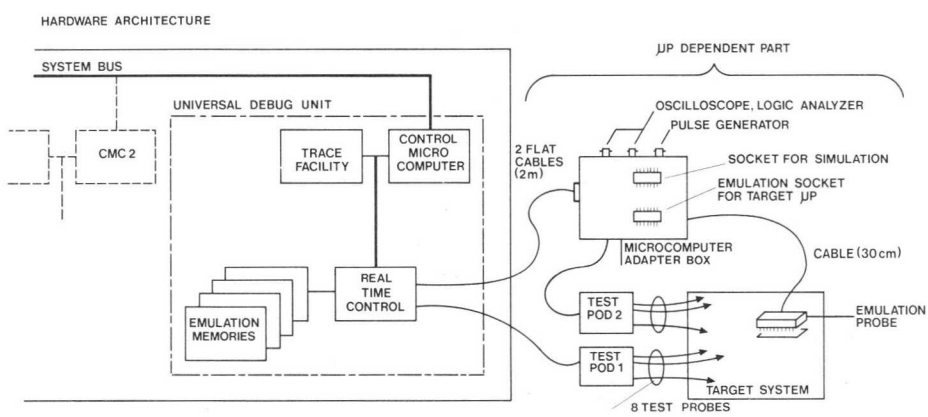
Output-port mapping

Segmentation and assignment are identical to the input port mapping. The output of a segment assigned to the PMDS may go to the PMDS display or to a disk file.

Clock selection for emulation

Three clocking methods are available:

– crystal clock
– programmable clock from the PMDS
– clock from an external source via a BNC on the MAB



Emulation memory

Two types of emulation memory are available. First there is a very fast memory to ensure real-time emulation. It has a capacity of 8k or 16k bytes per module, and up to four modules can be placed into the system. The access time is approx. 130ns.

The second type is a dynamic memory with a capacity of 8k, 16k, 32k or 64k bytes per module. Up to four modules can be built into the system and the access time is approx. 450ns.

The memory types can be mixed. The memory mapping facilities allow flexible allocation under full user control.

Trace memory and event counter

Up to 255 sampled words may be stored in the trace memory. Sampling may be controlled by machine cycles, operation code or test probe, with a sampling rate of up to 5MHz. The information in the trace memory may be disassembled for user convenience. Possible trace stop modes are: pre, centre or post-triggering. The trace conditions are chosen with the aid of two qualifiers.

The 24-bit event counter can count up or down the various events in the system such as absolute time (up to 8s with a 0.5µs resolution), clock and instruction cycles, interrupt-acknowledged cycles, test-probe input and trigger points. The event-counter window is user-programmable, giving full control of the start/stop time.

Microcomputer adapter Box (MAB)

In the MAB, various microprocessor/microcomputer architectures are hardware-adapted to the UDU architecture The interface between the MAB and the UDU consists of a dual flat cable.

The characteristics below are common for all MABs. The MAB is connected to the target system's microcomputer socket via a flexible cable and the emulation probe. There are two sockets on each MAB:

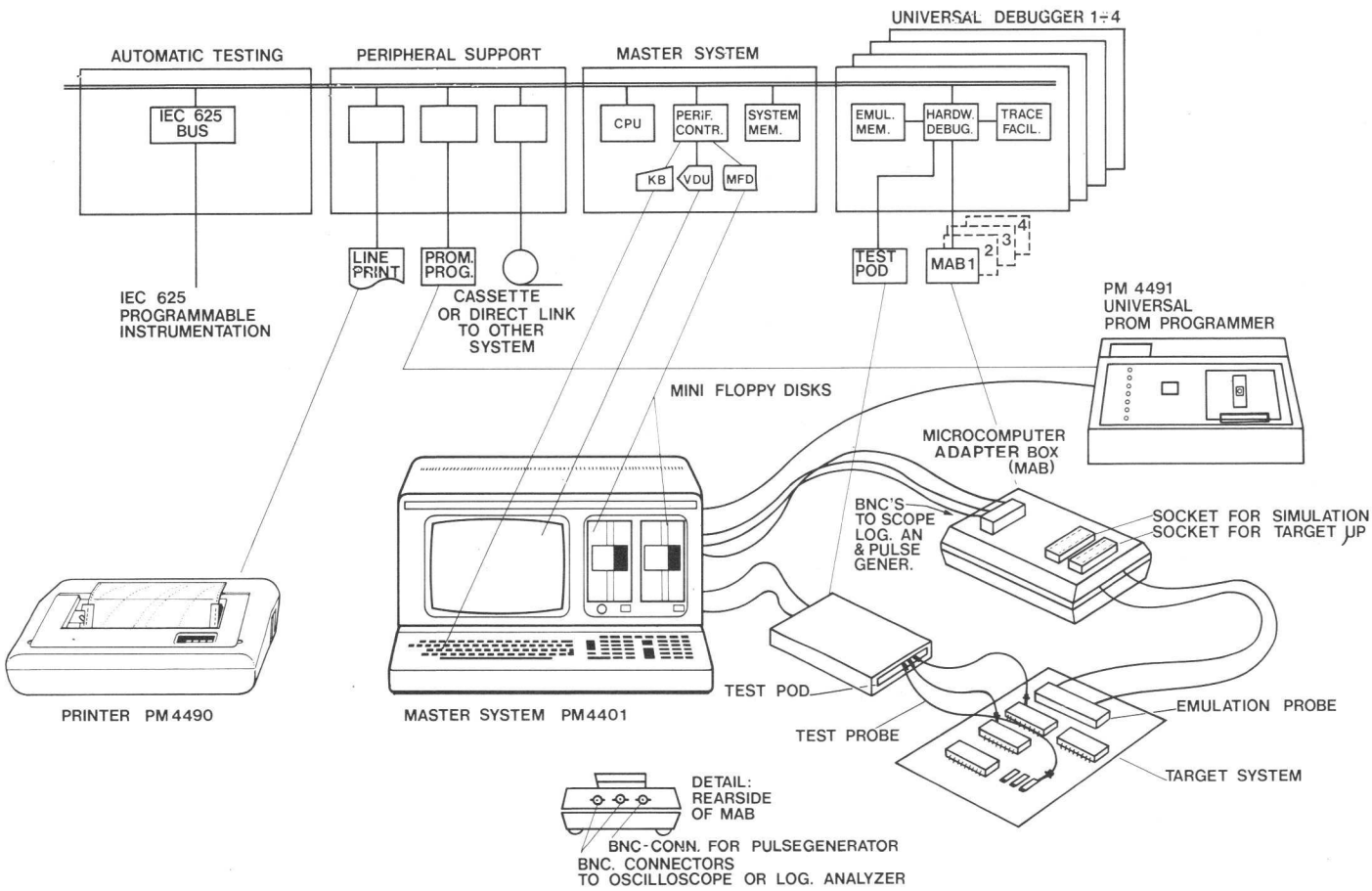
- an emulation socket for the target microcomputer
- a simulation socket to accept the emulation probe in the simulation mode (no target system connected or available)

Each MAB is also provided with three BNCs. Two of them supply sync. pulses for an oscilloscope or logic analyzer, and the third is the input for external clock signals from a pulse generator.

At the time of introduction, the PMDS supports the MAB-8085 up to 5MHz (8085A-2 version) and the MAB-Z80 up to 4MHz (Z80A version). The MAB-6500 will support all types of this family, e.g. 6502, 3, 4, 5, 6, 7, 12, 13, 14 and 15 up to 2MHz (6500A version).

Test pod

For 8-bit microcomputers, two PM 8820 test pods may be connected to the system. Each pod contains 8 test probes with programmable threshold voltages. One pod is connected direct to the system, whereas the other is connected to the MAB. For 16-bit microcomputers, one test pod with 8 probes is available.



TECHNICAL SPECIFICATION

The PHILIPS MDS is based on the PM 4401 master system and configured in accordance with the customer's wishes. These wishes are translated into options which are placed in the master system cabinet, with the exception of peripherals, MABs and test pods.

PM 4401 MASTER SYSTEM

CENTRAL PROCESSING UNIT (CPU)

Type
LSI mini-processor Philips P 851:
16 bit capability, 14 program registers, 160 micro-programmed instructions, 64k-byte address range, micro-diagnostics

MAIN STORE (RAM)

Type
Fast dynamic RAM: 64k bytes on one board

Access time
450ns for 16bits.

MASS STORAGE

Type
Mini floppy-disc drive FD 250

Capacity
Two or four drives with 320k bytes (formatted) each

Average access time
298ms

KEYBOARD

Model
Free-standing unit

Type
Alphanumeric, numeric and miscellaneous. Generates 128 ASCII-characters, with function control and function codes. Serial data transmission allows input of up to 800 characters per second to main frame. Error checks built in. Indicators for I/O, INPUT and CAP/LOCK

Keyboard groups
Typewriter part: 53 keys
Special functions: 8 keys
Numeric pad: 18 keys
Cursor control/editing: 9 keys
User definable: 2 × 8 keys
Indicators: 3 light-emitting diodes

MONITOR

Type
Video display, P4 white

Screen size
12-in (30cm) diagonal

Alphanumeric representation
24 lines of 80 characters each

Graphical representation
7 × 9 dots

Character set
128 ASCII characters

GENERAL PURPOSE HARDWARE OPTIONS

PM 4470 V24 SERIAL INTERFACE
V24 bit-serial of 20mA current loop.
Baud rate selectable between 110 and 9600 Baud, input/output independent. Word length 5-8 bits. Parity check. Cable lengths of up to 300 metres.

PM 4471 IEC-BUS INTERFACE
In conformity with IEC-625 standard. Able to act as a controller, talker or listener

PERIPHERAL EQUIPMENT

PM 4490 HIGH-SPEED LINE PRINTER

Printing data
Printing at a rate of up to 180 characters per second over a width of 136 characters maximum on normal paper

Character data
Set of 96 characters USASCII in a matrix of 9 × 7 dots may be printed in normal, elongated or expanded type

Self-test capability
Allows printing of a rotating, fixed alphanumeric character pattern

PM 4491 UNIVERSAL PROM PROGRAMMER (see also PM 8430 and PM 8431)

Universal programming
Programs bipolar PROM, PAL, MOS EPROM, FPLA, PMUX, FPGA and diode matrix via 'Programming Pak'

Data storage
Standard 4k × 8 (32k bit) RAM, expandable to 16k × 8 (128k bit)

Data input/output
- LOAD data from master device to RAM
- VERIFY function to check data transferred from master
- INPUT from serial port
- INPUT COMPARE function verifies a second input of external data with that already in RAM
- OUTPUT through serial port
- PROGRAM device to manufacturer's spec

Serial port
- RS 232C or 20mA current loop, full or half duplex
- Baud rate: external switch-selectable baud rates of 50, 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, 9600 or 19200
- ASCII character format definition by internal switch: parity ON/OFF, EVEN/ODD parity, ONE/TWO stop bits
- Data transfer format: ASCII-Hex
- Data inversion of the incoming bit stream possible by internal switch

Display
LED indicators of machine status and operating mode

PM 4493 EXTERNAL MINIFLOPPY-DISC SUB-SYSTEM*
This is a cabinet containing two disc drives (for specifications see under MASS STORAGE) interfaced to the minifloppy-disc control in the PM 4401 master system

PMDS HARDWARE OPTIONS

PM 8400 UNIVERSAL DEBUG UNIT

Structure
The debug unit is designed for a multitude of tasks, i.e. for a multitude of users. Its main functions are: microcomputer control, real-time control, memory and I/O mapping

Triggering
Two breakpoints with 48 match condition bits each are available. The match conditions are '0', '1' or 'X' (don't care) and may be set for address, data, control, extended control and test probes. The breakpoint settings allow numerous trigger combinations. Each breakpoint is externally available on a sync-pulse output.
Example of line distribution to monitor the target microprocessor 8085.
- address 16 lines
- data 8 lines
- control 4 lines
- extended control 4 lines
- test probes, standard 8 lines
- test probes, extra 8 lines

together 48 lines of the target system

* Request price quote

Match counters
Two match counters able to count up to 256 matches

I/O mapping
Partitions the target microprocessor's input and output address spaces into 256 segments

Memory mapping
Partitions the target micro-processor's memory address space into 256 segments

PM 8410 TRACE FACILITY UNIT

Real-time memory
- memory depth: 255 history steps
- memory width: 48 traced lines divided into address, data, status-control and test-probe lines
- trace frquency: d.c. to 5MHz
- trigger qualifiers: one external and two internal trigger qualifiers enable conditioning of the triggering to when a qualifier is true
- trigger modes: post-triggering, i.e. immediate break emulation; centre-triggering, i.e. break emulation after 128 traces; pre-triggering, i.e. break emulation after 255 traces
- trace-clock sources:
  machine cycle
  opcode fetch machine cycle
  instruction cycle
  pos/neg transition-selectable
  test probe

Event counter
- count range: 24 bits
- count frequency: d.c. to 5MHz
- modes: up and down counting (time out)
- count sources:
  real time (0.5μs resolution)
  target micro-processor (tμP) clocks
  t μP machine cycles
  t μP instruction cycles
  t μP interrupt acknowledge machine cycles
  test probe
  each trigger point

DYNAMIC EMULATION MEMORIES

Type
Dynamic RAM memory

Capacity
PM 8411 32k bytes
PM 8412 64k bytes
PM 8415 8k bytes
PM 8416 16k bytes

Access time
450ns

PM 8413 FAST EMULATION MEMORY

Type
Static RAM memory

Capacity
8k bytes

Access time
130ns

PM 8414 FAST EMULATION MEMORY

Type
Static RAM memory

Capacity
16k bytes

Access time
130ns

Microcomputer Adapter Boxes (MABs)
External boxes with buffering/interfacing logic for target microcomputer to and from UDU-bus. They contain a socket for the target microcomputer, a socket for simulation, two BNCs for sync.-pulse output and one BNC for pulse generator input.

PM 8420 MAB-8085
Emulating 8085 up to 8085-A2 speed

PM 8422 MAB-Z80
Emulating Z80 family up to Z80A speed

PM 8424 MAB-6500
Emulating 6500 family up to 6500A speed

PROGRAMMING PAKS

PM 8430 PROGRAM PAK AND SOCKET ADAPTER
For INTEL 2716 and TI 2516

PM 8431 PROGRAM PAK AND SOCKET ADAPTER
For INTEL 8741 and 8748; others optionally available

TEST PODS

PM 8820 TEST POD FOR EIGHT TEST PROBES
Programmable threshold voltage

PM 8819 EXTENSION KIT FOR TEST POD PM 8820

PMDS SOFTWARE OPTIONS

PM 8460 CROSS-ASSEMBLER
Cross-assembler supporting 8085

PM 8462 CROSS-ASSEMBLER
Cross-assembler supporting Z80

PM 8464 CROSS-ASSEMBLER
Cross-assembler supporting 6500

PM 8470 PASCAL 8085*
Compiler to adapt PASCAL to the target microprocessor's object code

DEBUG PROCESSORS
The debug processor translates the wishes of the user into actions of the PMDS' debug part. Five command classes are available for this purpose:
- general commands
- parameter setting commands
- emulation control commands
- debug commands
- load commands

The following debug processors are available

PM 8480 DEBUGGER
Supporting 8085

PM 8482 DEBUGGER
Supporting Z80

PM 8484 DEBUGGER
Supporting 6500

PM 8490 SOFWARE PACKAGE FOR MASTER SYSTEM PM 4401
This package contains the micro-computer independent parts:
- MDS monitor
- Control command interpreter
- Text editor
- Linker
- PROM-processor

PM 8495 INSTRUMENTAL BASIC*
If the PMDS is used as an IEC-bus controller, this BASIC interpreter with extensions can be used to support:
- IEC-bus instrumentation
- Plotter
- String handling
- Matrix operation (PM 8496 only)

* Request price quote

The PM 4421 Philips microcomputer development system can be supplemented by a number of hardware and software options to provide real-time emulation capability for a range of different microprocessor units.

The complete support system for the Intel 8085 microprocessor consists of:

Cross-assembler PM 8460

Debugger PM 8480

Microcomputer adapter box (MAB) PM 8420

new
Intel 8085 support

SPECIFIC MICROPROCESSOR SUPPORT FACILITIES FOR PM 4421 PHILIPS MICROCOMPUTER DEVELOPMENT SYSTEM.

Cross-assembler PM 8460

The cross-assembler is an automatic extension of the standard PM 4421 software package which translates assembly-language modules into object modules that are acceptable as input for the universal linker. A range of cross-assemblers are provided to cater for the different architectures and instruction sets of the various microprocessors available and in common use today. New cross-assemblers can be produced quickly and at low cost thanks to special generation methods. The large number of common features in different cross-assemblers facilitates retraining on changeover to a new microprocessor type. A few of the many advanced features common to all PMDS assemblers are:

- conditional code generation. This allows a system program to be changed to meet different user requirements or hardware configurations without having to modify program modules.
- MACRO facility. This avoids the need to key-in frequently repeated program lines every time they are used. It also allows the creation of structured data tables in a versatile way.
- memory type specification. Assembler directives are provided that allow the user to specify which parts of program or data areas must be in RAM and which in ROM. This allows the link editor to detect errors in mapping that could otherwise be difficult to find.
- error messages. Each assembler detects many different types of syntax errors and gives a code letter to indicate the type of error. Error types are machine-independent, and need therefor only be learnt once.
- cross-reference listing. This is an alphabetic list of all user symbols giving their values and the line number(s) to which they are referenced. This makes the understanding of large modules much easier.
- modular support. To allow modular programming, it is necessary to specify which part of a module needs to be accessed by other modules and which parts refer to other modules. This information is used by the assembler to find errors and also by the linker to link the separate modules together. Full support for this modular approach is available in the PMDS assemblers.
- paging support. Some microprocessors and microcomputers have memories divided into physical units (pages) of a fixed size. This causes special mapping problems. These special requirements are also supported by the PMDS.

The PM 8460 cross-assembler can handle either the Intel 8080 or 8085. The two extra instructions (RIM and SIM) provided with the 8085 are enabled by a model directive through which the model being used is specified. A built-in checking facility in the cross assembler gives a warning signal if these two instructions are used with the 8080.

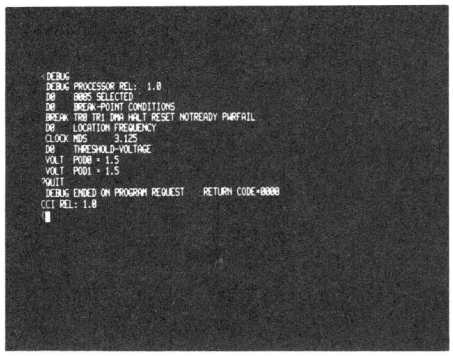
Standard Intel instruction mnemonics are used in the cross-assembler, resulting in some symbols being reserved for the symbol table.

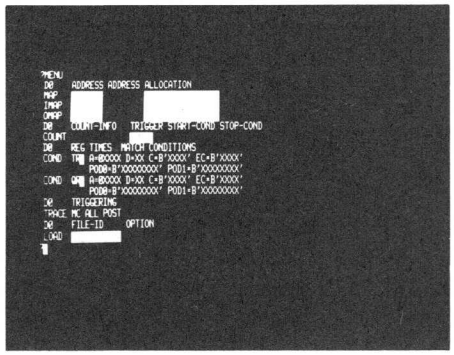
Therefore they cannot be used as labels. These symbols are A, B, C, D, E, H, L, M, SP, PSW. Uses of these symbols are shown in the cross-reference table.

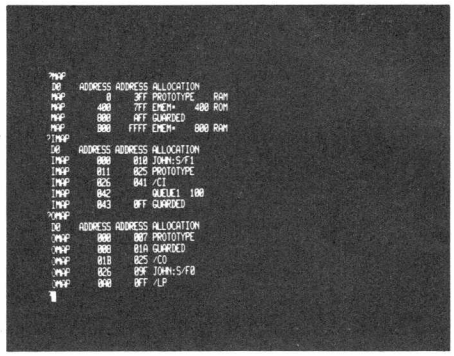
Debugger PM 8480

The debugger controls the universal debugger and its options (emulation memories, trace memory, event counter etc.). This control is based on a set commands to be given by the user.

The debugger is started from the CCI by the DEBUG command:







The debug session is terminated by the QUIT command, and can be logged on diskette or by the printer.
A debug session can be started by the control command DEBUG.
Information about the debug unit selected will be displayed on the screen. The debugger can support from 1 to 4 debug units, each of which has 2 modes of operation:
– interrogation mode
– emulation mode
In the interrogation mode the user can issue commands to specify control information, display status information etc. In the emulation mode only a STOP command for that particular debug unit will be accepted. An emulation run on a target microprocessor can be in 2 different modes:
– real-time mode
– step mode
A debug session starts in the interrogation mode for all debug units. The debugger switches to the emulation mode when a RUN or STEP command is given. At the end of an emulation the debugger processor switches back to the interrogation mode. An emulation run is ended by a STOP command or when a match of a break condition is encountered. The debug session is ended by a QUIT command.

Menu command

This command displays the layout of a number of commands which the user should issue before starting an emulation run. The user can use the displayed layout to prepare his commands, but is not obliged to do so. The menu command is used by placing the cursor on the line containing the required command and filling the indicated fields with adequate information. The line is entered by pressing the 'transmit' key. After a prompt is received for the next command, the same procedure can be repeated, and the previous command may also be re-used.

PARAMETER SETTING COMMANDS

These commands are used to set the debug unit in a particular position, and may be compared to knobs on a conventional measuring device.

Mapping commands

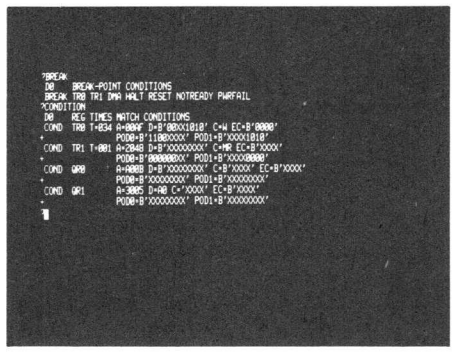
The address space of the target system memory is divided into 256 segments, each of 256 bytes. Each segment can be assigned to the target system memory or to the emulation memory, or can be given the 'guarded' status. The type of memory (RAM or ROM) in each segment can also be specified. The MAP command is for setting the mapping parameters to allocate memory in either the user prototype or the microcomputer development system. The IMAP and OMAP commands each provide 256 ports which can be individually allocated in either the user prototype system or the microcomputer development system.

Clock selection

Three clocking methods are available:
– crystal clock
– programmable clock from the PM 4421 PMDS system, with 4 different frequencies.
  – 0.521MHz
  – 1.562MHz
  – 3.125MHz
  – 4.687MHz
  – clock from an external source via a BNC on the MAB.

Break command

The break command specifies the break conditions for the emulation run. For the 8085, these are as on the display shown below:



Condition command

This command is used to set the match conditions for the breakpoints. Two breakpoints with 48 match condition bits each are available. The match conditions are

'0', '1' or 'X' (don't care), and may be set for address, data, control, extended control and test probes. The breakpoint settings allow numerous trigger combinations. Each breakpoint is externally available on a sync.-pulse output; the line distribution to monitor the target microprocessor 8085 is:

- address 16 lines
- data 8 lines
- control 4 lines
- extended control 4 lines
- test probes, standard 8 lines
- test probes, extra 8 lines

total 48 lines of the target system.

Match counters

Two match counters able to count up to 256 matches are provided.

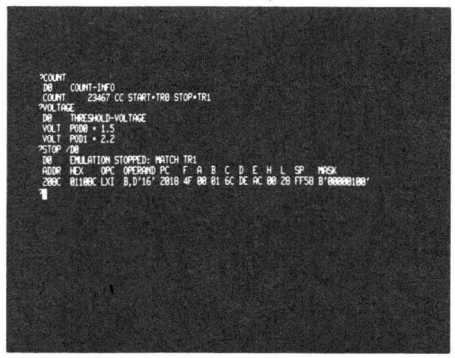
Event counter

The optional event counter is a 24-bit counter which can be driven under parameter command by one of the following user-system signal sources:

- clock cycle
- machine cycle (default)
- instruction cycle
- real-time (microsecond pulses)
- user probe line (1 particular line of the user probe)
- interrupt acknowledge line
- break condition 0
- break condition 1

The counting process takes place continuously during an emulation run, or can be started and/or stopped on break condition 0 or 1 and parameter command control. The first use of the event counter will simply be a measurement of time in absolute or relative terms. A second possibility is to add the clause DOWN with a specified starting value. The counter will then count down instead of up under the same conditions as mentioned before down to zero. The zero-counter will cause an emulation stop if the ENABLE/DISABLE command allows it.

- count range: 24 bits
- count frequency: d.c. to 5MHz



- modes: up and down counting (time out)
- count sources:
  real time (0,5μs resolution)
  target microprocessor (tμP) clocks
  tμP machine cycles
  tμP instruction cycles
  tμP interrupt acknowledge machine cycles
  test probe input
  each break condition

Voltage instruction

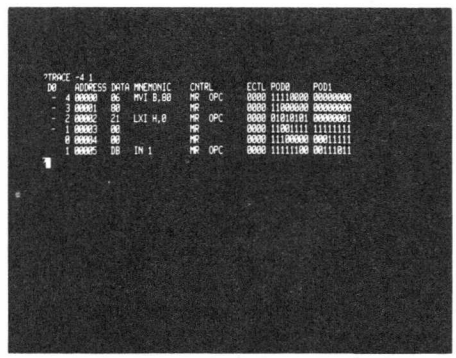
This instruction is used to set the threshold level of the test probes. For the Intel 8085, a total of 2 test pods, each with 8 probes, can be connected to the user's prototype system. POD 0 is connected to the development system, and POD 1 to the MAB 8085.

Trace command

This command shows the history of the program during emulation. It is the software driver for the PM 8410 trace facility unit, which features:

Real-time trace memory

- memory depth: 255 history steps
- memory width: 48 traced lines divided into address, data, control, extended control and test-probe lines
- trace frequency: d.c. to 5MHz
- trigger qualifiers: one external and two internal trigger qualifiers enable conditioning of the triggering to when a qualifier is true



- trigger modes: post-triggering, i.e. immediate break emulation; centre-triggering, i.e. break emulation after 128 traces; pre-triggering, i.e. break emulation after 255 traces
- trace-clock sources:
  machine cycle
  opcode fetch machine cycle
  instruction cycle
  pos/neg transition-selectable test probe

Microcomputer Adapter Box PM 8420

The MAB is the hardware unit acting as an interface and buffer between the PMDS and the target microprocessor. Two sockets are provided: one is for the 8085-A2 target microprocessor; while the other is a simulation socket for hardware simulation when prototype hardware is not yet available, to which the emulation probe is connected. The emulation socket also allows an external clock from the target system to be applied. Two sync. outputs – one for each break condition – are provided, together with a BNC connector for connection of an external clock.

NEW

Universal PROM programmer PM 4491

Universal - programs bipolar PROM, PAL, MOS, EPROM, FPLA, PMUX, FPGA and diode matrix

Standard 4k×8 (32k bits) RAM for data storage: expandable to 16k×8 (128k bits)

New plug-in Programming Paks can easily be changed without disturbing RAM memory

Remotely operated via serial interface (RS232C and 20mA current loop)

Automatic self-test and error detection

Internal continuous RAM test to flag power-induced memory failure

External switch-selectable baud rates to 19200 bits/s

Lightweight and portable

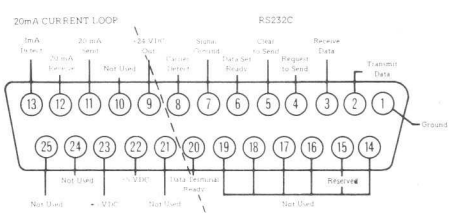
The PM 4491 Universal PROM programmer complements the versatility of the PM 4421 Microcomputer Development System, and gives the user full freedom of choice of the PROMs to be used in a prototype system. The PM 4491 is made by Data I/O, acknowledged leaders in the field of programming equipment, and its functions include loading, copying and verifying PROMs, patching and examining data, and insertion of PROM checksums.

TECHNICAL SPECIFICATION

Remote-control operation
- LOAD data from PM 4421 master system to RAM
- VERIFY function to check data transferred from master
- INPUT COMPARE function verifies a second input of external data with that already in RAM
- OUTPUT through serial port
- blank-checking of PROMs
- PROGRAM device to manufacturer's specification

Serial port
- RS232C or 20mA current loop, full or half duplex
- Pinout diagram
- Baud rate: external switch-selectable 50, 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, 9600 or 19.200 bits/s
- ASCII character format definition by internal switch: parity ON/OFF, EVEN/ODD parity, ONE/TWO stop bits
- Data transfer format: ASCII-Hex
- Data inversion of the incoming bit stream is accomplished by setting an internal polarity switch.

Display
LED indicators for power on and programming mode



POWER REQUIREMENTS

Power consumption
35W

Mains (line) voltage
100, 120, 220 and 240V_{AC} ±10%

Mains (line) frequency
50 to 60Hz

ENVIRONMENTAL CHARACTERISTICS

Temperature range
0 to +45°C (+32 to +104°F) operating
−40 to +70°C (−40 to +158°F) storage

Humidity
Up to 90% (non-condensing)

DIMENSIONS AND WEIGHT

(w×h×d) 381×152×273mm
(15×6×10.75-in)
approximately 6.4kg (14lb)

NEW

High-speed matrix printer PM 4490

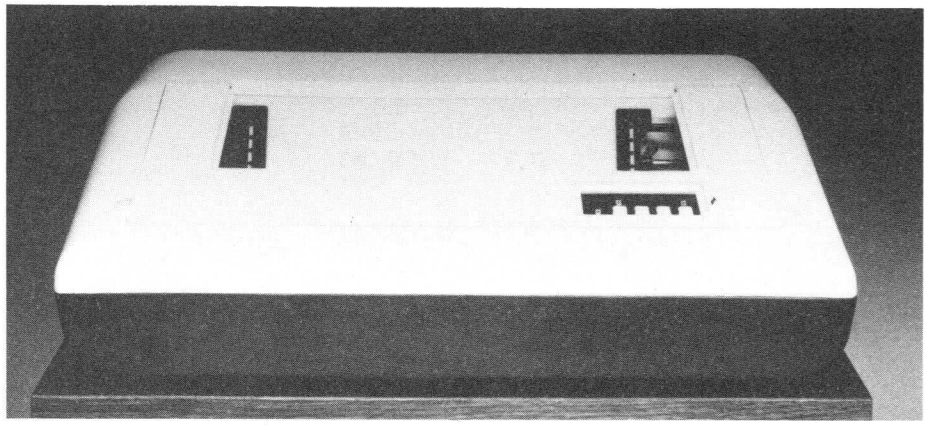
Full 96 ASCII character set

Serial interface

7 wide × 9 high dot matrix for up to 63 dots of printing flexibility

Built-in high reliability

The high-speed matrix printer PM 4490 enables the bi-directional printing of data at a rate of up to 180 characters per second. Printing at this speed starts when a line is loaded into the memory and continues as long as there is a line of data to be printed.
The next line to be printed is completely in the memory by the time the previous line has been printed. This line will then be printed in reverse, since the printer operates bi-directionally. Because the print head provides a 9 high × 7 wide dot matrix, true underlining and the printing of upper case, lower case and descenders is possible. The print head has no moving cores attached to the print wires, but employs armatures to ballistically propel the matrix wires in free flight to ribbon and platen. Such a system substantially reduces drag and minimizes tip wear. This, together with a servo-motor drive system that operates clutches, belts and return springs, makes for maximum reliability.
The print-out may be on almost any form of paper up to 0.46mm (0.018-in) thick and 406mm (16-in) wide. The printer has its own micro-processor which allows programmable forms and font control. The programmed format is retained when the power to the printer is turned off. This battery powered format retention system operates only when the a.c. power is interrupted and holds format settings up to 96 hours at a time.



TECHNICAL SPECIFICATION

PRINTER MECHANISM

Speed
Up to 180 characters per second

Matrix
9 dots high by 7 dots wide

Number of columns
136

Character format
136 characters per line
4 characters per centimeter (10 characters per in)
6 or 8 lines per in vertical (6 or 8 lines per 2.5cm)

Character set
Standard 96 characters USASCII

Carriage return time
Less than 500ms for the full line

Tab speed
Up to 125 centimeters per second (50-in/s)

FORMS HANDLING

Paper feed mechanism
Adjustable, with pin leed tractor for handling standard business forms

Paper advance speed
30 milliseconds for one line

Slew rate
19.5 centimeters per second (7.5-in/s)

Maximum paper width
406mm (16-in)

Paper
Single part or multipart interleaved with carbon paper up to a maximum total thickness of 0.46mm (0.018-in)

Paper alignment
A switch on the front panel permits positioning of the paper at 0.05mm (1/48-in) increments

VERTICAL FORMATTING

Vertical tab set
Control codes in the data stream allow remote setting and clearing of vertical tab settings

Vertical tab
Slews to next vertical stop

Double space
selects single or double line feed

Auto line feed
Selects automatic line feed functions upon carriage return

Addressable vertical tabulation
Advances to the selected line

Perforation skip-over
Available

HORIZONTAL FORMATTING

Horizontal tab set
Codes set and clear horizontal tab stops

Horizontal tab
Carriage moves to next stop upon receipt of tab code

Addressable horizontal tabulation
Moves directly left or right to the selected column position

RIBBON

Standard inked nylon ribbons, with reinking roller in printer. Ribbon life up to ten million characters

SPECIAL FUNCTIONS

Self test capability
Allows printing of a rotating, fixed alphanumeric character pattern

Character print
Normal, elongated or expanded

Space/blank compression
Automatically compress all spaces or blank characters into a one, two or three character string

INDICATORS

Paper out
Lights up as soon as the paper has run out

Audible alarm
Signals a fault condition

SERIAL INTERFACE

Type
EIA-RS232C/CCITT for 7 or 8 bit data codes, plus 1 or 2 bits and odd, even or no parity

Clock rates
75, 110, 300, 1200, 1800, 2400, 4800 or 9600 bits per second

POWER REQUIREMENTS

Power consumption
160W

Mains (line) voltage
105 to 129V or 210 to 250V

Mains (line) frequency
48 to 62Hz

ENVIRONMENTAL CHARACTERISTICS

Temperature range
+10°C to +45°C
(+50°F to +112°F) operating
−50°C to +70°C
(−60°F to +158°F) storage

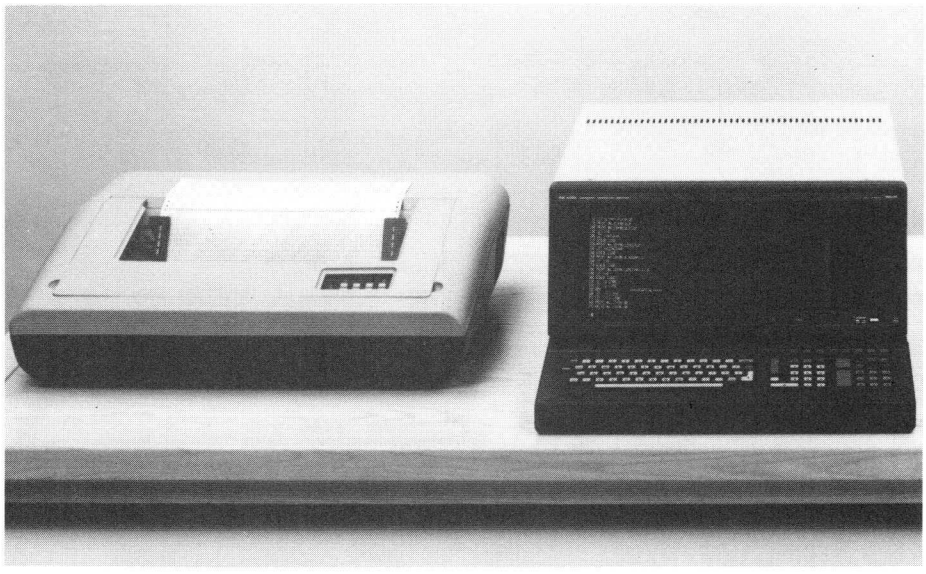
Humidity
10% to 90% relative humidity, noncondensing

Note:
When continuous forms are printed the ambient temperature should be within +10°C to +38°C (50°F to 100°F) and the relative humidity should be within 25% to 62% to assure good paper stacking.

DIMENSIONS AND WEIGHT

(w × h × d) 686 × 203 × 432mm
(27 × 8 × 17-in)
Approximately 23kg (50lb)

High-speed matrix printer PM 4490 in test set up with PM 4400 compact computer.



Unit	Features	Function	Accuracy	Page
LINE RECORDERS				
Flatbed *compact* series				
PM 8251	Standard compact, single line	X-t	0.25% (0.5%)	80
PM 8252	Standard compact, double line	X_1, X_2-t	0.25% (0.5%)	80
PM 8202	Modular compact, single line	X-t	0.25% (0.5%)	82
PM 8222	Modular compact, double line	X_1, X_2-t	0.25% (0.5%)	82
Vertical				
PM 8110	Minirecorder, single line	X-t	1%	84
PRINTING RECORDER				
PM 8210	Printing recorder	X-t plus alphanumeric print-out	0.25% (0.5%)	86
MULTIPOINT RECORDER				
PM 8236	12-point	X-t	0.25%	88
X-Y RECORDERS				
PM 8040	OEM standard DIN A4	X-Y	0.25%	91
PM 8041	Standard DIN A4	X-Y	0.25%	91
PM 8141	Multipurpose DIN A4	X-Y	0.25%	91
PM 8131	Multipurpose DIN A3	X-Y	0.25%	94
PM 8132	Two-pen DIN A3	X_t, Y_1, Y_2	0.25%	94
INTELLIGENT DIGITAL X-Y PLOTTER				
PM 8151	Multipen, intelligent plotter DIN A3 format	X-Y from digital input	Addressable resolution 0.1mm	95
CONSUMABLES				
Consumables, various				98
PROCESS CONTROL INSTRUMENTATION				
Transokomp 250				100
PCS line recorders				102

Introduction

Progressive development

Like all other instruments in the Test & Measuring series, recorders continue to develop to meet the new challenges of advancing technology and new applications. Moreover, the incorporation of digital circuitry in certain models has opened up many interesting possibilities for the user.

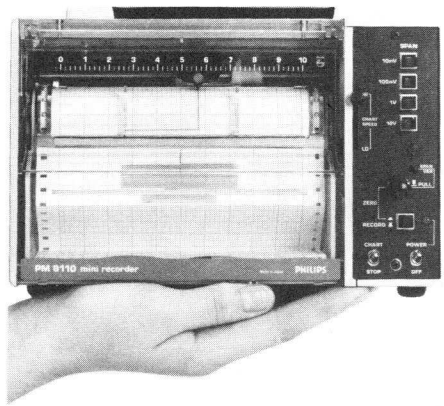
Otherwise complicated instrumentation has become even simpler to understand and operate and benefits like automatic self-testing routines are becoming a standard feature. Yet, where the more everyday, basic, requirements remain, recorders meeting this less sophisticated level of application have also been progressively upgraded in terms of reliability, accuracy and overall quality.

For these reasons, the range of Philips instruments offered cover practically every requirement to be found in R & D labs, specialized research and observation, production line and field operation. Without overlooking the needs of the OEM sector.

Versatility

There are many options to choose from. The X-t group embrace several different styles and types which include single- and double-pen models, a programmable, multipoint recorder, an analog-plus-digital printing recorder and a mini-model for general back-up work.

The similarly well-proven range of X-Y units offers several different versions, covering both DIN A3 and DIN A4 chart sizes. Single- or double-pen models are standard and an intelligent X-Y plotter features an abundance of sophisticated facilities. Also included in this group is a special, OEM-styled, economy version.



PM 8110 is an excellent back-up recorder which can be powered by a DC/AC inverter or rechargeable battery unit for field application.

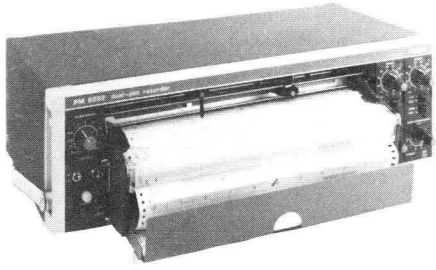
Quality aspects

The essential elements of modern recorder performance are the conflicting features of a delicate, sensitive instrument mechanism, to give high-grade accuracy, coupled with formidable, physical robustness. Certainly, the total package must be technologically adequate, be able to withstand the rigours of industrial environments and have a long, trouble-free operational lifetime.
Philips, with the long experience as both designer, manufacturer, supplier *and* user has more than met these requirements. All instruments are manufactured to the various IEEE, VDE and IEC requirements appropriate to each particular model.
Users can therefore be confident that all the units described in this section will meet their stated quality standards on every point. They can be relied on in terms of sensitivity, accuracy, stability and long-term trouble-free usage. And they can withstand the physical punishments likely to be found in whichever environment they are selected for use in.

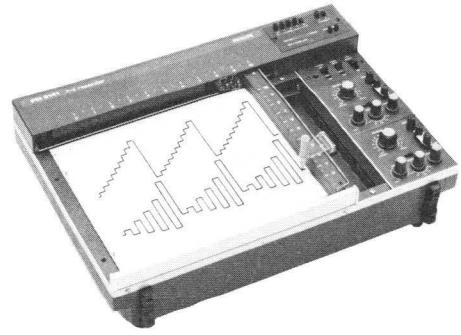
Which X-t recorder?

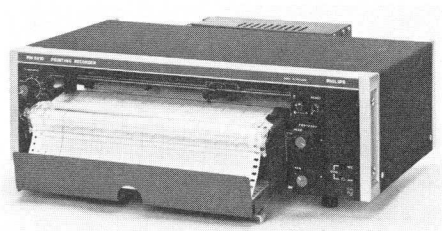
There are four types of X-t recorders to choose from:
The **Compact** family for one- or two-pen recording on 250mm wide chart, for conventional analytical work through to applications which demand a 'versatile recorder' which can be remotely controlled.
The **Compact** design concepts were based on the desire to telescope together the major benefits of both vertical and flatbed styles. The resulting instrument therefore allows the user to enjoy the better features of both types. These include:
- a flatbed recorder that can be built-in
- choice of rackmounting or bench use
- in bench situations, other instruments can be stacked on top without affecting operation
- a projecting table for note-making

PM 8222 two-pen recorder is one of the modular Compact series which combine the benefits of flatbed and vertical recorders into one instrument.



Single-pen X-Y recorder PM 8131 has DIN A3 format with high stability and neglegible temperature drift.





The printing recorder PM 8210 features simultaneous recording of both analog and digital data on the chart.

– Z-fold chart system for easy back-reference, convenient record storage and uncomplicated loading.
– recordings that can be seen directly at the pen tip.

The **Minirecorder** for maximum economy, uses 120mm chart width, yet retains all the features of a conventional laboratory recorder PLUS portability.
This is a useful instrument for general back-up applications in field, service and production situations, especially where trends need to be followed.
The **Multipoint** recorder for measuring up to twelve channels of information, which may be a mixture of voltages and temperatures from different thermocouples or resistance thermometers.
This unit, the PM 8236 provides a really versatile performance and incorporates a pinboard matrix programming unit which allows selection of any or all channels for measuring up to six different types of input.
The **Printing recorder** is based on the **Compact** series physical design. However, it combines an analog trace with digital print-out on the same chart. Unlike its competitive counterparts, it does not stop recording during the printing operation. Each 80-character line can be printed at a speed of 30ch/s and the alphanumeric information can be positioned anywhere on the trace.

Which X-Y recorder?

The A-4 chart size recorder is available in two versions for application versatility. STANDARD version, type PM 8041, has 9 input ranges, max. sensitivity 2mV/cm variable span and full zero positioning controls.
MULTIPURPOSE version, type PM 8141, extends the flexibility by offering 14 input ranges, increased sensitivity to 50μV/cm and 5 ranges for zero position from −400% to +100% fsd. For both of these recorders, a timebase option can be inserted, if an X or Y variable function must be plotted against time.

Two, A-3 chart format models are available, where higher resolution is required. The single line multipurpose version PM 8131, with 14 input settings, max sensitivity of 50μ/cm and zero suppression up to −400% and the two-line model PM 8132, with 15 ranges, 200μV to 10V/cm and built-in time base.
The fundamental design concept of the X-Y single and double pen series is common for all units.
Basics include a strong, 19-in diecast frame (for bench or rack mounting), high accuracy, low drift, fast pen speed characteristics. The resulting high-precision instruments are further enhanced by efficient electronic and mechanical overload protection, giving increased reliability and a long operational lifetime.
The new Intelligent X-Y Plotter PM 8151 offers many unique features. It accepts digital data inputs from desk computers, IEC-controllers, time-sharing systems, etc. There is a choice of 8 pens (programmable) and 120 characters in 5 different national fonts, upper and lower case. The integrated microprocessor greatly simplifies operation, initiates and controls all operations and provides self-testing routines.

New OEM model

The PM 8040 is also introduced this year and is specially aimed at the OEM sector. A 'stripped down' version of the PM 8041 it will be of interest in situations where a recorder is needed, for instance, in a single, dedicated function. Special versions can also be supplied for OEM applications, on request.

Quality is a priority

All instruments in this range of recorders meet their specified environmental and safety tests. Careful and searching checks and tests made at the various levels of manufacture, plus the selection of the most suitable materials, ensure that the final products will give excellent service.

Quality is a priority and user may expect to enjoy the long-term stability and reliability of performance that has become a major characteristic of Philips recorders.

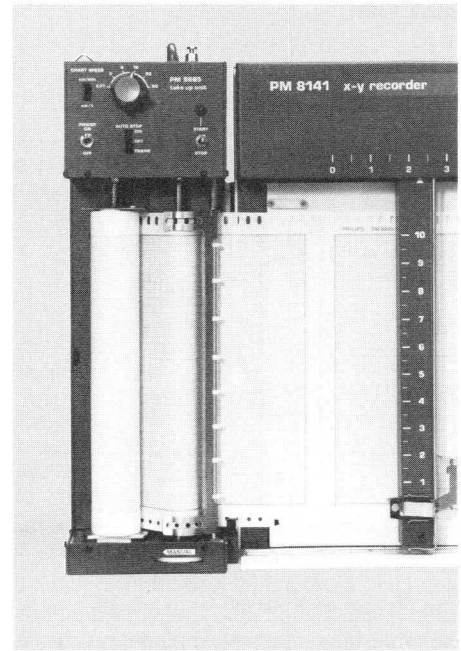
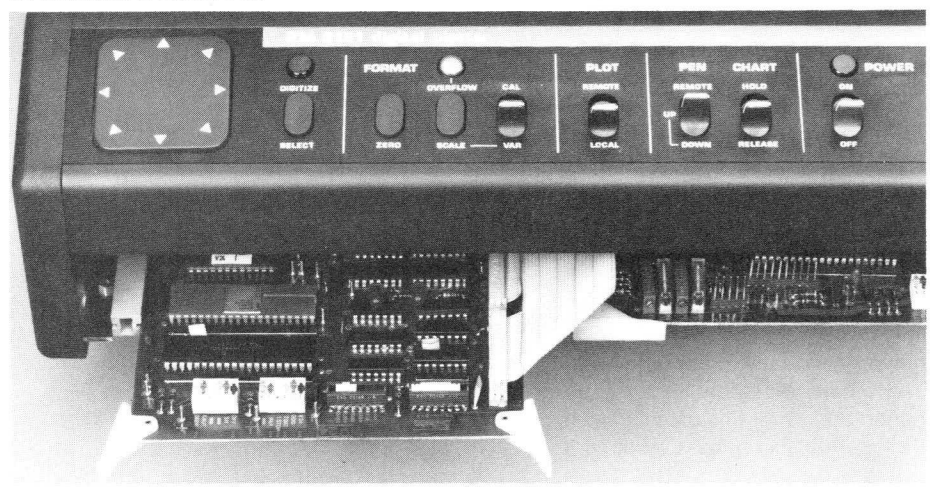


Chart transport unit PM 9885 shown fitted to X-Y recorder PM 8141.

Detail of intelligent X-Y plotter PM 8151 showing the uncomplicated control panel and the ease of access to the electronics circuitry. Microprocessor control initiates an automatic self-test routine every time the instrument is switched on.



Standard compact recorders
PM 8251 Single pen
PM 8252 Dual pen

250mm width Z-fold chart, for optimum resolution and maximum convenience

Clean, reliable pens, each giving 2500m of smudge-free recording

Twelve overlapping input ranges
PM 8251/02: 3.5mV . . . 50V
PM 8251/22: 0.35mV . . . 5V

12 chart speeds

Remote control facility

Heated stylus recording version PM 8251T

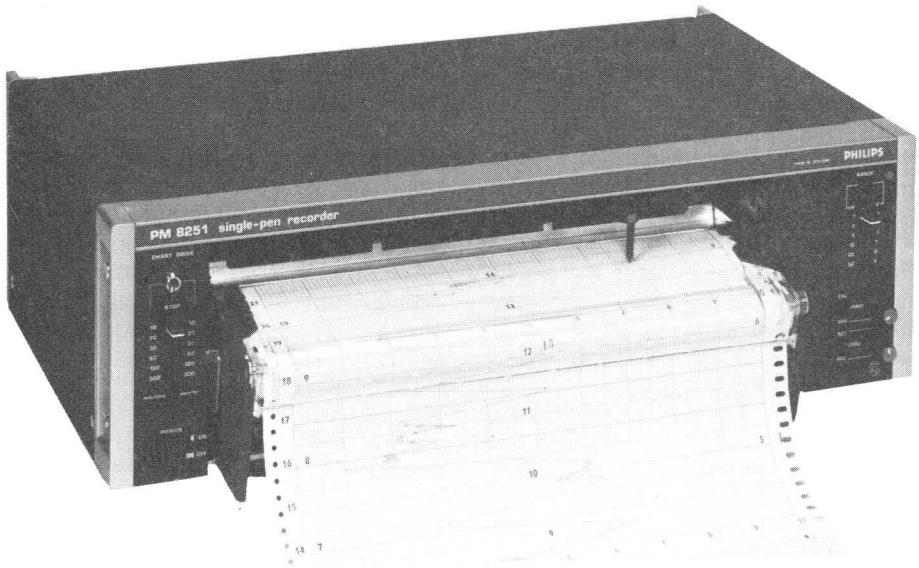
These chart recorders are intended for long, continuous everyday use in laboratories for recording of chemical, electrical or mechanical parameters: their response characteristics make them particularly suitable for analytical applications. Both instruments utilise the already proven chart drive mechanism and writing systems employed in the well established generation of Philips modular *compact* recorders. They can be mechanically and electrically interfaced with many other instruments.

Whilst the conventional flatbed recorder tends to occupy considerable bench space, the *compact* cabinet construction allows the recorder to be stacked with other instruments. Rackmounting is catered for. All controls are located on the front panel and signal inputs are at the rear.

Nylon fibre tipped pen cartridges avoid ink spillage on to chart or hands and give immediate, reliable writing performance with a 50% longer writing life than most other designs.

The Z-fold chart is driven by an electronically controlled stepper motor which eliminates mechanical gearboxes. The chart cassette accepts a 20m book of charts and is very easily fitted or removed. A projecting flat writing table allows notes to be made without obscuring the pen tip, during operation. Slide switches select the chart speeds, 12 calibrated ranges and zero setting. Pen response is 0.6s.

For all options, chart start/stop and servo-kill can be remotely controlled and speed trigger pulses can be externally applied. A special version utilizes a heated stylus having a virtually unlimited recording life. The chart material is thermosensitive paper and line thickness can be controlled with a contrast adjustment.



ACCESSORIES SUPPLIED

Operating manual
Chart paper (1 pack of 5 books)
PM 9920
For PM 8251 2 nylon pen cartridges, red (type PM 9857/05)
For PM 8252 2 nylon pen cartridges red (type PM 9857/05) and 2 nylon pen cartridges, blue (type PM 9856/05)
Service kit containing:
1 fuse 125mA slow
2 fuses 250mA slow
1 bottle contact fluid
2 brushes

CONSUMABLE SUPPLIES

PM 9856/05	Nylon pen cartridge set of 10, blue (PM 8252)
PM 9857/05	Nylon pen cartridge set of 10, red (PM 8251 + PM 8252)
PM 9857B/05	Set of 10 ink cartridges, blue, for use in top channel instead of PM 9857/05 red
Z-fold chart paper	(one pack contains 5 books, each 20m long)
PM 9920/00	Scaled 0...100 linear, time lines at 10mm
PM 9920/01	Scaled 100...0 linear, time lines at 10mm
PM 9920/04	Scaled 0...100 linear, time lines at 15 and 30mm
PM 9920/05	Scaled 0...100 linear, time lines at 2, 10, 20mm

Z-fold chart thermo-sensitive paper (one pack contains 5 books, each 20m long).

PM 9930/02	Without scaling
PM 9930/03	Scaled 0...10 linear Time lines at 2.5 and 10mm

OPTIONAL ACCESSORIES

PM 9867	19-in rackmount brackets

HOW TO ORDER

Available versions

- PM 8251/02
  PM 8252/02
  Sensitivity: 3.5mV...50V
- PM 8251/22
  PM 8252/22
  Sensitivity: 0.35mV...5V
  PM 8251T/22
  Sensitivity: 0.35mV...5V
  with heated stylus for thermosensitive writing
- For OEM applications single span options and different chart speeds are available on special request.

TECHNICAL SPECIFICATION	Standard compact		Modular compact	
According to IEC definitions	PM 8251	PM 8252	PM 8202	PM 8222
Number of pens	1	2 (pen distance 5mm)	1	2 (pen distance 5mm)
Accuracy	Sensitivity setting: ≤ 500mV; ±0.25% of reading ≥ 1V ; ±0.5% of reading			
Temperature range	5...40°C rated range of use −5...50°C, limits of operation (ink freezes between −5 and −10°C) Storage and transport −40...+70°C			
Temperature drift	4μV/°C typical (worst case 8μV/°C)		inclusive pre-ampl., 0.75μV/°C typical exclusive pre-ampl., 4μV/°C typical	
Full scale balancing	0.6s		0.25s	
Frequency response (amplitude decrease of sinewave)	−10% at 1.25Hz for 66% of full scale −10% at 2.5Hz for 10% of full scale		−10% at 3.5Hz for 66% of full scale −10% at 5Hz for 10% of full scale	
Linearity	±0.05% FSD (independent potentiometer linearity)			
Input ranges	12 calibrated spans 10–20–50–100–200–500mV 1–2–5–10–20–50V Variable span control increasing sensitivity by a factor 3 approx.			
	on request: – single range (OEM applications)		to choice: – single range – calibrated sensitivity 1mV with preamplifier	
Zero setting	−5...105% continuously zero check switch		−20...120% continuously. With multirange unit zero suppression down to −500% in 5 steps (additional error 0.1% for each scale offset)	
Input impedance	1MΩ constant			
Source impedance	does not affect dynamic response			
Damping	overshoot 1% maximal – factory adjusted			
Input	floating asymmetrical			
Stray voltage rejection			Without multirange PM 9872/02	With multirange PM 9872/02
– 1kΩ source impedance – Lo to ground – input range 10mV	DC CMRR 126dB AC CMRR 130dB AC SMRR 46dB		DC CMRR 126dB AC CMRR 96dB AC SMRR 32dB	126dB 136dB 52dB
Max. input voltage (between Hi and Lo)	input range ≤ 0.5V max. $30V_{DC}$ input range ≥ 1V max. $50V_{DC}$		$250V_{DC}$	
Max voltage between Lo and earth	For safety requirements. max. $60V_{DC}$ or $42V_{eff}$ (test voltage $500V_{eff}$)			
Chart format	Z-fold, effective recording width 250mm, total length 20m, folds 75mm width.			
Chart speeds	12 speeds: 1-2-3-6-12-30cm/min and cm/hr Other speeds on request		11 speeds: 0.05–0.1–0.2–0.5–1–2–5–10 20–50–100cm/min	
Chart drive control	Forward transport only. Front panel control of stop and speed selection. Remote control standard for chart start/stop, servokill and speed pulses		Forward and Reverse. Front panel control of start/stop, fast forward/reverse and speed selection. Remote control optional.	
Penlift	– manual		– manual – electrical optional	
Writing system	disposable cartridge, nylon fibre pen; recording length 2500m PM 8251T/02: thermo stylus			
Power requirements	AC 110, 127, 220, 245V ±10%; 50/60Hz			
Nominal power consumption • off balance • in balance	15VA 10VA	25VA 10VA	45VA 35VA	75VA 55VA
Dimensions	Height 133mm (3E), Width 440mm, Depth 350mm			
Weight	8kg	9kg	9kg	10kg

Advanced performance with 0.25sec FSD response time

Wide chart speed range, stepper motor driven

Modular construction permits precise purpose design

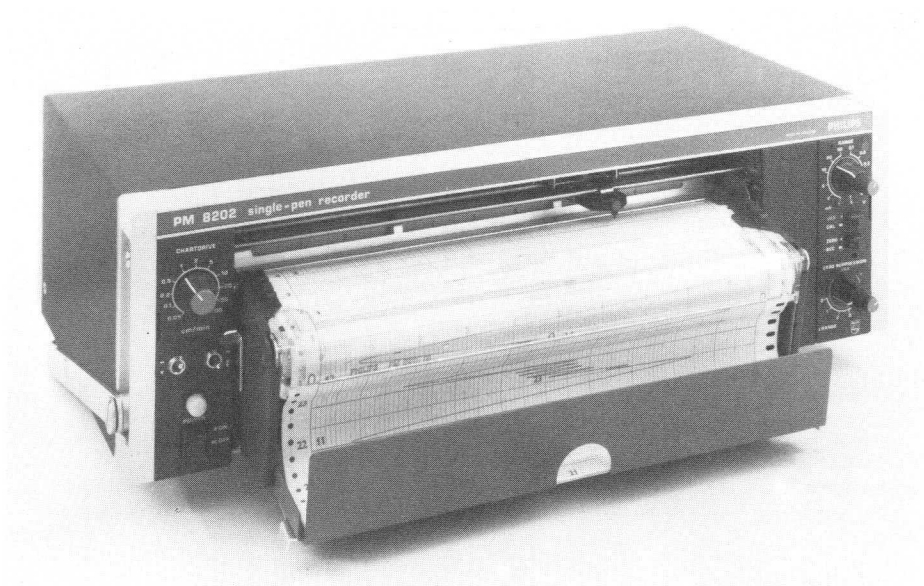
Choice of single range or multirange sensitivity setting, 0.35mV to 100V

Linearization units for temperature recordings

Wide range of remote control options and accessories

Modular compact recorders
PM 8202 Single line
PM 8222 Double line

For more demanding applications, the PM 8202 single pen and PM 8222 double pen recorders offer an advanced specification plus a broad range of options.
Their fast response time – just 0,25 seconds for 250mm full scale deflection – permits accurate recording of even the high speed, narrow peaks found in analytical chemistry, for example.
The sensitivity can be selected to give any desired signal amplitude from 0.35mV to 100V, by means of single or multirange attenuator modules – used either alone or in combination with a preamplifier.
Thermocouple units with automatic cold junction compensation and linearization of output widen application in engineering and research.
Thus, by adding the accessories of your choice, you can chose the recorder to meet your precise requirements.
This gives you maximum versatility – yet you pay only for the features you really need. And the mix of options can be changed at a later data should you wish to adapt the instrument to a different function.
Chart drive can be remotely controlled and synchronised with physical phenomena other than time. One of the control interfaces also provides for various types of output pulse – which can be used to synchronise external equipment with the recorder itself.



Technical specifications for PM 8202 and PM 8222 appear on P81.

TECHNICAL SPECIFICATIONS
OF ACCESSORIES

PM 9870M/PM 9879M – single-range box
Conditions input signal to level of servo system amplifier. Carries input terminals Hi and Lo, plus measuring earth terminal.

PM 9871 – pre amplifier
Single PC board for accurate, calibrated and low drift sensitivity settings smaller than 10mV. Automatically overruled with sensitivities set to 10mV+ (with single span boxes or multirange unit).

PM 9872 – multirange unit
Used with or without preamplifier, to provide:
Sensitivity setting
- Stepwise calibrated ranging for full scale:
  10–20–50–100–200–500mV
  1–2–5–10–20–50V
- Approx. 3× sensitivity increase, for variable span adjustment between calibrated settings
- With preamplifier PM 9871 down to (0.35mV).

Zero Control
- Continuous zero positioning −5% to +105%
- Fixed zero offset in five calibrated steps:
  −100%, −200%, −300%, −400%, −500%
- In combination with continuous adjustment, zero can be set at any position from −500% to +100%
- Zero check button sets measuring carriage to visible scale

Linearisation amplifiers for thermocouples
PM 9873 for Fe-Const
PM 9874 for Chromel-Alumel (NiCr-Ni)
One PC board per channel, fitting into common housing at rear of recorder.
Temperature range:
PM 9873 −200 to + 750°C
PM 9874 −200 to +1200°C
Output: 1mV/°C. Accuracy: ±1°C
Cold junction compensation, max. error ±0.06°C/°C at 23°C±5°C.
Can be connected to single range unit PM 9870 or used with multirange PM 9872
Calibrated according to IPTS 68

PM 9861 – remote control interface I
Offers TTL-logic control of:
Chart forward/reverse
Start/Stop
Fast forward/fast reverse at max. speed
External pulses for chart speed
Choice internal/external pulses
Outgoing synchronisation pulses:
Internal clock pulse, 300Hz or free running when fast forward/last reverse is actuated.
Motor pulse, depending on chart speed setting (300Hz at 6000cm/h)
Synchronisation pulse/cm when using synchronisation module for chart displacement feed-back (available on special request)
Space available on socket for two slave potentiometers with one side common.

PM 9862 – remote control interface II
Provides TTL-logic control plus power supplies for:
Servo kill (channels 1 and 2 separately)
Electrical penlift
Event marker, right hand
Event marker, left hand
Two slave potentiometers can be connected with one side common.

PM 9863 – remote control interface III
Replaces PM 9862, for contact closure control of:
Chart forward/reverse
Start/stop
External pulses for chart speed

Electrical penlift
Event marker, right hand
Event marker, left hand
Two slave potentiometers can be connected independently.

PM 9864 – min/max alarm units
Permits minimum and maximum to be screwdriver set independently over full scale. Single contact – max. load 100V, 500mV or 10W, whichever is greater.
PM 9864/01 for one channel
PM 9864/02 independent min. and max. for two channels. Necessary slave potentiometer(s) included in delivery.

PM 9865 – slave potentiometer
Connects via remote control interfaces. Resistance 3.8k Ω approx.; max. load $25V_{p-p}$. Two slave potentiometers can be fitted to recorder PM 8222.

PM 9866 – electrical penlift
A solenoid plus appropriate fittings, operated by 12V/600mA supply. Common to both pens for two-line recorder. Automatic pen left on switch-off.

PM 9868 – event markers
Mounted on chart transport cassette and register outside calibrated areas.
Operate on 12V/50mA signal, and can be controlled by PM 9862 or PM 9863.

CONSUMABLE

Recording pens

1. **PM 9857/05** – nylon pen cartridge RED Pack of 10. Standard for single pen recorders **PM 8202/ PM 8251** and for upper channel of models **PM 8222/ PM 8252**. Same penmodel is available in colour BLUE under type no. PM 9857B/05.

2. **PM 9856/05** – nylon pen cartridge BLUE Pack of 10.
Standard for 2nd, lower channel of models **PM 8222/ PM 8252**.

3. **PM 9857/15** – event marker pen RED Pack of 10 disposable cartridges, each giving more than 500m recording.
Fit both right hand (PM 9868/05) and left hand (PM 9868/10) markers.

Recording chart
Pack of 5 books
Each 20 meters length

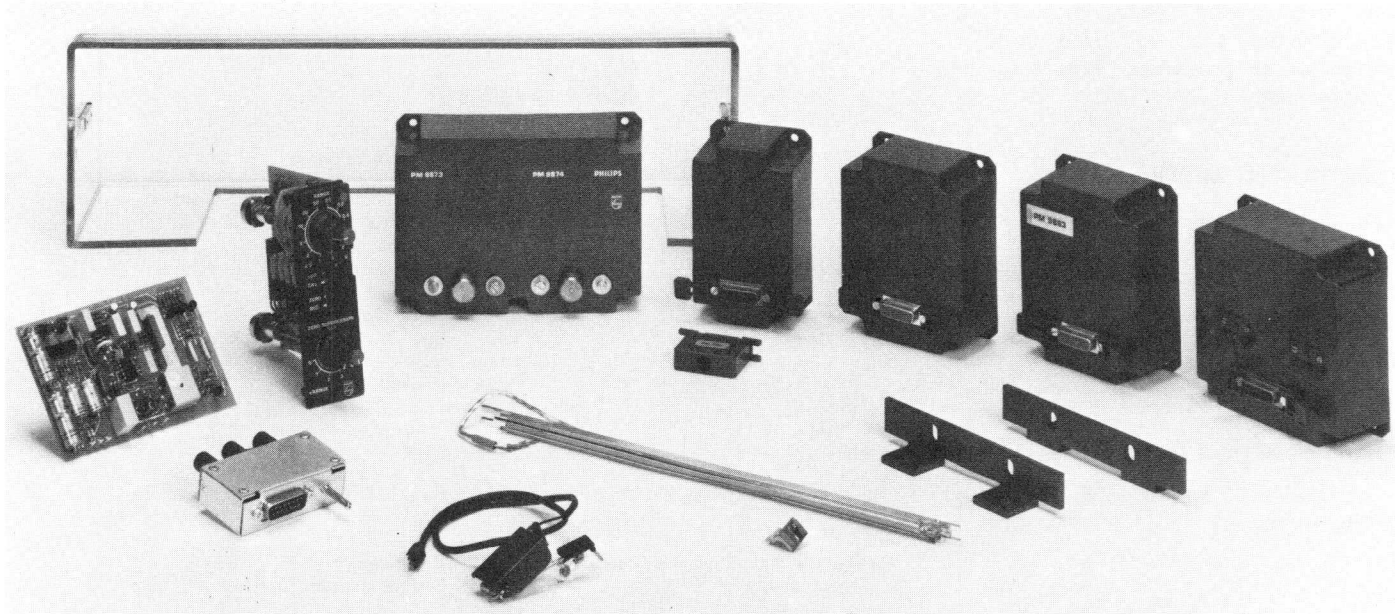
4. **PM 9920/00** Left hand zero 0...10. 100 divisions linear. Time lines 10mm
PM 9920/01 Right hand zero 10...0. 100 divisions linear. Time lines 10mm

5. **PM 9920/04** Left hand zero 0...10. 100 divisions linear. Time lines 15mm
PM 9920/05 Left hand zero 0...10. 100 divisions linear. Time lines 2mm

Specially calibrated charts can be supplied, subject to a minimum order quantity of 10 packs. Quote type number **PM 9929/xxx** and give full details of calibration required. The suffix for reordering and documentation of the chart will be confirmed on receipt of the order.

ACCESSORIES SUPPLIED

- carrying handle
- mains cable
- refolding magazine
- operating manual
- service kit with:
  nylon pen incartridges
  potentiometer contact fluid
- 1 packet with 5 books of folded chart;
  PM 9920/00 (0...100lin)



- 120mm chart width
- Four calibrated input ranges and variable span adjustment
- 2 Standard chart speeds (3 options)
- Adjustable zero setting
- Built-in calibration
- Compact dimensions and low weight
- Mains or battery operation
- Ideal for OEM

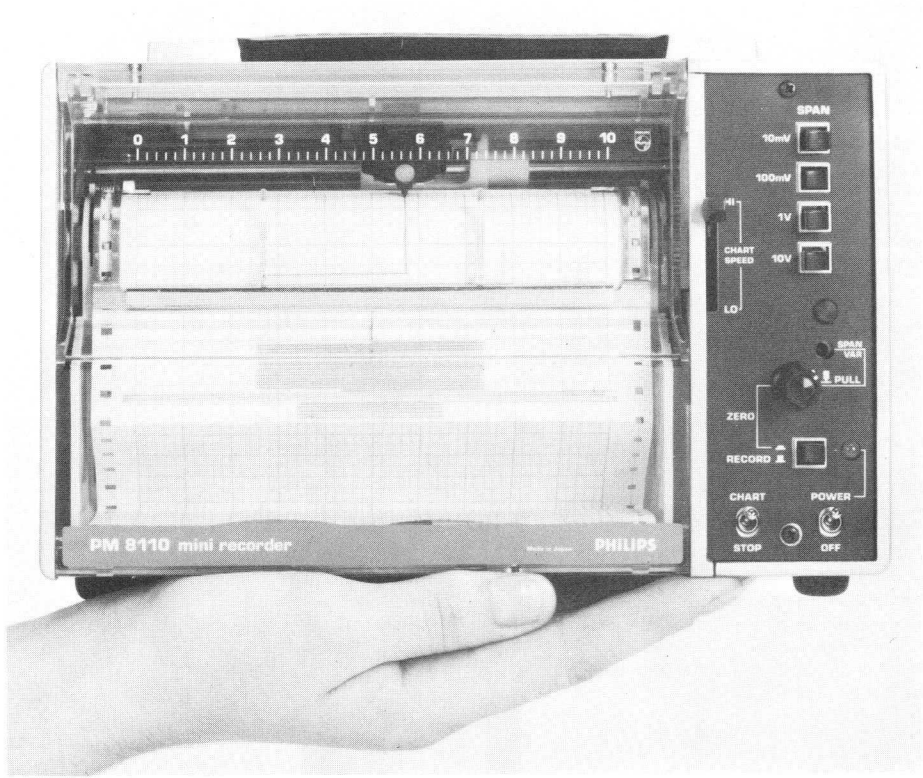
Single line minirecorder PM 8110

Most R & D labs will find the PM 8110 an ideal back-up recorder to support the more sophisticated types, especially where trends, rather than instantaneous values need to be seen. Industry too needs compact portable recorders for on-site monitoring or for incorporation in OEM equipment. The very compact and light weight PM 8110 will fulfil these and many other varied applications.

Used with suitable transducers, for instance, it will monitor mechanical or physical parameters: it can also find application in pollution monitoring, gas chromatography or similar chemical analyses.

The 120mm chart width achieves a 20% better resolution than conventional 100mm types and the various options for chart speeds enhance the general performance. The convenient Z-fold chart allows full access to all recordings over its full length and the nylon pen ink cartridge is easily fitted or removed.

All controls are located on the front panel and a calibration facility is built-in. Easy servicing is assured by a modular design which gives easy access to all components.



TECHNICAL SPECIFICATION

Accuracy
Maximum error ±1% of FSD

Reproduceability
< 0.5% of FSD

Temperature drift
< 20µV/°C max.

Input sensitivity
Push-button control, 4 positions: 10mV, 100mV, 1V and 10V
Variable span control between the ranges increases span to $100V_{FSD}$

Zero setting
Continuous zero adjustment over full scale and zero check switch

Step response time
< 0.5s for FSD

Frequency response
10% amplitude decrease for sinusoidal voltage with amplitude of 66% of scale: 2Hz

Chart speeds
PM 8110/OX:
Standard, 5 and 20mm/min. On/Off switch at the front
For alternative chart speeds, see options.

Chart
Z-fold chart, refolding automatically
Effective recording width: 120mm
Length per book: 15m

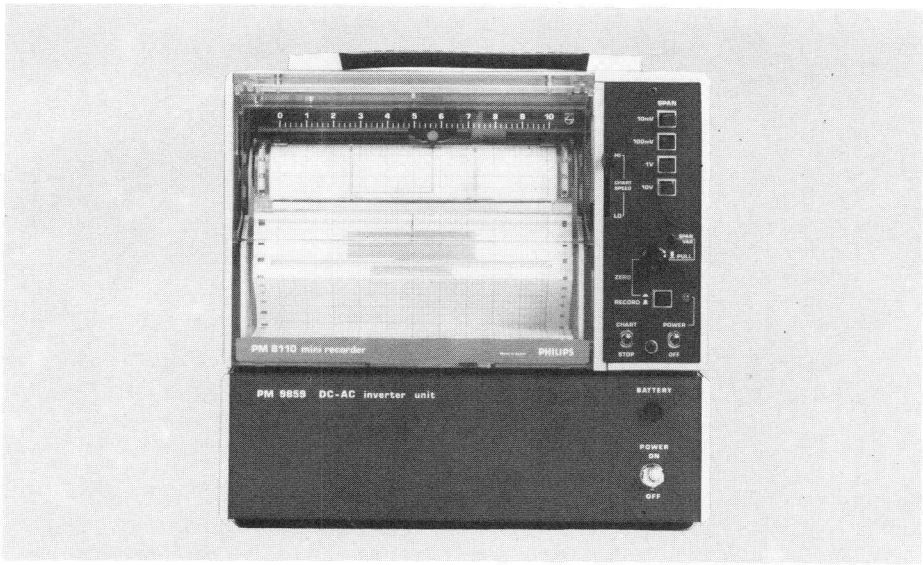
Writing systems
Disposable nylon pen cartridge
Recording length 2500m approx.
Manual pen lift
The chart and writing system is protected by a transparent front cover.

Potentiometer
Straight rod, with direct coupling to measuring carriage
Linearity: ±0.15% of FSD

Input impedance
1MΩ

Source impedance
10kΩ max.

Damping
Factory adjusted. Overshoot < 1mm



PM 8110 shown fitted with DC-AC inverter PM 9859

Stray voltage rejection
With 1kΩ between Hi and Lo
AC CMRR 80dB
AC SMRR 15dB 40dB with optional filter
DC CMRR 90dB

Max. input voltage
Between Hi and Lo
$100V_{DC+ACpk}$ for 10mV and 100mV ranges
$300V_{DC+ACpk}$ for 1V and 10V ranges

Max. voltage between Lo and ground
$24V_{DC}$ (Test voltage $500V_{eff}$)

Isolation resistance
> 5MΩ between input terminals and earth

Power requirements
100–117–217–234V ±10%

Dimensions and weight
(w × h × d) 214 × 130 × 170mm
(8.4 × 5.1 × 6.9-in)
3kg (6.6lb)

Measuring system
Null balance potentiometric servo system with DC-amplifier and servo motor

Calibration voltage
At the rear a switch is provided which connects a 50mV calibration voltage to the input of the instrument. This voltage serves to calibrate the variable span setting.

ACCESSORIES SUPPLIED

- Carrying handle
- Power cable
- Operating manual
- Chart
  2 folded books of 15m each, 0...10 lin. type PM 9910
- Ink
  2 disposable nylon pen cartridges, colour blue type PM 9856/05.

OPTIONAL ACCESSORIES

PM 9859 DC–AC inverter for internal and external battery operation. Input voltage (DC) 12V ±10% or 24V ±10% (selected by switch). Input current approx. 0.5A at $12V_{DC}$
Output voltage (AC) 220V square wave, 50 or 60Hz. Output power 10VA max. Internal batteries (PM 9397) provide 5 hours operation and a switch selects internal/external battery operation
Dimensions: (w × h × d)
214 × 65 × 170mm
Weight:
1.3kg without internal batteries
2.7kg with internal batteries fitted
Mounting:
the inverter is fitted underneath the minirecorder

PM 9397 Rechargeable battery (2 required) sealed lead acid 6V 3Ah
PM 9880 19-in rackmount kit
PM 9881 Input signal filter
AC SMRR 40dB

INSTRUMENT OPTIONS

PM 8110/2x Mini recorder with non-standard chart speeds of 20 and 80mm/h
PM 8110/4x Mini recorder with non-standard chart speeds of 20 and 80mm/min.
N.B. Other chart speeds on request.

CONSUMABLES

PM 9856/05 Nylon pen cartridges blue, set of 10
PM 9910 Pack of Z-fold charts, 5 books each 20m length, scale 0...10lin.

IEC-625

Printing recorder PM 8210

Two independent instrument functions in one compact package

Silent recording of analog and alphanumeric data on same chart

Microprocessor controlled print head

Alphanumeric print-out positioned anywhere on chart; format selected by programming

High printing speed: 30 characters/s

Choice of standard and optional interfaces

The Philips PM 8210 printing recorder combines both analog recorder and digital printer in a single instrument. Unlike existing printing plotters the PM 8210 has independent operation of the recording channel and printing function.
Hence the recording is not interrupted for printing digital information.

The PM 8210 will be of great interest for experimental or routine applications (as, for example: analytical equipment; testing and control of batches during production).

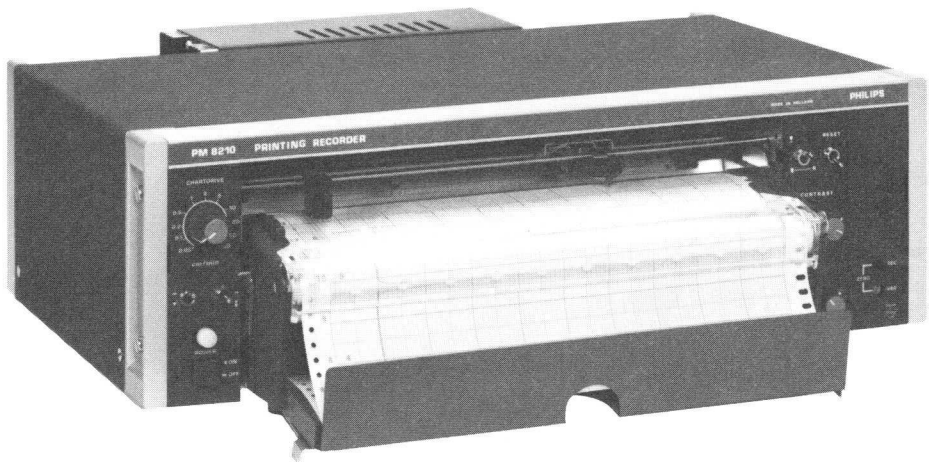
Operation is very simple. The analog output from a process or device under test is fed directly to the PM 8210 recorder channel. The printhead is moveable along the whole X-as: so during analog recording digital information can be printed on any desired place to pinpoint certain events during the experiment. Furthermore, on the completion of a process or analysis, specific records of an evaluation can be printed in any desired format on the chart. (E.g. labelling of batch, patient identity in clinical applications, basic quantitative information, etc.) It is also possible to rewind the chart to the beginning of a form and afterwards printing of information along the analog trace.

Recorder channel

The recorder section operates as a normal X-t chart recorder, employing a heated stylus. For the analog input there is a wide choice of range boxes, a pre-amplifier and a multirange unit available. Control of zero-setting adjustment of span etc. is possible via the front panel.
Via interface commands the pen-lift and servo'kill' can be controlled. A manual pen-lift is also provided.

Printing channel

The print head utilizes a 7-dot matrix printing technique, the character font being based on the 5 × 7 matrix, giving print fonts of 2.7mm high. It is positioned on the chart by means of a stepper



motor, as controlled by the microprocessor interface. Up to 80 characters/line can be printed over a 240mm with a speed of 30 characters/sec.

Chart control

In the analog mode the chart speed can be controlled in discrete steps:
a. by front panel control adjustment
b. by programming via interface.
The chart speed is continuously variable by means of externally generated pulses; gating of these pulses is controlled by programming via the interface.

Versions and interfaces

To adapt the instrument to the applications (OEM or stand-alone) and interfaces the following basic instrument and options will be available:
- PM 8210 printing recorder with CPU and character generation, with TTY/ simplified V24 interface.
- PM 9890 V24 serial interface plug-in board (RS 232C).
- PM 9891 IEC-625 interface plug-in board.
- PM 9892 8-bit parallel interface plug-in board.

Functions of PM 8210

The PM 8210 has the following possibilities:

1. Printer functions
   - Decoding of alpha-numeric characters to the 5 × 7 dot matrix.
   - Carriage return, line feed and back space.
2. Printer control
   - Horizontal and vertical tabulation.
   - Form feed.
   - Block mode, sending data at high transmission rate to the printer and printing afterwards at print speed.
3. Recorder control
   - Thermic pen up/down.
   - Selection of chart speed.
   - Analog servo kill.
   - Control of external chart speed pulses.

TECHNICAL SPECIFICATION

HARDWARE SPECIFICATION

ANALOG SECTION

Measuring ranges
(to be ordered separately)
– Single range:
⩾10mV PM 9870M/. . up to 50V
< 10mV PM 9870M/. . plus pre-amplifier PM 9871/02
– Multi range:
10mV to 50V PM 9872/02
1mV to 5V PM 9872/02 plus pre-amplifier PM 9871/02

Input
Floating, a-symmetrical

Accuracy incl. non-linearity and dead band
1mV up to 500mV ±0.3% fsd
±0.2% of reading
1V up to 50V ±0.3% fsd
±0.4% of reading

Response time
⩽ 0.25s for full scale

Overshoot
⩽ 1%

Dead band
⩽ 0.2% of full scale (=0.5mm)

Reference voltage drift
Zener diode ±100ppm/°C

Zero drift
> 10mV range ⩽ 8μV/°C
⩽ 10mV range ⩽ 1μV/°C

Input resistance
1MΩ ±1%

Isolation resistance
2000MΩ between LO and ground

Max. input voltage
$-42V_{RMS}$ between HI and LO
$-42V_{RMS}$ between HI/LO and ground

Stray voltage rejection
– DC CMRR 126dB
– AC CMRR 96dB (with PM 9872/02: 116dB)
– AC SMRR 32dB

DIGITAL SECTION

Input/output
Serial input to be used as
– TTY 4-wire 20mA current loop (R_{Ext} ⩽ 100Ω)
– Simplified V 24
Received characters will be echo'ed

Word composition
1 start bit
7 data bits
1 parity bit (no parity check)
2 stop bits

Baud rate
110 or 300 baud, adjustable

Input buffer capacity
100 bytes

REGISTRATION

RECORDING PEN

Type
Heated stylus

Heating time
~ 1min

Control
Temperature and thus line thickness can be controlled from the front

PRINTING HEAD

Type
Semi-conductor 7 dot

Character dimensions
Horizontal and vertical dot distance 0.42mm
Height 2.9mm

Contrast
Dot temperature (and thus contrast) adjustable from the front panel
Automatic correction of print head temperature by means of thermistor

Character font
64 characters in 5×7 dot matrix according to ISO 646

Number of characters/line
80

Print speed
– in character mode 12ch/sec
– in block mode 30ch/sec

Carriage return time
Max. 1sec from 100%–0%

Distance between printed information and pen position
10mm

CHART DRIVE

Chart speed
0.05-0.1-0.2-0.5-1-2-5-10-20-50-100cm/min

Speed control
– By switch at the front, in local mode
– Via the interface in the remote mode
– Via external trigger pulses
(TTL level, width ⩾ 10μS and duration ⩾ 33mS)

Positioning of the chart
Via switch at the front without influencing the software counter

Reverse chart transport
– Via switch at the front of the instrument
– Via interface commands (backwards form feed and backwards vertical tabulation)

End-of-paper detector
When no paper is left stylus and printhead are lifted and input and execution of commands are stopped

GENERAL

Environmental conditions
According to IEC 359

Climatic conditions
Ambient temperature: reference 23°C ±1°C
Rated range of use: +5°C...+40°C
Limit range of storage: −40°C...+70°C
Relative humidity: 20%...80%

Safety
Class 1: according to IEC 348

Radio frequency interference
According to CISPR II

POWER REQUIREMENTS

Voltage
110, 127, 220 and 245V ±10%, switchable

Frequency
50 and 60Hz ±1.5%

Power consumption
200VA

DIMENSIONS AND WEIGHT

(w×h×d) 440×133×420mm
(17.4×5.25×16.5-in)
15kg (33lb)

ACCESSORIES

Analog input (please state when ordering)
Single range input units:
1mV PM 9870M/21 } In combination with
2mV PM 9870M/22 } pre-amplifier
5mV PM 9870M/23 } PM 9871/02
10mV PM 9870M/04
20mV PM 9870M/05
50mV PM 9870M/06
100mV PM 9870M/07
200mV PM 9870M/08
580mV PM 9870M/09
1V PM 9870M/10
2V PM 9870M/11
5V PM 9870M/12
10V PM 9870M/13
Multi range input units:
10mV to 50V, 12 ranges, PM 9872/02
1mV to 5V, 12 ranges, PM 9872/02 in combination with pre-amplifier PM 9871/02

Sundries
PM 9860: Transparent front cover
PM 9867: 19-in mounting brackets (set of two)

Interface options
PM 9890: CCITT V 24/standard
RS 232 C
Switch selectable baud rates to 120 baud in the character mode and 9600 baud in the block mode
PM 9891: IEC-625
PM 9892: 8-Bit parallel interface

Consumables
Z-fold chart thermo-sensitive paper (one pack contains 5 books, each 20m length)
PM 9930/02: Without scaling
PM 9930/03: Scaled 0...10 linear, time lines at 2.5 and 10mm
(Relative humidity when using this paper 20%...70%)

SOFTWARE SPECIFICATION

CONTROL FUNCTIONS
Control functions are coded with either one code or with a code string.

Single code functions (ISO-7)
carriage return: back space: end of text: form feed: line feed: start of text: horizontal tabulation: vertical tabulation

Code string functions (preceeded by ESC-code)
backwards form feed: backwards vertical tabulation: pen up: pen down: recorder on: recorder standby: remote control: local control: semi X-Y: Xt mode: stop: forward: call of custom function

Programmable parameters
chart speed: horizontal tabulation definition: form feed definition

DATA TRANSMISSION

There are two modes for sending data to the printing recorder:

The character mode
When data is continuously transferred to the printer, the received character or command will be executed immediately. In case of simple serial data transmission (TTY or simplified V 24), the sending end must ensure that this is done at a correct speed. This can be achieved:
– by transmitting at a low enough rate (⩽ 120 band)
– when a format effector (carriage return, line feed, horizontal tabulation, etc.) has been sent.
In case of data transmission with handshake (complete V 24, IEC-625 or 8-bit parallel) the transmission rate will be determined by the printing recorder.

The block mode
In the block mode transmission it is possible to send a text block or a sequence of control commands at a high transmission rate. After receiving the block terminator the control commands will be interpreted or a text printed at printer speed (30 characters/sec.).
The maximum block length is 100 characters.

INITIALISATION PROCEDURE

When switching on the instrument or when applying the 'reset' control a 'U' will be sent by the TTY output at a transmission speed of both 110 and 300 baud and the text 'PM 8210 READY' will be printed preceeded by a line feed and followed by a vertical tabulation and a carriage return. The message can be skipped by a simple internal action.
If an optional I/O card is fitted then with the PM 9890 V 24 interface card a '★' will be sent and with PM 9891 IEC-625 card a 'SRQ' will be asked.

Choice of 1 to 12 point recording

Selection of up to 6 input ranges via pin board programming

Input range cards for thermocouples, resistance thermometers and mV

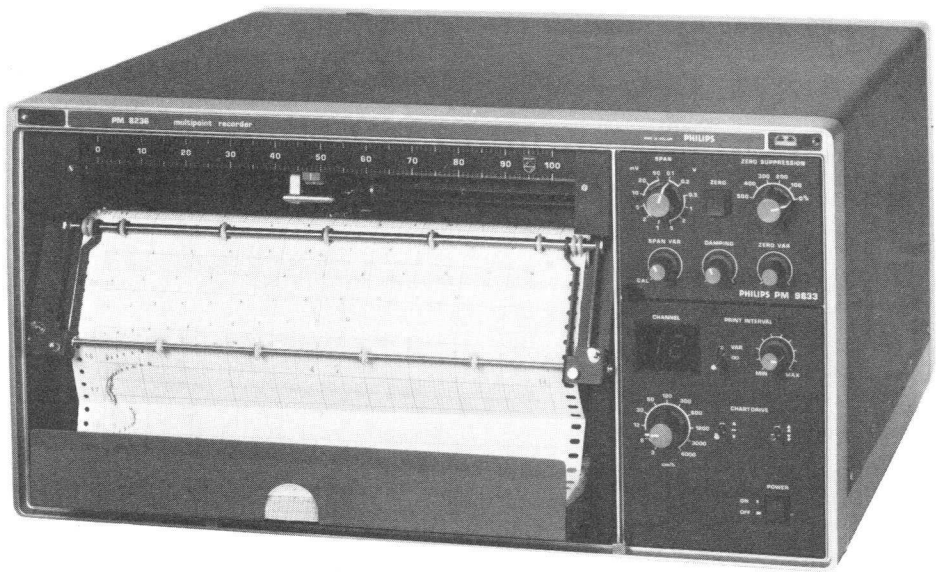
Print interval continuously variable from 1 to 20secs

Convenient Z-folding chart system with stepper motor, remote controllable

6-colour print head with dots and selective channel identification

Multi-point recorder PM 8236

The PM 8236 is a modular, multi-point recorder having up to 12 input channels. Although specially designed for laboratory use, the protection given by a transparant cover with rubber sealing and scale illumination also allows the instrument to function in industrial environments.
The recorder employs a number of unusual and unique features which are worth mentioning in detail. For example: the chart table pulls out to give easy access to a pin board matrix. Removing the relevant pin, as shown in fig. 1, means that the channel is skipped from the recording sequence. Even if channels 2 to 11 are removed, and the instrument is only recording on channels 1 and 12, then the traverse delay is only 500ms. This pin board matrix is also used to program the six-range input module. Channel indication is by bright 11mm LED display.



Versatile printing

The printing head uses impregnated felt pads that give three months continuous operation. The dots are printed in six standard colours. Pulling out a small lever, shown in fig. 1 gives a channel identification that is printed alongside every 13th dot, as illustrated in fig. 2. The printing head can be converted in a few seconds to allow the instrument to function as a single line, continuous recorder. For this purpose a clip-on line attachment is provided as standard. (fig. 3)

Programmable operation

By means of the matrix board the channels in use can be programmed to 6 different range cards by simply inserting the pin at the appropriate cross section.

Z-folding paper system

A convenient self-folding paper system is used. The chart folds neatly into a magazine, thereby eliminating the problem of paper take-up. The chart is easily torn across the perforated folds, easy to examine along the entire length and very convenient for filing. When the recording direction is reversed the supply magazine inside the instrument takes up the paper again.
Alternatively, if a free-running paper supply is required, then the exit magazine can be hinged upward, which serves as a writing table for notes at the same time.

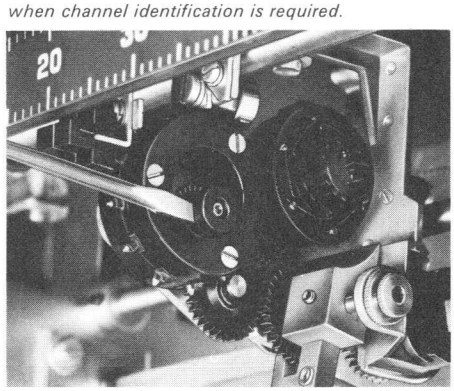
Remote control

Functions such as stop/start; reverse/forward; servomotor stand-by and print command can be controlled remotely. The use of a stopper motor for the chart drive also allows the chart feed parameter to be synchronised with an external signal. This feature allows the instrument to be used as a semi X-Y recorder. Provisions for remote channel identification are supplied.

Input flexibility

The universal unit is calibrated in 12 steps from 1mV to 5V, with a non-calibrated control that extends the full scale sensitivity to 0.3mV. Zero suppression is variable up to 500%.
The single range unit can be used for measurements with mV, thermocouples TC, thermal resistors TR and mA. This unit carries a damping control and a stand-by switch. It is used with the appropriate pc range card.
The six-range unit, as its name implies, can contain up to six single range pc cards. They are simply programmed using the 6 × 12 pin board matrix so that virtually any parameter can be recorded on any channel.

Fig. 1. Shows the small lever that is pulled out when channel identification is required.



TECHNICAL SPECIFICATION

Number of channels
Any number up to max 12
Choice of skipping by pin-board matrix

Accuracy (incl. linearity)
a. mV or Volt
20...30°C ⩽ ±0.25% of f.s.d. with minimum of 4μV between 5 and 20°C and between 30 and 40°C ⩽ ±0.5% of f.s.d. with min of 8μV
b. Thermocouples
For automatic cold junction compensation additional error of ±1°C
c. Resistance thermometer
20...30°C ⩽ 0.3% of f.s.d. with minimum of 0.1°C. Between 5 and 20°C and between 30 and 40°C ⩽ ±0.6% of f.s.d. with min of 0.2°C

Input sensitivity
Max sensitivity: 1mV f.s.d. calibrated
Max span : 50V f.s.d.
For resistance thermometers:
Min span : 10°C
Max span : 250°C

Warming-up time
30min approx

Zero drift
⩽ 0.25μV/°C

Dead band
⩽ 0.5mm

Print interval
1s...20s approx.
Adjustable by variable control.
Printing and switching to next channel can be remotely controlled.
(one pulse for each step)

Chart speeds
By stepper motor, triggered by mains frequency (50 or 60Hz).
3 - 6 - 12 - 30 - 60 - 120 - 300 - 600 - 1200 - 3000 - 6000cm/h, forward and reverse.
Overruled by manual 'fast', starts to run at low speed for proper line adjustment.
At the driver pc board provisions are made to facilitate all speeds being scaled down by a fixed factor.

Chart
Effective recording width 250mm
Z-fold chart, length 20m.

Response time
⩽ 0.5s over 90% scale

Overshoot
Max 1% of full scale.
'DAMPING' adjustable with potentiometer at input modules.

Remote control
Standard connector provided at rear
Chart transport: – start/stop
– forward/reverse
– TTL-pulses for stepper motor
Printer : Printing and switching to next channel by contact closure.
Also see optional accessories.

Input
HI-LO and Guard
Floating with respect to earth

Input impedance
Up to 50mV (potentiometric positions)
– in balance: infinite
– out of balance: >2MΩ
Above 50mV (attenuator positions)
– 1MΩ approx.

Max. permissable source impedance
Up to 50mV: 10KΩ/mV (max 100KΩ)
above 50mV: no limit
Under the above conditions the dynamic response will not be affected.
The error due to source impedance can be calculated as follows:

$$\frac{\text{R source}}{\text{R input} + \text{R source}} \times 100\%$$

Isolation Resistance
Between input terminals and guard or earth: >4000MΩ
Between guard and earth: >4000MΩ

Max continuous voltage on input terminals
HI and earth: 60V
LO and earth: 24V
Guard and earth: 24V
Test voltage: $500V_{AC}$

Max overload voltage
In positions < 50mV:
5V per mV span, with max of 50V
In positions ⩾50mV: max 250V.

Interference suppression
(In acc. with IEC 384)
1kΩ between HI and LO;
LO and Guard interconnected.
AC CMRR:

Range	Suppression	
	>...dB	>...x span
1 mV	118.8	2200
2.5mV	121.6	3000
5 mV	127.9	6300
10 mV	126.9	5600
25 mV	111.1	900
50 mV	104.0	400
100 mV	83.5	38
200 mV	81.5	30
500 mV	78.5	21
1 V	74	12.5
2 V	68.5	6.5
2 V	62	3.2
10 V	55.5	1.5

DC CMRR: >132dB
AC SMRR: > 46dB

Supply voltage
110-127-220-245V ±10%
50 and 60Hz ±5%
Power consumption: max 75VA

Dimensions
Height : 222mm (5E)
Width : 445mm (19" rack mounting)
Depth : 450mm
Weight : 28kg approx incl. front dust cover and rear cover

Climatic conditions
(where instrument complies with specs, based on IEC 359)
Ambient temperature: +5...+40°C
(Where the instrument still functions)
–5...+50°C
(storage and transport)
Ambient temperature: –40...+70°C

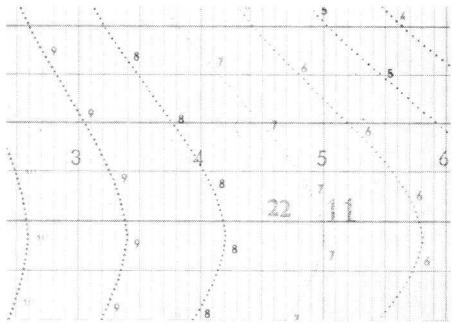


Fig. 2. Shows how every channel is identified by the relevant number printed alongside every 13th dot.

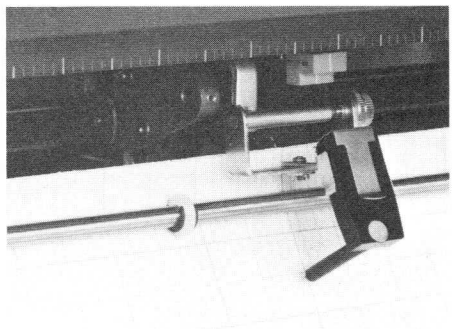


Fig. 3. Illustrates how the pen attachment can be clipped on so as to provide continuous recording of any one individual channel.

Fig. 4. Detail of range input module PM 9833, control panel and LED channel indicator.

ACCESSORIES SUPPLIED

- Dust-tight front cover with chart illumination.
- Rear cover to protect the input terminals from electro-magnetic interference
- Operating manual
- Mains lead
- One pack of 5 chart books, PM 9920/00
- 2 ink wheels, type PM 9839/02
- Pen holder with pen
- Maintenance material

Standard range cards
(delivery ex-stock)

1. Pt–Pt. 10% Rh. BS 1826

PM 9840A/01	0–1000°C
02	0–1500
03	500–1000
04	1000–1600

2. Chr. Alu ISA type K (NiCr–Ni DIN)

PM 9842A/01	0–	50°C
02	0–	100
03	0–	150
04	0–	250
05	0–	400
06	0–	600
07	0–	800
08	0–	1000
09	0–	1200
10	500–	1000
11	−50–	+100

3. Pt–Pt 10% Rh ISA type S (NBS)

PM 9843A/01	0–1000°C
02	0–1500
03	500–1000
04	1000–1600

4. Fe–Const ISA type J

PM 9844A/01	0–100°C
02	0–150
03	0–250
04	0–500

5. Cu–Const ISA type T

PM 9845A/01	0–100°C
02	0–150
03	0–250

6. Cu–Const DIN

PM 9847A/01	0–100°C
02	0–150
03	0–250

7. Fe–Const DIN

PM 9848A/01	0–100°C
02	0–150
03	0–250
04	0–500

Remark: Range cards for thermocouples are provided with a standard copper resistor of 300Ω approx for cold-junction compensation, with the exception of the range cards for Pt 10% Rh–Pt thermocouples; these are provided with a copper resistor of 30Ω approx.

8. Pt 100Ω according DIN 43760

PM 9842B/01	0–	10°C
02	0–	25
03	0–	50
04	0–	100
05	0–	200
06	−50–	+150

To be used in conjunction with a current source PM 9854/01. This plug-in p.c. board fits into its own connector inside input modules PM 9831 and PM 9832 and is common for all range cards.

9. mV

PM 9840M/01	0...	1mV
02	0...	2,5
03	0...	5
04	0...	10
05	0...	20
06	0...	25
07	0...	50
08	0...	100
09	0...	250
10	−0,1...	+1
11	−0,5...	+0,5
12	−10...	+10
13	−50...	+50
14	−100...	+100
15	0...	200
16	100...	500
17	40...	200
18	0...	1V
19	−1...	+1V
20	−25...	+25mV
21	0...	500mV
22	0...	2V
23	0...	5V
24	0...	10V

Standard range cards are provided with two calibrated chart reading rules. For current (mA) measurements an accurate resistor has to be shunted across HI and LO input terminal of the required channel.

Special range cards and scales
Range cards with a span deviating from the standard ranges, for external cold-junction compensation or for other types of transducers can be ordered as follows after consultation of your sales representative:
PM 9849A/xxx for thermo-couples
One calibrated scale is included.
Cold-junction compensation is automatic unless specified otherwise
PM 9849B/xxx for resistance thermometers.
NTC-sensors or humidity transducers.
Please specify required scale.
One scale is included on delivery.
PM 9849M/xxx for DC signals
Note: A scale is not included and has to be specified separately
PM 9849S/1xx single calibrated chart reading ruler.
PM 9849S/2xx double calibrated scale.

OPTIONAL ACCESSORIES

Setpoint unit PM 9834/01*
Min and max, adjustable over full scale.
Contact closure to rear connector, floating.
Max load: 10W, 75V_{DC} or 50V_{AC}; 0.5A whichever is greater.
Delivery includes required slave potentiometer.
Wiring provided at standard rear connector.

Lefthand event marker PM 9835/01*
Indicates outside calibrated area.
Operates at TTL signal.
Wiring provided at standard rear connector.

Channel identification slave switch* PM 9837/02
Mounted inside recorder, offers double pole contact synchronous with channel switching.
Max load: 10W, 75V_{DC} or 50V_{AC}; 0.5A whichever is greater.
Connector and plug included.

Rackmount brackets PM 9838/02
Two carrying brackets to be mounted at each side of the recorder for 19" rack or panel mounting.

Remote programming lead PM 9841/01*
A cable which enables remote programming of 6 × 12 matrix board for channel and range selection.
Connector and plug included.

* Factory mounted on request.

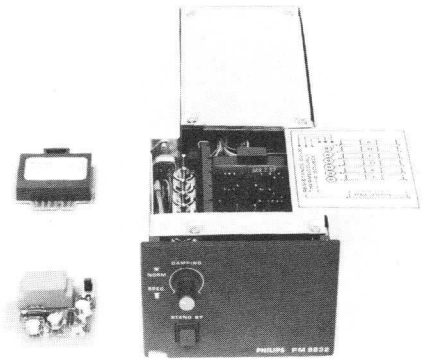


Fig. 5. Six-range module PM 9832 with measuring range card and current source.

CONSUMABLE SUPPLIES

Chart paper
Packet of 5 books of each 20m length
PM 9920/00 0...100 lin, time lines every 10mm with hour indications every 20–30–60–120 and 300mm.
PM 9920/01, as /00 but calibrated 100...0
PM 9920/04, 0...100 lin with time lines every 15mm
PM 9920/05, 0...100 lin, time lines every 2, 10 and 20mm
Special calibrated chart on request at minimum ordering quantity of 10 packs.

Ink wheel
PM 9839/02, spare set of 4 clip-on ink wheels, individually sealed. 6 colours: red, green, blue, violet, brown and black.
Operating life: 3 months continuous
Storing life: 2 years after manufacturing date.

Ink cartridge
For clip-on line recording:
- PM 9856/10 pack of 10 nylon pen cartridges – blue
- PM 9856R/10 pack of 10 nylon pen cartridges – red
- PM 9856S/10 pack of nylon pen cartridges, 2 of each colour black, blue, geen and red.

new*

DIN A4 X-Y recorders: Standard PM 8041 OEM-type PM 8040* Multipurpose PM 8141

Vector speed ⩾ 100cm/s

Acceleration 4g

Accuracy: ±0.25% FSD

Multirange (PM 8041/8141 and single range PM 8040)

Common mode rejection: 130dB

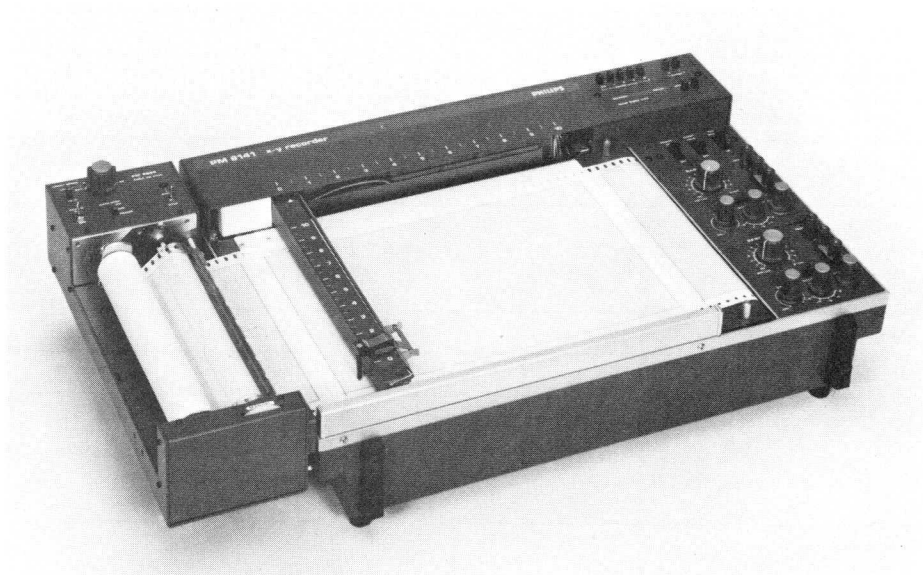
Throughbed construction for ROLL CHART or SINGLE SHEET

Calibrated + variable span

Full scale zero adjustment and suppression to −400% (PM 8141)

OEM model PM 8040

Optional time base and automatic chart transport



PM 8141 with attached chart transport unit PM 9885

PM 8040, 8041 and 8141 recorders offer an A4 format with high writing speeds to meet todays demand for high-grade instruments, whatever the application. For this reason, these recorders use the same basic construction; the PM 8141, however, has more sophisticated features, viz.:
- higher sensitivity
- wider range of sensitivities
- zero suppression

PM 8041 – same quality at a lower price

The only difference between the top-quality multipurpose DIN A4 recorder PM 8141, illustrated above, and the standard DIN A4 recorder PM 8041, is a more limited choice of input sensitivities and a reduced zero-setting range. All other features are identical, since the PM 8041 uses the same mechanical and electrical construction.

The same high writing speed, acceleration, accuracy and all other specifications that ensure top-quality recording are thus also available very economically with the PM 8041. The latter is ideal for all dedicated recording processes, where reliability is even more important than for general purpose recording

PM 8040 – OEM type X-Y recorder

This instrument is a stripped version of PM 8041/8141 (single range screwdriver controls, etc.) and is an economy model intended mainly for OEM applications.

All instruments offer a unique feature not normally associated with the A4 format. This allows preprinted chart rolls to be used. The rolls are located in a magazine recess allowing each frame to be easily fitted in position. For subsequent recordings, the used chart is released and pulled across the chart table and the new one quickly located in position. This facility maintains the correct sequence of a series of recordings and simplifies chart fitting. The charts are suitably perforated to allow separation of individual recordings where necessary.

An optional time base module, PM 9884 can be fitted to both models. It can be used for X or Y axis, has 5 calibrated sweep speeds and automatic pen lift and reset. The functions start/penlift and reset can be remotely controlled.
A chart transport unit PM 9885 is available, providing a wide range of chart speeds and an automatic, complete A-4 frame shift at pushbutton command. Start/stop, pulse rate and frame shift can be remotely controlled.

TECHNICAL SPECIFICATION	PM 8040	PM 8041	PM 8141	PM 8131	PM 8132
Accuracy of span	Max. error ±0.25% of f.s.d.				
Dead band	Max. 0.1% of f.s.d.				
Temperature drift	50µV/°C max.	20µV/°C max.	0.5µV/°C max.		3µV/°C max.
Writing speed	X-axis ⩾ 60cm/s Y-axis ⩾ 85cm/s				X- and Y-axis ⩾ 60cm/s
Vector speed	⩾ 100cm/s				⩾ 85cm/s
Acceleration (input filter switched off)	X-axis: 2100cm/s² Y-axis: 3800cm/s²				X-axis: 1700cm/s² Y-axis: 3800cm/s²
Linearity of pot. meter	⩽ ±0.1% of f.s.d.				
Input sensitivity	Fixed span	Multirange in 1-2-5 sequence			
	1V f.s. Variable 0.5...1.2V	9 ranges, calibrated 2mV to 1V/cm. Variable span with **increasing** sensitivity by factor 3	14 ranges, calibrated 50µV to 1V/cm Variable span with decreasing sensitivity by factor 3.		15 ranges, calibrated 200µV to 10V/cm. Variable span with **increasing** sensitivity by factor 3.
Zero setting	0...100% of scale				−100...+100% of scale (6 turn pot)
Zero suppression			4 steps to −400%		
Input impedance	1MΩ constant				
Source impedance	10kΩ max.				
Damping	Factory adjusted, overshoot 1% max.				
Input	Floating and guarded. Inputs parallel at rear connector.				
Stray voltage rejection with 1kΩ between HI and LO connected to earth	DC CMRR 130dB AC CMRR 90dB AC SMRR 60dB	190dB 90dB 60dB			120dB 120dB 60dB
		All instruments are provided with a switchable input filter to limit small signal transients.			
Max. overload voltage between HI and LO	$100V_{DC}$	Ranges 0.05-2mV/cm; $200V_{DC}$ Ranges 5mV-1V/cm; $400V_{DC}$			0.2-20mV/cm; $200V_{DC}$ 50mV-10V/cm; $400V_{DC}$
Leakage resistance	500MΩ	5000MΩ between input terminals and earth			
Safety requirements (acc. to IEC 348 and VDE 411)	Max. admissable voltage between Guard and earth: $24V_{DC}$ HI/LO and earth: $42V_{DC}$ Test Voltage $500V_{AC}$				
Recording area	Width 180mm Length 250mm			Width 250mm Length 380mm	
Chart format	DIN A-4 Sheets			DIN A-3 Sheets	
Chart hold	Electro static – Recording area markings and pinpoint light guides				
Pen lift	Electrical, local and remote control by contact closure (TTL Compatible)				
Writing system	Nylon pen cartridge; recording length 1500m Alternative 'Rotring' adapter available (PM 9858)				Pen distance: 2.5mm Nylon pen cartridge, recording length 1000m.

<table>
<tr><th></th><th>PM 8040</th><th>PM 8041</th><th>PM 8141</th><th>PM 8131</th><th>PM 8132</th></tr>
<tr><td rowspan="3">Timebase</td><td colspan="4">PM 9884, optional; 5 sweep speeds; switcheable to X or Y axis.</td><td rowspan="2">Standard built-in
6 sweep speeds (X only)
0.2-0.5-1-2-5-10s/cm</td></tr>
<tr><td>10-20-40-100-200s
full scale</td><td colspan="3">0.5-1-2-5-10s/cm</td></tr>
<tr><td colspan="5">Accuracy ±0.3%; linearity ±0.5%
Operating controls at front panel and remote control by contact closure (TTL-compatible). Automatic pendown at start; and automatic penlift and reset at end of scale.</td></tr>
<tr><td>Chart transport
unit for A-4 models only</td><td colspan="3">PM 9885, optional
10 chart speeds, stepper motor driven:
3-6-15-30-60cm/min. – cm/h.
Automatic frameshift by pushbutton control.
Remote control: – speeds by ext. pulses
– start/stop
– frameshift start</td><td colspan="2"></td></tr>
<tr><td>Power requirements</td><td colspan="5">110, 117, 217, 234V_{AC} ±10% .50/60Hz</td></tr>
<tr><td>Temperature range</td><td colspan="5">Rated range of use 5...40°C
Limits of operation −5...+50°C (ink freezes between −5 and −10°C)
Storage and transport −40...+70°C</td></tr>
<tr><td>Dimensions: (H × W × D)
Weight:</td><td colspan="3">130 × 482 × 340mm (5.1 × 19 × 13.4-in)
10kg (22lb)</td><td colspan="2">150 × 482 × 488mm (5.9 × 18.9 × 19.2-in)
15kg (33lb)</td></tr>
<tr><td>Standard accessories
supplied with the instrument</td><td colspan="5">Operating manual, dust-cover, maintenance kit, remote control connector, chart paper, penholders and inkcartridges</td></tr>
<tr><td>Consumables</td><td colspan="4">Writing system
Nylon pen cartridge; recording length 1500m (Boxes of 10)
Type PM 9856/10, Blue
Type PM 9856R/10, Red
Type PM 9856S/10, Set with colours red, blue, green and black (2 of each)
Chart rolls
Pack with 5 chart rolls of 15m length each: PM 9940/02 A–4 frames with mm grid
/03 Continuous grid.</td><td>Nylon pen cartridges
(boxes of 10)
PM 9875B/01 Blue
PM 9875R/01 Red</td></tr>
</table>

Single pen DIN A3 X-Y recorder PM 8131
Two pen DIN A3 X-Y recorder PM 8132

PM 8131

Vector speed ⩾100cm/s

Acceleration Y-axis: 3.8g

0.25% accuracy

0.05mV/cm sensitivity

−400 . . . +100% zero setting

Disposable nylon cartridges

PM 8132

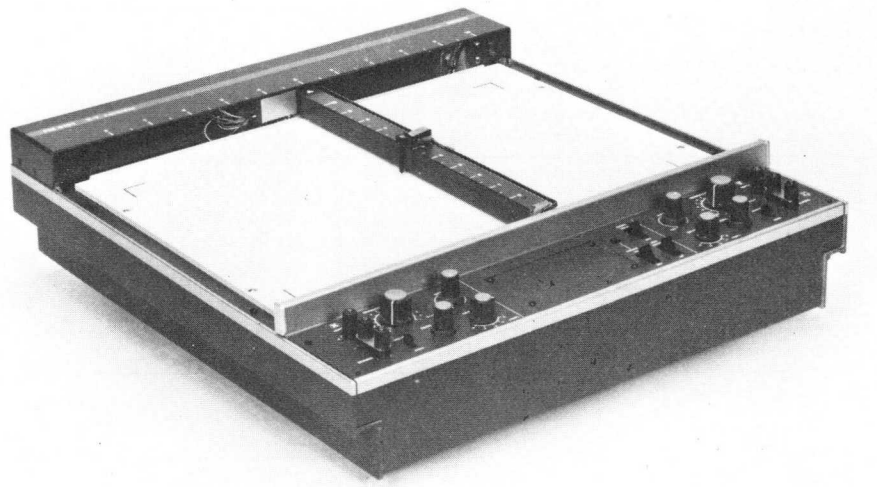
Vector speed ⩾85cm/s

0.25% accuracy

0.2mV/cm sensitivity

−100 . . . +100% zero setting

Standard built-in timebase



PM 8131

The single-pen DIN A3 format recorder PM 8131 (illustrated here) and the two-pen DIN A3 recorder PM 8132 offer the same outstanding features as the DIN A4 models, plus a larger recording area for increased resolution.

The sophisticated two-pen PM 8132 meets the most stringent laboratory requirements and allows the recording of two variables against a third or against time.

A3 format, single-pen recorder PM 8131

The PM 8131 has been specifically designed for research and development applications, requiring a very high resolution. This is achieved by the combination of high stability with minimal temperature drift and an A3 chart format.
The high recorder speed and acceleration offer an accurate recording of the given signal.

A3 format two-pen recorder PM 8132

Employed in research and development applications, the PM 8132 can reduce project duration by eliminating sequential recordings of such events. Moreover, the simultaneous recording of three related events avoids the problems encountered when attempting to reproduce dynamic situations of superimposed single-pen recordings.
A timebase is provided as standard for the X-axis and can be remotely controlled.

The specifications for PM 8131 and PM 8132 appear on P 93.

IEC-625

NEW

Multipen Intelligent plotter PM 8151

Programmable choice of 8 pens, nylon tip or Rotring Isograph

120 characters of 5 different fonts, upper and lower case

Scaled X and Y axes and full grids

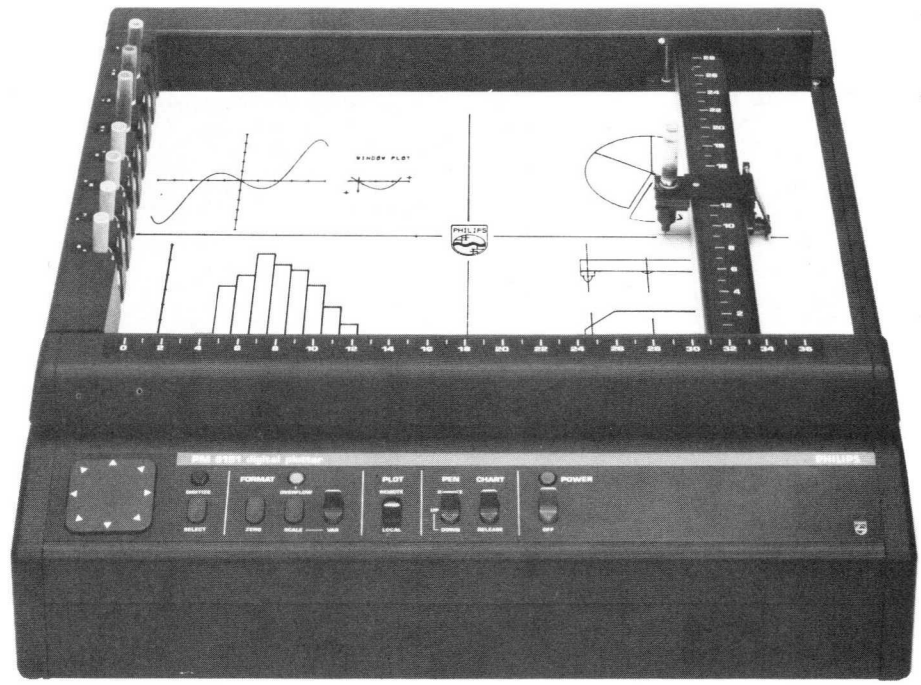
Window plotting and programmable offset both with off-scale data handling

Up and down scaling

Tabulating functions

Absolute and relative plotting

800bytes input buffer, expandable with 1K byte



The multi-colour plotter PM 8151 is microprocessor controlled and will accept digital data from any source such as IEC-controllers, desk computers, time sharing systems or offline stations, directly or via a modem. These input data will be rapidly and accurately converted into a graphic representation of the test values, design data or calculation results as formatted by the computing system. The many outstanding features of this instrument makes it suitable for a very wide range of applications.
The programming of its functions is extremely simple and even the most complex drawings can be executed with small, byte saving instructions.

Graph quality

A special feature is the possibility to use standard draughting pens like the Rotring Isograph pens. This permits the selection of pens employing Indian ink and having different line widths. As a result of the high accuracy and the automatic controlled plotting speed, all drawings are of a consistently high technical standard. Whilst an Isograph pen remains in its store (one of the 4 upper positions) the pen orifice is temporarily sealed to prevent it from drying out. This ensures a perfect trace when starting the drawing operation.
The pen store also accepts nylon tipped pens, available in different colours. For realisation of high quality drawings on transparents or plastic folios the plotting speed can be slowed down to a preset level by a switch on the CPU board.

Plotting intelligence

Built in microprocessor Zilog Z80 controls linear interpolation for vector generation, absolute and relative plotting and drawing of circles and arcs both clockwise and anti-clockwise with starting and final angles to choice. A very convenient feature is the plotting of scaled drawings of calibrated X and Y axes in positive and negative direction. By programming the length of a scale division, full grids can be plotted by simplified commands.

Graph identification

Besides the identification of plotted graphs in different colours and line thickness by selection of pens, there are also simple commands available for 5 different line types and 5 point-centered marks to distinguish lines. The high penlift frequency of 15Hz ensures that whilst maintaining the plotting speed, the dotted or broken lines are of reproduceable quality.

Window plotting

When a certain section only of a drawing needs to be plotted, that section can be isolated from the total plot and framed. When off-scale data are received the plotter will stop at the selected boundary limit, raise the pen and move to the spot where the calculated data return within the window and then restart plotting again. By selecting a different scale on the control panel the windowed section can be enlarged or reduced without change of programme. Large drawings can be divided into segments and joined again after plotting. This is achieved with the command 'offset' which shifts the X and Y coordinates, permitting data to be plotted that were previously off-scale.

Characters
Plots and drawings can be labelled with upper and lower case characters, and a choice can be made from 5 different national European character fonts.
The height and width of the characters may be independently programmed and slanted if required. Also the direction of the printing can be programmed in multiples of 1 degree through 360°.

Tabulating
The plotter is provided with the functions carriage return, line feed and back space for horizontal and vertical tabulation, as a standard. The unit spacing and separation of this tabulation is defined by the function of character sizing.

Digitizing
Upon receipt of the specific digitizing command either the plotter transmits the current coordinates automatically or the user transmits the data by push button control to the host computer after having set the pen to the positioning a digitizing sight with magnifying viewer is provided. This assembly has the same fitting as the standard pen.

Interfacing
The PM 8151 is available in two different versions, meeting virtually any demand for connecting to calculation of controlling systems:

- Serial asynchronous, PM 8151S
  EIA RS 232C/CCITT V24, switchable to time sharing and 20mA current loop.
  In time sharing systems the plotter can be switched on and off as a listener and automatically transmit data directly between the system and a terminal.
- IEC-Bus, PM 8151B
  Provides connections both for IEEE 488 and IEC 625 interface.
  The data transmission is bitparallel and byte serial.

The interface boards are interchangeable and the different parameters can be set by the keys provided at the front of the board.

Input buffer
An 800 byte input buffer is available for storage of incoming data. Whilst plotting the data in first-in, first-out sequence the host equipment thus can be occupied with other routines and no data are lost when, for any reason, the plotting operation is stopped. For special purposes, such as for time sharing operation, an 1K byte additional input buffer is optional.

Programmable chart transport
Using chart rolls with a total of 60 DIN A3 formats the transport unit can be programmed to advance in multiples of 1cm. Thus the plotter can be conveniently used at places where many plots or drawings have to be made unattended.

Special OEM-Options
With the aid of a ROM-expansion, special characters as well as user defined subroutines can be made firmware resident. They can be commanded by a single ASCII-character followed by the appropriate parameter listing.
Examples are: higher order interpolations, contour lines, special symbols for electrical engineering, grid maps, etc.

Microprocessor monitoring
In addition to the continuous handling and processing of data to produce the desired plot, the microprocessor monitors other functions to ensure maximum drawing quality and operational simplicity. This includes:

- A self-test routine after power-on.
  The plotter performs an internal routine test and the only visible activity is the lifting of the upper pen (1) which then runs to zero.
- Automatic lifting of the pen when it has been down too long on the same spot.
  This prevents ink bleeding on that spot.
- Automatic determination of the interpolation steps for drawing of circles, related to the radius.
- After each interpolation, comparison with the absolute position.
- Control of plotting dynamics; high speed positioning with lifted pen and reduced speed for accurate and high quality of plotting.
- With off-scale data handling, the calculation of the point of re-entry into the graphic area.

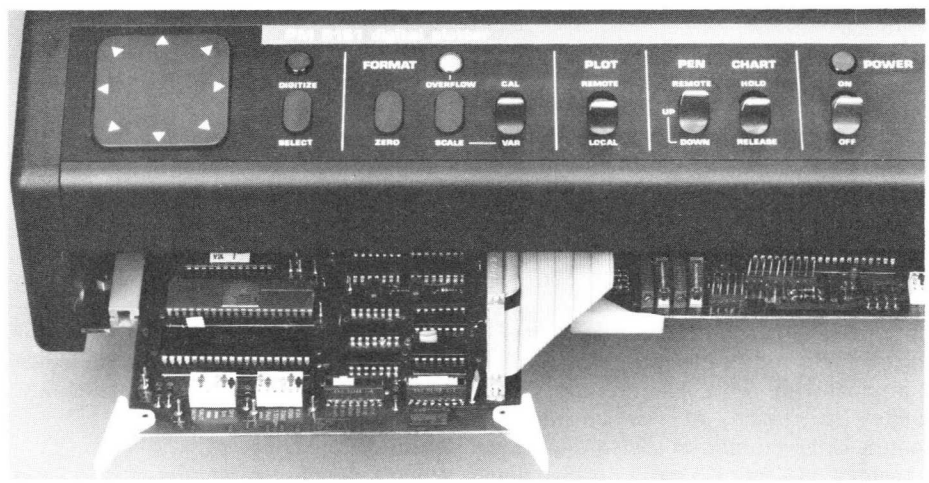
Front panel controls
The number of controls has been kept to a minimum, these are logically arranged for ease of operation.
All controls that influence the pen position are enabled only when the plotter is manually switched to 'LOCAL' or if user interaction is requested by, for example a digitizing command. Plotting action can be stopped at any time without losing data, when for instance a pen has to be changed manually or when altering the 'zero' position or the 'scaling'.

Manual pen selection and positioning
With the small square floating panel the pen can be directed to any required position on the plotting area.
For an accurate positioning for instance when digitizing, and using the digitizing sight, the pen starts at low speed and gradually increases to normal running speed.
By means of the 'select' switch and the arrows on the panel, corresponding to the pen numbers, any selected pen can be picked up. The pen currently in use is first returned into its depot before the new pen is picked up.

Selectable zero
Zero can be set at any location within the overall mechanical limits. As a result, drawings can be shifted and the format adapted. The automatic off-scale data handling enables this change of format withous a change of programme.

Selectable scale
In position 'variable' the scale can be enlarged or reduced both in online and offline operation. By this means a drawing or graph can be dimensioned between an enlargement by two and a reduction down to one tenth of the original.

Digitize and select
Upon a special command from the host



A detail showing the very simple control panel and the ease of access of the printed circuit boards.

computer, point coordinates can be transferred to the memory of that computer. A special digitizing sight, fitting in the penholder, is supplied with the instrument and enables accurate positioning. In the mode PLOT LOCAL the SELECT switch is used to programme the selected zero position, variable scale and selection of pens.

Pen lift

UP and DOWN overrule the REMOTE position, also in the remote plotting mode.
When the pen remains down too long on one spot it lifts automatically and will only go down again upon receipt of the next plotting command.

Chart hold

The chart hold is electrostatic and permits the use of any kind of paper of different formats.
When the PLOT switch is the LOCAL mode and CHART control on RELEASE, the plotting arm and pen are freely moveable ('servokill'). This feature is useful when a chart has to be removed in between plotting activities or pens have to be exchanged.

TECHNICAL SPECIFICATION

Plotting Area
Y-axis 280mm
X-axis 338mm
DIN A-3 format chart
(297 × 240) is accepted

Number of pens
Up to 8
Use of Rotring Isograph pens possible with supplied pen adapter.
The 4 upper positions are, specially for Isograph pens, provided with protecting tabs to prevent drying out. Standard supplied are nylon tip pens in different colours, type PM 9876.
Digitizing sight also fits in the pen depot.

Accuracy
0.1% of full scale

Linearity
Better than ±0.1%

Repeatability
±0.1mm for same pen
±0.3mm between different pens.

Positioning speed
100cm/s

Vector plotting speed
30cm/s. Can be preset to approx. 10cm/s.

Character plotting speed
3ch/s (3mm height)

Pen frequency
Max. 15Hz

Scaling
Calibrated;
1 unit = 0.1mm
variable; adjustable
1 : 10...2 : 1;
1 unit = 0.01...0.2mm

Smallest addressable move
0.1mm with calibrated scale
0.01...0.2mm with user defined scale

User defined zero
Anywhere within mechanical limits

Programmable offset
Range of number $2^{15} - 1$
$-32768 \leq n \leq 32767$

Input buffer
800 bytes
Expandable with additional 1K byte

Paper hold down
Electro Static

Control characteristics
Microprocessor Zilog Z80

Off scale data handling
Automatic calculation of interrupt with mechanical boundary or currently defined graphic limits. When on scale data are received again the new intercept is calculated and plotting resumed. Pen is lifted during off scale handling.

Interfaces
PM 8151B, according to IEEE-488 and IEC 625.
PM 8151S, provided with serial interface according to EIA RS 232C and CCITT V-24.
It can also be switched to 20mA current loop, time sharing and be connected to a modem.

Type	–	Asynchronous
Baud rate	–	Selectable from 110-300-600-1200-2400bdps
Character	–	7 bit : 7 bit + parity bit 8 bit : 8 bit + parity bit
Stop bit	–	1, 2 bit
Parity	–	on-off; even-odd

Power
110/220/240V ±10%
50/60Hz
Power consumption 30VA approx.

Size
H × W × D
160 × 466 × 452mm
(6.3 × 18.4 × 17.8-in)

Weight
13kg

Supplied with instrument
- User manual with operating and programming instructions
- Graph paper metric grid pad of 50sheet
- Accessory kit containing: fuses, ink, etc

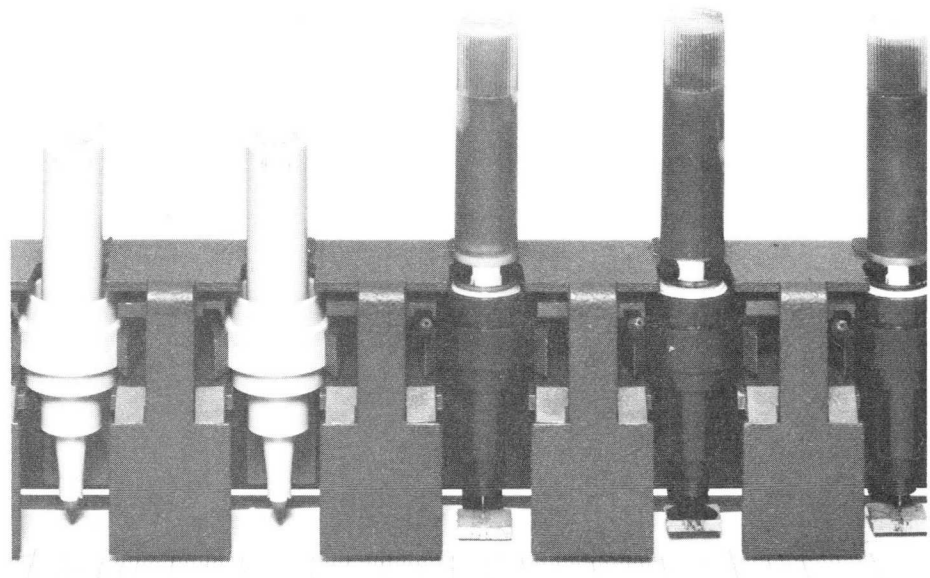
Optional
- Programmable chart transport unit PM 9886/01
  In styling fully adapted to the plotter.
  Consisting of supply roll holder and transport unit.
  Supplied with one roll of chart, sufficient for approx. 60 A-3 format plots.
  Chart advance can be programmed in multiples of 1cm.

- **Cables:**
  PM 9480/01 IEC-625 with 2 connectors (1m)
  PM 9481/01 IEC-625 with 2 connectors (2m)
  PM 9482/01 IEC-625 with 2 connectors (4m)
  PM 9888A/01 V-24 with 2 connectors (3m)
  PM 9888B/01 V-24 with 1 connector (3m)

CONSUMABLES

Pens
Sets of 10 disposable nylon tip pens
PM 9876 A/01 black
PM 9876 B/01 blue
PM 9876 G/01 green
PM 9876 R/01 red

Chart
Packet of 5 rolls, each for approx. 60 A-3 plots.
PM 9950/02 – blank



The pen capillary tubes are sealed off to prevent evaporation when not in use.

Consumables for recorders

CURRENT PEN CARTRIDGES FOR PHILIPS X-Y AND LINE RECORDERS

	Description				Line recorders								X-Y recorders							Plotter
	Type number	./	/..	colour	8110	8251	8252 channel upper	8252 channel lower	8202	8222 channel upper	8222 channel lower	9868 event marker	8041	8141	8131	8132 channel upper	8132 channel lower	8182 new pen system channel upper	8182 new pen system channel lower	8151
	PM 9856[1]	—	01	blue									○	○	○					
	9857[1]	—	01	red									○	○	○					
	9856	—	05	blue	○			○			○									
	9857	—	05	red		○	○		○	○										
		B	05	blue		○	○		○	○										
	9857	—	15	red								○								
	9856	—	10	blue									○	○	○	○				
		R	10	red									○	○	○	○				
		S	10	set of 4 colours									○	○	○	○				
	9857	—	10	red													○			
	9875	B	01	blue														○	○	
		R	01	red														○	○	
	9876	A	01	black																○
		B	01	blue																○
		G	01	green																○
		R	01	red																○

[1] To be used with penholder PM 9858/01

Also available: set of 4 ink-wheels PM 9839/02 for multipoint-recorder PM 8236.

REVIEW OF CHART PAPER FOR PHILIPS X-Y AND LINE RECORDERS

	Type no.	/..	Line recorders						Printing recorder	Multipoint recorder	X-Y recorders					Plotter
			8110	8251	8251T	8252	8202	8222	8210	8236	8040	8041	8141	8131	8132	8151
120mm Z-fold paper	9910	01	○													
250mm Z-fold paper	9920	01*		○		○	○	○		○						
250mm Z-fold thermosensitive paper (blank)	9930	02			○				○							
(grid)		03			○				○							
Roll paper (A-4 grid)	9940	02									○	○	○			
(continuous grid)		03									○	○	○			
Roll paper (blank)	9950	02														○
Sheet paper (A-4)	—	—									○	○	○			○
(A-3)	—	—												○	○	○

* see page 83

Novel linear motor without electrical connections to moving parts

Contactless, capacitive feedback system

Quartz-stabilized stepping motors for chart drive and printing

Simple changing of measuring ranges

Separate, exchangeable scale strips

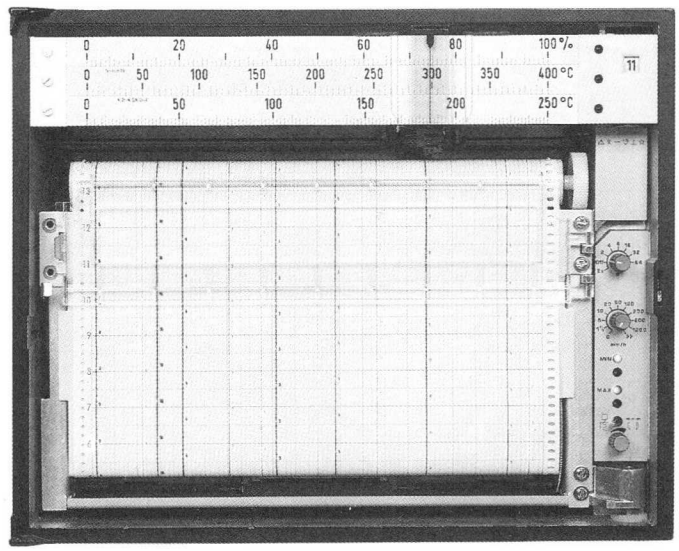
Nine chart speeds plus high-speed drive

Versions for 24 V_{DC} supply

Choice of roll or Z-fold chart paper

Multi-point recorder Transokomp 250

Transokomp 250 is a compensating point recorder for 6 or 12 channels. Recording width is 250mm and measurement error only 0.25%. Thermocouples, resistance thermometers or current/voltage sources can be connected directly. Measuring ranges are selected with plug-in conditioning modules.
Designed for general industrial use, Transokomp 250 finds application in iron and steel, chemical industry, industrial furnaces, power, and foodstuffs industries. High flexibility also makes this recorder suitable for research, development, and test applications.



TECHNICAL SPECIFICATION

INPUT

Direct voltage
Span: 2mV...2V: with chopper stabilized amplifier.
Input resistance: ⩾ 1GΩ
Quiescent current: 1nA approx.
Zero suppression: 0...2 × span, but not more than 2V.

Span: 0.8...2V: with operational amplifier
Input resistance: ⩾ 1MΩ
Quiescent current: 0.3μA approx.
Zero suppression: 0...2 × span, but not more than 2V.

Span: 2...40V: with voltage divider in conditioning module (either amplifier)
Input resistance: ⩾ 10kΩ/V.
Zero suppression: 0...2 × span, but not more than 33V.

Thermocouples
Spans: see 'Direct voltage'.
Options (for all thermocouple types):
Built-in temperature compensation;
reference temperature 20°C; additional error ⩾ 2K.

Built-in TC break protection: upscale action (standard) or downscale action; additional error approx. 0.2%/10Ω external resistance.

Direct current
Non-intrinsically safe input circuits:
Measurement derived from voltage dropped across a shunt resistor (one shunt needed across terminals of each current input).
Standard values of shunt:
10Ω, 50Ω, 1000Ω, ±0.05%, temp. coeff. 25ppm/K.

Instrinsically safe input circuits:
Measurement derived from voltage supplied by an external matching module (one module needed per current input, no shunts necessary).
Voltage from matching module: 0...377.4mV (with 0...20mA)
0...377.4mV (with 0...20mA)
75.5...377.4mV (with 4...20mA).

Resistance thermometer Pt 100
Thermometer to DIN 43 760
Measurement with chopper stabilized amplifier and built-in constant current source.
Measuring span: ΔR = 7.8...400Ω.
Span start: 10...250Ω.
Thermometer current: 2mA
Resistance per lead: ⩽ 200Ω
Lead resistance: adjustment to 10Ω with 2-wire connection; not critical with 3-wire connection
Temperature difference measurement: both lead resistances must be equal

Potentiometric transducer
Measurement with chopper stabilized amplifier and built-in constant current source
Measuring span: ΔR = 30...500Ω
Span start: 0...0.5 × total resistance
Total resistance: ⩽ 1500Ω (including 3 × lead resistance)
Current through sensor: 2mA
Lead resistance: no equalization necessary

Alternating current and voltage
Possible with external conditioning

Interference suppression
(sine wave 48...62Hz and 0.25% error)
Common mode interference: ⩽ $50V_{RMS}$
Series mode interference: < 10 × span, if span is < 50mV; < 5 × span, if span is > 50mV

RECORDING

Measurement principle
Null-balance system with preamplifier, DC linear motor, and capacitive displacement pick-up.

Input channels, measuring ranges
Six or twelve-channel recorder with 1 or 1...3 measuring ranges

Basic error to IEC 484 (DIN 43 782)
⩽ 0.25% of span, but not less than 12.5μV referred to the recorded value

Dead band: ⩽ 0.1% of span

Linearity error: ⩽ 0.1%

Response time
< 1s for 95% of final value

Printing
Recording head prints points in six colours; on 12-channel recorders the channel number in printed together with every 25th point

Print interval
Selectable 2, 4, 16, 32 or 64s
Internal stop switch for print drive. Print drive can also be started and stopped by an external contact

Colour sequence
Violet, red, black, green, blue, brown, to DIN 43831

Scale
Consists of 3 strips, each with a different graduation, if required
Length: 250mm

Chart drive
Quartz controlled stepping motor
Chart speeds: $1\frac{2}{3}$, 5, 10, 20, 60, 120, 200, 600 and 1200mm/h
Internal stop switch for chart drive
Chart drive can also be started and stopped by an external contact
Additional high-speed drive: 15360mm/h (not for continuous operation)
Error of chart drive: ⩽ 5 minutes/month

Chart paper
Depending on version, roll charts (to DIN 16230) or Z-fold charts can be used
Automatic take-up spool for roll charts
Chart width: 270mm
Recording width: 250mm
Chart length: 32m
Fold depth: 80mm

POWER SUPPLY

AC versions
Supply voltage: 110-120-22-240V, 48...62Hz, selectable (normal setting 220V) or 24V
Voltage tolerance: −15%...+10%
Power consumption: 18...32VA

DC versions
Supply voltage: 24V
Voltage tolerance: 18...31V
Power consumption: 18...32W

Power supply effect
±0.1% of span (within specified voltage limits)

Fuses
Cartridge fuses to DIN 41571
M 0.16C for 220 and 240V_{AC}
M 0.315C for 110 and 120V_{AC}
M 1.6E for 24V_{AC+DC}

ENVIRONMENTAL

Temperature limits
For specified accuracy: 0...40°C
For operation: −10...+50°C
For storage: −25...+80°C

Relative humidity
⩽ 75% yearly average, no condensation

Temperature effect
±0.1% of span/10K (within specified temperature limits)
±0.05% of span/10K additionally, if zero suppression is fitted

EXPLOSION PROTECTION

Protection type
Intrinsic safety (Ex)i G5
to VDE 0171 and EN 50020
PTB certificate applied for
Installation: outside hazardous area; passive sensors can be connected directly; active sensors need a matching module (see 'Versions')

OPTIONS AND ACCESSORIES

Releasing contact
Semiconductor switch (open collector) fitted as standard. Switch closes approx. 0.5s before next channel is selected.
Switch rating: ⩽ 30V_{DC}; ⩽ 40mA

Additional channel selector
Depending on version, 6 or 12 additional relays with contacts rated at ⩽ 100VA; ⩽ 250V ~; ⩽ 1A ~

Limit contacts
1 min. and 1 max. limit contact possible on all versions. Electronic limit value sensing.
Signalling: 1 relay per limit value with passive, normally open contacts rated at ⩽ 100VA; ⩽ 250V ~; ⩽ 1A ~
Adjustment: (0) 1...100% of scale with screwdriver
Switching hysteresis: < 1%
Two index pointers are supplied for marking the selected value. LED's indicate when a limit value is reached (relay de-energized).

Event marker
Supplied as mounting kit for fitting to recorder after removal of transport clamps. Event marker is fitted to right of scale, and marking is done with violet fibre-tip pen at 100% of scale (2mm deflection to left). With marker fitted, printing carriage movement is limited electronically to 90% of scale
Triggering is with external, normally open contact rated at ⩽ 35V; ⩽ 30mA

Pen attachement
Available as mounting kit for retro-fitting
Pen attachment enables a continuous (line) recording to be made of a single input channel. The attachment is clipped to the printing carriage and makes a violet trace with a fibre-tipped pen

GENERAL

Housing
Door fitted with lock and key to DIN 43832
Mode of protection: to IEC 144 (DIN 40050)
Front: IP 54; Terminal compartment: IP 40
Fixing clamps: 290 DIN 43834
Front dimension: 360 × 288mm
Depth: 295mm

Electrical connection
To screw terminals for 2 × 1.5mm² cable including crimp and
1 flat-pin connector A 6.3 × 0.8 DIN 46244 or
2 flat-pin connectors A 2.8 × 0.8 DIN 46244

Mounting method
In panel cut-out

Mounting position
NL 90 DIN 16257 (vertical −15/+0°)

Weight: 18kg approx.

Connecting diagram: 401215074101

Dimension drawing: 401215062971

Operating instructions: 401215052001

Accessories
1 Operating instructions
2 recording charts (Z-fold or roll)
4 fixing clamps
2 inking wheels
2 door keys
1 channel identifying label (TAG label)
1 fuse each of type M 0.16C, M 0.315C, M 1.6E

PCS-One & Two-channel Line Recorder

Two-speed chart drive fitted as standard
Intrinsically safe input circuits
Simple and reliable recording pens
Up to eight hours past-record always visible
Simple plug-in range change resistors
Live zero/true zero selection
Response speed adjustable 3 . . . 65s

Profile

The PCS-line recorder records any variable which can be converted to a standardized signal of 0...5mA up to 0...50mA and 1...5mA up to 10...50mA
The input signal is conditioned by a plug-in range resistor.
The recorder provides an extremely reliable chart record which is printed by a nylon-tipped cartridge. A scale graduated 0...100% linear one side and square root on the other is fitted as standard, but scales can be fitted with graduations to suit the units and range of the recorded variable.
On two-channel versions each channel can record a different input. This is particularly useful for recording related variables such as temperature/humidity; speed/torque; etc. With a standard chart speed of 20mm/h, up to eight hours of chart record are visible when the recorder is partially removed from the case.
The recorder operates from all standard AC supply voltages and frequencies. A 24/42V_{AC} version can be supplied if required.

TECHNICAL SPECIFICATION

INPUT

DC CURRENT

Span
Selected by plug-in resistor
0...5, 0...10, 0...20 or 0...50mA_{DC}
After removing a soldered link, these values become:
1...5, 2...10, 4...20 or 10...50mA_{DC}

Input resistance for current
Depends on current range and causes a drop of 2V, i.e. for 0...20mA it is 100Ω

DC VOLTAGE

Span
0...2V_{DC}. Up to 220V possible with external Signal Conditioning Unit

Input resistance
20.5kΩ±2%

Source impedance
⩽1kΩ

Interference suppression
Series mode: ⩽6V_{p-p} at 50Hz
Common mode: ⩽220V_{RMS} at 50Hz

These values cause an error of ⩽0.5% of 3s settling time. With longer setting time, suppression is even better.

POWER SUPPLY

AC versions
Supply voltage: 110-120-220-240V; 50 or 60Hz, or 24/42V; 50Hz
Voltage tolerance: −15%...+10%
Power consumption: 18VA (2 channels) or 13VA (1 channel)

Voltage effect
⩽0.15%

MONITORING AND OPERATING FACILITIES

Scale
Length: 100mm
Graduation: 0...100% linear one side
0...100% square root on reverse
Graduation to specification also available

Chart roll
Chart width: 120mm
Chart length: 16m
Recording width: 100mm
Visible length: 40mm from front; 160mm with recorder drawn forward
Drive: synchronous motor with 2 speed drive
Speed: 20–1200mm/h, 10–600mm/h or 60–3600mm/h

Recording
Method: continuous with disposable nylon tipped pen
Colour: violet for single pen recorder; violet/red for two pen recorder
Settling time: 3...65s, continuously adjustable
Positioning error: ⩽0.25%
Overall error including hysteresis: ⩽0.5%

ENVIRONMENTAL

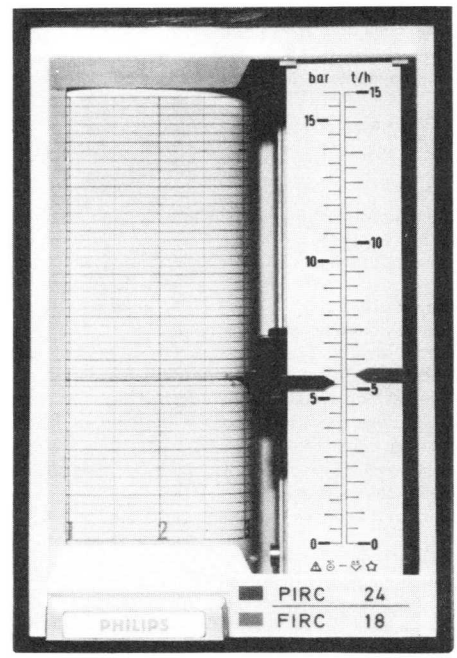
Temperature limits
−10...+50°C

Temperature effect
⩽0.2%/10K

EXPLOSION PROTECTION

Classification
Type: Intrinsic safety (Ex) i G5 to VDE 0171 on input circuit(s)
Certificate: PTB no. III B/E 21 125s

Installation
Outside hazardous area



GENERAL

Housing
Material: sheet metal
Mode of protection: to DIN 40050 (IEC 144)
Case: IP 50. Terminals: IP 20. Front: IP 40

Mounting position
Vertical

Mounting method
In panel cut-out

Weight
Single pen recorder: 6.8kg approx.
Two pen recorder: 7.2kg approx.

Connecting diagram
Diagram 401215072021 available on request

Dimensions
(w × h × d) 96 × 144 × 422mm approx.
Dimension drawing no. 401215060321 available on request

Operating instructions
Manual no. 401215050522 included in delivery of equipment

Accessories
2 mounting clamps, Type A, for high packing density
2 rolls of chart paper; linear graduation
1 service kit

Multimeters and voltmeters

Unit	Description	Voltage	Current	Resistance	Temp. facility	Page
ANALOG MULTIMETERS						
PM 2412A	General purpose	300mV...1kV$_{DC}$ 3V...600V$_{AC}$	10mA...6A$_{DC}$ 100mA...6A$_{AC}$	1Ω...10MΩ		106
PM 2504	High accuracy	10mV...1kV$_{DC/AC}$	1mA...30A$_{DC/AC}$	10Ω...100MΩ linear scale		108
PM 2505	Electronic	100mV...1000V$_{DC}$ 100mV...600V$_{AC}$	1μA...10A$_{DC}$ 1μA...10A$_{AC}$	100Ω...30MΩ linear scale		110
DIGITAL MULTIMETERS						
PM 2517E/X	Portable (4-digit)	1V...1000V$_{DC}$ 1V...600V$_{AC}$	100mA, 10A$_{DC/AC}$	1kΩ...10MΩ	Yes	112
PM 2522	General purpose ($3\frac{1}{2}$-digit)	200mV...1000V$_{DC}$ 200mV...600V$_{AC}$	200μA...2A$_{DC/AC}$	200Ω...20MΩ		114
PM 2522A	General purpose ($4\frac{1}{2}$-digit)	2V...1000V$_{DC}$ 2V...600V$_{AC}$	2mA...2000mA$_{DC/AC}$	2KΩ...20MΩ	Yes	115
PM 2523	Autoranging ($3\frac{1}{2}$-digit)	200mV...1000V$_{DC}$ 200mV...600V$_{AC}$		200Ω...20MΩ		117
PM 2524	Autoranging ($4\frac{1}{2}$-digit)	200mV...1kV$_{DC}$ 2V...600V$_{AC}$	2000mA$_{DC/AC}$	2KΩ...20MΩ	Yes	118
PM 2526	DC-coupled RMS meter ($4\frac{1}{2}$-digit)	200mV...1kV$_{DC}$ 20mV...600V$_{AC}$		200Ω...20MΩ	Yes	120
PM 2527	True RMS meter ($4\frac{1}{2}$-digit)	200mV...1kV$_{DC}$ 20mV...600V$_{AC}$	2μA...2000mA$_{DC/AC}$	200Ω...2000MΩ	Yes	122
VOLTMETERS						
PM 2434	High sensitivity Analog DC	10μV...1kV$_{DC}$				125
PM 2554	High sensitivity Analog AC	1mV...300V$_{AC}$ (2Hz...12MHz)				126
ACCESSORIES						
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Miscellaneous accessories						128

Introduction

It is a curious combination of facts that finds multimeter design becoming increasingly more complex while the instruments themselves become much easier to use! Levels of accuracy, stability, versatility and reliability continue to improve. Yet front panel layouts have become less crowded, controls have become fewer, operation simpler, useability exteded.
All these improvements are a direct result of Philips ever-growing experience as designer, manufacturer *and* user. These benefits will become evident from a study of the current range in multimeters and voltmeters.
This covers analog and digital meters which will satisfy most measurement problems in laboratory, workshop or field situations calling for varying degrees of precision.

PM 2505

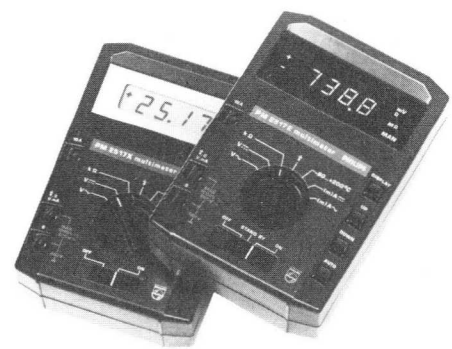
New analog meter movement

Whilst the demand for digital multimeters exceeds that for analog types, this latter group still occupies a substantial proportion of general demand.
Philips recognizes the continuing requirement for analog applications and has committed itself to recent research programmes for the development of an improved analog meter movement.
The result of these researches is the emergence of an electromechanical meter system that shows many advantages over its predecessors and other competitive devices. For instance, it has fewer individual component parts – 15, compared with conventional averages of over twice that number.
The immediate gain is that not only is the system less complicated to assemble, it is even more robust – a *must* for all analog meters. Easier assembly means shorter manufacturing timescales and the lower cost has helped to offset much of todays cost-spiralling in other areas of manufacturing. Yet another benefit has been the virtual elimination of magnetic radiation and practically complete immunization from the effects of stray fields. Moreover, backlash is a thing of the past. This advanced system clearly demonstrates Philips appreciation of the importance of analog meters in its current and future programme.
The new movement features in the PM 2505 analog multimeter, recently introduced into the T & M range. The PM 2505 is a compact electronic multimeter with many user-benefits such as it high, constant input impedance of 10MΩ. This ensures very high measuring accuracies, especially when compared with the performance of a 20000Ω/volt instrument.

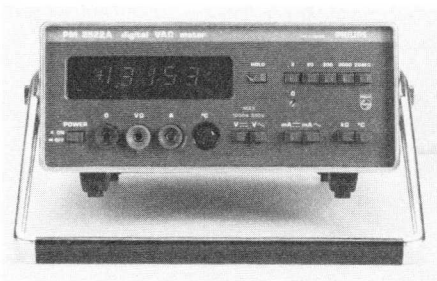
With 62 measuring ranges selected by a single rotary switch this is an extremely versatile instrument. Automatic polarity indication, a diode test facility and an audio signal for continuity checks put this battery-operated meter in a class of its own!

A wide choice

The total range of Philips multimeters offered gives the user a wide choice of price/performance ratios indeed. There is a model to meet practically every requirement from simple to ultra-sophisticated use, including integration into automatic testing systems.
Reviewing the digital programme, the small, yet high-performance PM 2517E/X models have already achieved a significant level of popularity. These 4-digit, hand-held meters will measure AC+DC voltage and current, also resistance and temperature. Automatic ranging ensures maximum resolution and accuracy for each measurement. Both models employ a true RMS detector to avoid errors introduced in 'average detecting' systems. IEC, VDE, UL and other international standards are fully complied with in these versatile, low-cost, fully protected instruments.
In addition to these instruments there are medium-priced units such as the $3\frac{1}{2}$ digit models, PM 2522 and PM 2523. Moderate cost, full circuit protection and high reliability are the main features of these units.
Both instruments are suitable for either laboratory and general-purpose applications, including radio and TV servicing. The PM 2523 can be considered to be the automatic version of the PM 2522.



PM 2517E and PM 2517X



PM 2522A

The $4\frac{1}{2}$-digit range consists of four models, the PM 2522A is the most economical unit. Its measurement parameters include, voltage, current, resistance and temperature, the latter with an optional probe.
The PM 2524 features a high accuracy and extremely fast autoranging. It also measures the same parameters as the PM 2522A.

For high precision on the bench or in automation

For really high-grade applications the choice focusses on instruments like the PM 2526 and PM 2527. Both instruments feature a true RMS measurement capability. Each unit is wired for IEC-bus interface and for parallel BCD output. VHF and temperature measurements can be handled by both units which also feature manual- and auto-ranging.
The PM 2527 offers extremely wide resistance ranges. The resolution in the lowest Ω-range is 10mΩ and the maximum measurable ohmic value is 2GΩ.

Milli- and micro-voltmeters

The high-precision electronic micro-voltmeter PM 2434 is extremely rugged for its class and may be used vertically or horizontally. Its accuracy of 1% rdg ±0.5% FSD is maintained for hum signals of 40dB; even at 60dB over full scale, the error is less than 2%. It features a chart recorder drive output and can be used as a sensitive pre-amplifier.
PM 2554 is a wideband AC millivoltmeter which will measure signals between 100μV and 300V. This high quality analog instrument has a sensitivity of 1mV (fsd) up to 300V over its 2Hz to 12MHz frequency range. Its high accuracy, up to 1% fsd ±1% of reading is underwritten by its inherently high stability (such that the instrument never needs recalibration). All ranges are protected from overloads up to $300V_{RMS}$ (or $400V_{DC}$). Applications cover a wide range from sub-audio phenomena such as mechanical vibrations, to HF and beyond.

PM 2527

PM 2523

Catering for accidents!

One of the major overall features of every multimeter in the Philips programme is the exceptionally good instrument protection arrangements. All units are well protected against overload due to user-error, including 220V on the resistance ranges. With the attention that has been paid to ruggedness of construction, these instruments are well suited to the rigours of long-term workshop and field use.

PM 2554

High manufacturing standards

All multimeters are manufactured to high professional standards and strictly tested to IEC regulations, ensuring long-term accuracy and reliability. A wide range of accessories are available to extend ranges and functions.

General purpose multimeter PM 2412A

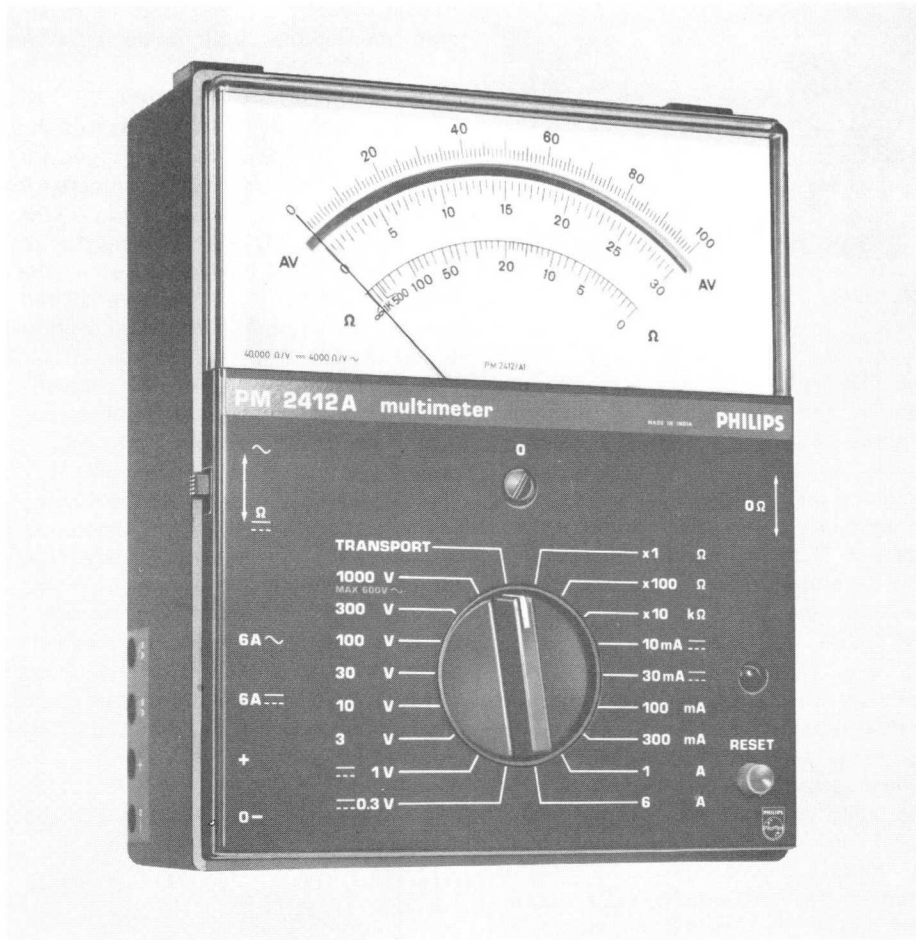
Tautband suspension type meter with 40 000Ω/V

One direct reading linear scale for AC and DC voltages and currents

Compact, rugged and light

Comprehensive electronic overload protection for all ranges

Single, rotating selector



A rugged, general-purpose multimeter with a high overall accuracy and excellent, foolproof, overload protection, the PM 2412A is also very light and compact. Range selection is by means of a single rotating knob. The combination of a wide scale, fine pointer and a mirror avoids parallex reading errors. Only two input sockets are provided for all ranges, with the exception of the 6A range. Several optional accessories are available which extend the basic facilities of the instrument.

Tautband, moving coil meter

The moving coil instrument has rugged, type 25μV system employing tautband suspension. This type of meter, combined with the synthetic case material, makes the instrument highly resistant to mechanical shocks and ideal for industrial and similar environments.

Electronic overload protection

The PM 2412A is designed to withstand rough electrical treatment. In fact the protection system covers every possible overload condition. An electronic circuit drives a relay that breaks the input in case of an overload that could damage the instrument.

This circuit does not only protect the voltage ranges, but also the resistance and most current ranges. The other current ranges are protected by a normal fuse that is easily replaced. Activation of the cut-out relay is indicated by a small pilot lamp. Simply pressing the reset button makes the multimeter operational. In the event of high voltage overload, where even short peaks could damage the instrument before the relay is actived, the maximum voltage is limited to about 2kV by a special high voltage protection circuit. Because of all these precautions, pointer or instrument damage is virtually impossible.

TECHNICAL SPECIFICATION

Model PM 2412A

DC-voltage

Ranges 0.3V, 1V, 3V, 10V, 30V, 100V, 300V, 1000V
Sensitivity 5mV
Accuracy 2%
Input resistance 40 000Ω/V
Maximum input voltage; protected to overload by an electronic cut-out relay circuit

AC-voltage

Ranges 3V, 10V, 30V, 100V, 300V, 600V
Sensitivity 50mV
Frequency range 40Hz...5kHz
Accuracy 3%
Input impedance 4000Ω/V
Maximum input voltage protected to overload by an electronic cut-out relay circuit

Resistance

Ranges 1Ω...10MΩ, in three ranges: 1Ω, 100Ω, 10kΩ with mid-scale rdngs: 20Ω, 2kΩ and 200kΩ
Sensitivity 5Ω
Accuracy 5%
Protected by an electronic cut-out relay circuit

DC-current

Ranges 10mA, 30mA, 100mA, 300mA, 1A, 6A
Sensitivity 0.5mA
Accuracy 3%
Voltage drop 200mV
Protected by electronic cut-out relay circuit and fuse

AC-current

Ranges 100mA, 300mA, 1A, 6A
Sensitivity 1mA
Accuracy 6%
Voltage drop < 1V
Frequency range 10Hz...1kHz
Protected by electronic cut-out relay circuit and fuse

General

Meter system tautband suspension 25μA
Reference conditions 23°C±10°C
Limit range operating temp. 0°C...55°C
Storage temp. −40°C...+70°C
Rel. humidity 20%...80%
Power supply for resistance measurements and protection circuit: 1×9V battery and 1×1.5V battery
Dimensions mm (w×h×d) 150×185×80 (6×7.3×3.1-in)
Weight 1kg (2.2lb)

Accessories supplied with instrument

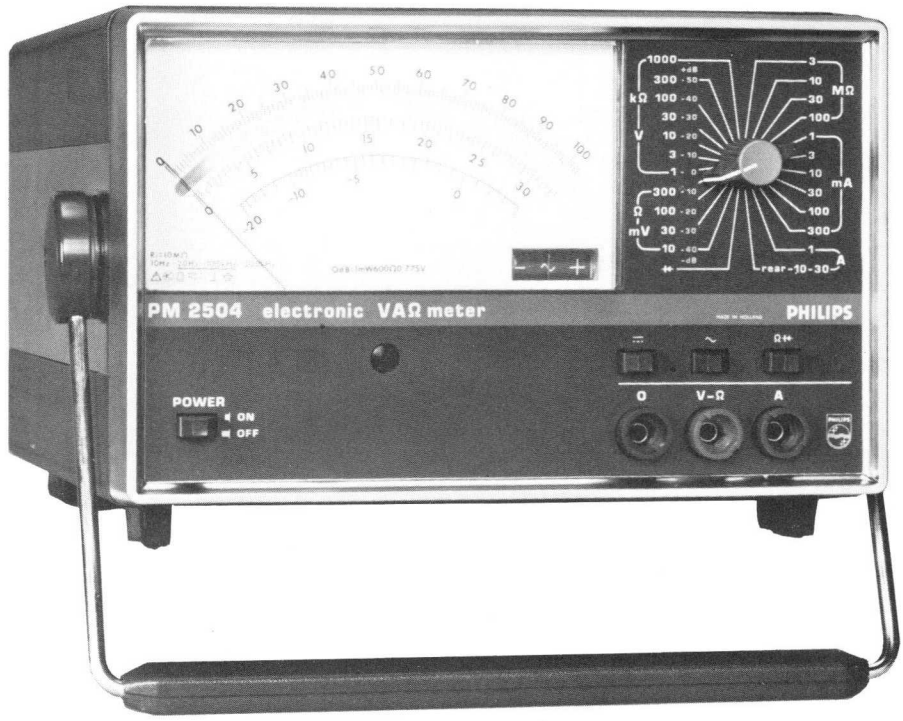
Measuring leads
Operation manual
Spare fuses

Optional accessories

Ever ready case PM 9273
HT-probe PM 9246
Current transformer PM 9245
HF-probe PM 9213

High accuracy portable multimeter PM 2504

1. . .2% accuracy on all ranges
Unique linear resistance scale
Compact, portable performance
Complete overload protection
1000h battery life; line supply option
High 200kHz bandwidth
Automatic polarity indication



The PM 2504 combines a high accuracy with extensive overload protection and ease of operation. This latter feature includes the unique linear resistance scale (instead of the conventional inconvenient and inaccurate logarithmic scale) as well as an attractive and ergonomically layed out front panel. Moreover this high accuracy is available for each and every application due to the instrument's portable performance. When battery power is low, and replacement inconvenient, the PM 2504 can be quickly recalibrated using the external calibration facility.
It also provides a display system with the same accuracy in both horizontal and vertical positions.
The meter has only three scales which makes for easy, unambiguous reading. They are 0–30, 0–100 and dB.

Extensive overload protection

The PM 2504 is one of the best protected multimeters available. Up to 1.5kV can be applied to all voltage ranges and full mains connected direct on resistance ranges, which is the most common overload error.

TECHNICAL SPECIFICATION

Model PM 2504

DC-voltage

Ranges 10mV, 30mV, 100mV, 300mV, 1V, 3V, 10V, 30V, 100V, 300V, 1000V
Polarity automatic by extra meter
Sensitivity 100μV
Accuracy 1%
Input resistance 10MΩ//70...115pF
SMRR 60dB
CMRR 100dB
Maximum input voltage 1500V_{DC} or V_{pk}

AC-voltage

Ranges 10mV, 30mV, 100mV, 300mV, 1V, 3V, 10V, 30V, 100V, 300V, 1000V
Sensitivity 100μV
Frequency range 30Hz...30kHz
Accuracy 1.5% FSD at 50...60Hz. Additional error: 20Hz...100kHz ±1%; 10Hz...20Hz: ±2%; 100kHz...200kHz: ±3% (1000V range < 10% for 10Hz...1kHz)

Input impedance 10MΩ//70...115pF
Maximum input voltage 1500V_{DC} or V_{pk}

Resistance

Ranges 10Ω, 30Ω, 100Ω, 300Ω,1kΩ, 3kΩ, 10kΩ, 30kΩ, 100kΩ, 300kΩ, 1MΩ, 3MΩ, 10MΩ, 30MΩ, 100MΩ
Sensitivity 0.1Ω
Accuracy 2.5% FSD for 10Ω, 300Ω and 1MΩ...10MΩ ranges; 1.5% for 1kΩ...300kΩ ranges; 5% for 30MΩ and 100MΩ ranges
Max. open input voltage 1V

Measuring current 1mA for 10Ω...300Ω;
31.6nA for 1Ω...10kΩ;
1nA for 30Ω...300kΩ;
100nA for 1MΩ...10MΩ;
3.16nA for 30MΩ...100MΩ

Testing semiconductors current 1mA; test volt. 1V
Protected up to 250V

dB measurements

Ranges 10mV/−40dB...1000V/+60dB

DC-current

Ranges 1mA, 3mA, 10mA, 30mA, 100mA, 300mA, 1A, 10A, 30A
Sensitivity 10μA
Accuracy 1.5%
Voltage drop 100mV...200mV

Protected up to 250V by fuse

AC-current

Ranges 1mA, 3mA, 10mA, 30mA, 100mA, 300mA, 1A, 10A, 30A,
Sensitivity 10μA
Accuracy ±1.5% for AC 50/60Hz
±2.5% for 10Hz...1kHz
Voltage drop 100mV...300mV

Frequency range 10Hz...1kHz
Protected up to 250V by fuse

General

Meter system tautband suspension 50μA
Reference conditions 23°±2°C
Temp coeff < 1%/10°C for all ranges
Limit range operating temp. −10°C...+55°C
Storage temp. −40°C...+70°C
Rel. humidity 20%...80%
Power supply batteries: 6×1.5V; external supply via 9V input socket

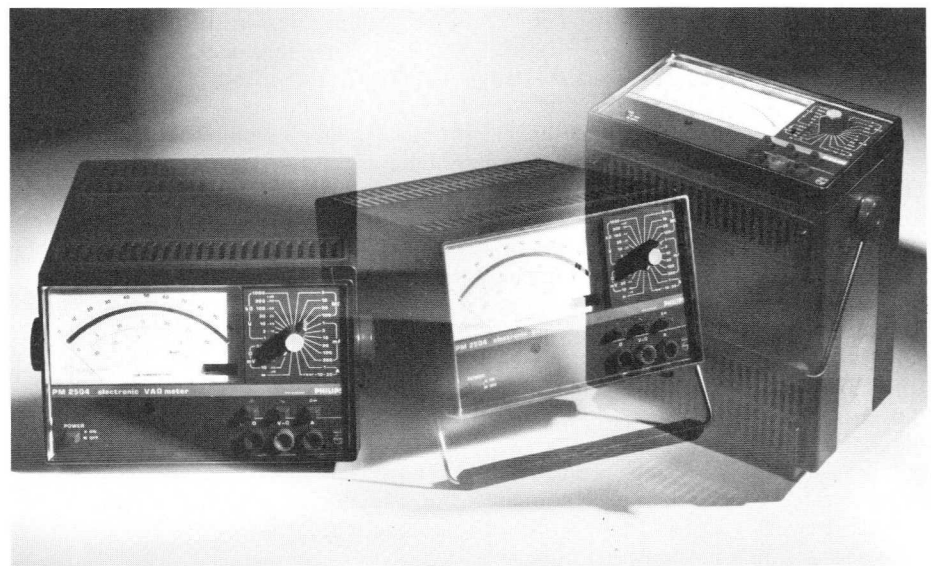
Dimensions mm (w×h×d) 236×145×298
(9.3×5.7×11.7-in)
Weight 2.7kg (5lb)

Accessories supplied with instrument

Measuring leads
Operation manual
Spare fuses

Optional accessories

HT-probe PM 9246
Current transformer PM 9245
HF-probe PM 9210 or PM 9213
Line supply unit PM 9218



The PM 2504 may be used in the various positions shown.

NEW

Electronic multimeter PM 2505

62 measuring ranges, high V&A sensitivity

10MΩ input impedance

Continuity check by sound signal

Linear resistance ranges

Automatic polarity indication

Unique meter movement for high accuracy and repeatability

Low power consumption

The PM 2505 is an extremely versatile, yet remarkably compact multimeter. Inbuilt features include very high accuracy and repeatability, high sensitivity and a constant input impedance of 10MΩ. Unlike conventional multimeters, which tend to use non-linear reversed scales for resistance measurement, PM 2505 has an easy-to-read *linear* scale giving accuracies well in advance of the usual 7 to 10% levels. Moreover, continuity checks (having less than 20Ω approx point-to-point resistance) are simplified by means of a built-in sound signal. A diode measuring facility is provided.

Automatic polarity indication makes it unnecessary to reverse test leads when undertaking different polarity checks. This feature also helps the user to adjust the meter to zero. Much attention has been given to the design of the new moving coil system, which has only 15 components.

The resulting movement is quite unique and has eliminated backlash and realized very high orders both of accuracy and repeatability. Moreover, it is physically robust, immune from external magnetic interference and does not radiate magnetic fields. The advanced electronic circuitry consumes minimal power giving an estimated 1000 hours operating life to the two 9V supply batteries (approximately six months of continuous everyday use).

Full overload protection is provided on all ranges. The voltage ranges, for instance, will accept 1000V continuously and peaks up to TV booster levels, whilst the current and resistance ranges will accept up to 265V.

A full range of accessories is available.

TECHNICAL SPECIFICATION

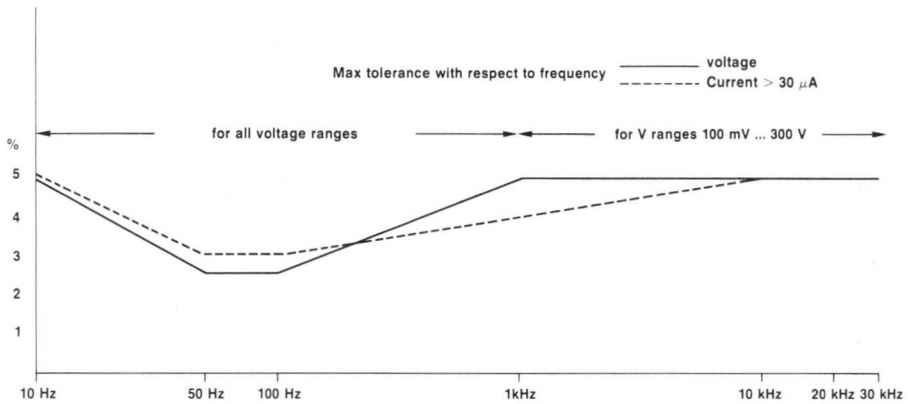
Model PM 2505

DC Voltage

Ranges: 100mV, 300mV, 1V, 3V, 10V, 30V, 100V, 300V, 1000V
Polarity automatic by extra meter
Sensitivity 1mV
Accuracy 1.5% (FSD)
Input impedance: 10MΩ
SMRR: > 60dB (50...400Hz)
Maximum input voltage: $1000V_{DC}$ or pk ($2000V_{pk}$ from high ohmic sources)

AC voltage

Ranges: 100mV, 300mV, 1V, 3V, 10V, 30V, 100V, 600V
Sensitivity: 1mV
Accuracy: 2.5% (FSD) at 50...60Hz
Input impedance: 10MΩ//75pF
Maximum input voltage: $1000V_{pk}$ or $600V_{RMS}$ ($2000V_{pk}$ from high ohmic sources)



Frequency response curve for PM 2505.

DC current

Ranges: 1µA, 3µA, 10µA, 30µA, 100µA, 300µA, 1mA, 3mA, 10mA, 30mA, 100mA, 300mA, 1A, 3A, 10A
Sensitivity: 0.01µA
Accuracy: 1.5% (FSD)
Voltage over shunt: < 100mV
Protection: Ranges up to 300mA with fuse (max. voltage 265V)
1A...10A not protected
Max. current 16A for 1min.

AC current

Ranges: 1µA, 3µA, 10µA, 30µA, 100µA, 300µA, 1mA, 3mA, 1A, 3A, 10A
Sensitivity: 0.01µA
Accuracy: 3% (FSD) 50...60Hz
Protection: Ranges up to 300mA with fuse (max. voltage 265V)
1A...10A not protected
Max. current 16A for 1min.

Resistance

Ranges: 100Ω, 300Ω, 1kΩ, 3kΩ, 10kΩ, 30kΩ, 100kΩ, 300kΩ, 1MΩ, 3MΩ, 10MΩ, 30MΩ
Sensitivity: 1Ω in 100Ω range
Accuracy: 3% FSD up to 10MΩ, 10% FSD in 30MΩ range
Max. measuring voltage: 100mV (1V in 30MΩ range)
Max. measuring current: 316µA

Continuity check

Audio signal at < 20Ω point-to-point resistance value
Protection up to $265V_{RMS}$ or $350V_{pk}$

Diode checks

Measurement of voltage over junction at 0.316mA. (Protection up to $265V_{RMS}$ or $350V_{pk}$.)

Battery check

Individual checks of + and − battery

GENERAL

Meter System: 50µA tautband suspension, centre magnet.
Separate polarity indication
Scales: Mirror scale: 0...100 and 0...300 for V, I and R measurements, dB scale, battery check.
Input: Combined for V and R
Separate for mA and A
CMRR 100dB at 50...60Hz
120dB at DC
Max. CM voltage 400V
Reference conditions: 23° ± 2°C
Temp. Coeff. 0.1%/°C for all ranges except 30MΩ
Operating temp: 0°C... +55°C
Storage temp: −25°C... +70°C
Rel. humidity: 10%...90% at 25°C
Power supply: 2 × 9V batteries
Battery lifetime approx. 1000h

Dimensions (mm): 118 × 170 × 62 (w × h × d)
Weight: 0.7kg

Accessories supplied

Measuring leads
Operating manual
Spare fuses

Optional accessories

Every-ready case PM 9278
HT probe PM 9246
Current transformer PM 9245
Current shunt PM 9244
HF probe PM 9210 and PM 9213

4-Digit portable multimeter PM 2517E/X

Full four digit display
Choice of LED or LCD
RMS AC measurements
Autoranging
Current up to 10 A
Optional temperature probe
Optional data hold probe
Overload protection up to TV booster voltages

PM 2517 is a very compact general-purpose multimeter with an extremely high price performance ratio. It measures volts, current, resistance and temperature on a full 4-digit display (max reading 9999) with automatic ranging to ensure maximum resolution for every individual measurement.
The instrument is available in two versions. PM 2517X has an LCD display, ideal for field service applications where reading under strong light and low battery consumption are important. PM 2517E uses LED's giving a bright display at lower light levels, making it suitable for inside use. To compensate for the higher power consumption the E-version is provided with a power saving circuit and an mains adapter. With the power saving circuit switched on the display is activated only during about 45secs after the display button is pressed.
AC measurements are made utilizing a true RMS detector. Therefore, the PM 2517 gives a true RMS display, whatever the waveform. A conventional 'average detecting' DMM will not, as shown in the table, (fig. 1). Errors and the need for a scope display are therefore eliminated.
The resolution of 100 μV and the basic accuracy of 0.2% of reading of ±0.05% of full scale compare well with laboratory instruments. Protection is complete from 265V in the current and resistance ranges to TV booster voltages (over kV peaks) in the voltage ranges.
The PM 2517 has only one easy-to-use main control avoiding any confusion when selecting a parameter or range (which is also displayed). Small enough for field use and sturdily constructed, it is also of sufficient size to contain many professional features and to meet the international quality standards such as IEC, VDE, UL etc.
A number of useful low priced options extend the application of the instrument. With the temperature probe direct reading of temperature between −60°C and +200°C is achievable. A HF probe extends the frequency range in excess of 100MHz. A special feature is the DATA HOLD probe which 'freezes' a measurement, allowing the user to first concentrate on connecting the probe correctly.

true RMS	5 V	5 V	5 V	5 V
reading on PM 2517	5 V	5 V	5 V	5 V
reading on "average detecting" meter	5 V	5,55 V	4,7 V	3,2 V

Fig. 1 shows comparison of reading accuracies between 'average' detecting and true RMS methods.

TECHNICAL SPECIFICATION

Model	PM 2517 E/X
Digits	4
Display	9999
Type	LED (E-version) or LX (X-version)
Range selection limits	9999 and 0900

DC-Voltage

Ranges	1V, 10V, 100V, 1000V
Polarity	automatic '+' and '−' sign
Resolution	100μV in lowest range
Accuracy	± (0.2% of rdng ±0.05% of rng)
Input resistance	10MΩ up to 10V; 9MΩ over 10V
SMRR	> 60dB up to 10V range > 40dB for 100V and 1000V range
CMRR	100dB for DC; 80dB for AC (50/60Hz) Maximum common mode voltage 400V
Response time	average < 2 sec
Maximum input voltage	$1000V_{DC}$ or $1000V_{RMS}$ Protected against TV booster voltage
Temperature coefficient	< 300ppm/°C

AC-Voltage

AC-to-DC conversion	true RMS
Ranges	1V, 10V, 100V, 600V
Resolution	100μV in lowest range
Frequency range	40Hz...20kHz
Accuracy	± (0.5% of rdng ±0.1% of rng) at 50/60Hz for other frequencies see graph
Input impedance	2MΩ up to 10V; 1.8MΩ over 10V
Maximum input voltage	$600V_{RMS} + 400V_{DC}$ with maximum peak value of 1400V. Protected against TV booster voltage.
Temperature coefficient	< 300ppm/°C

Resistance

Ranges	1kΩ, 10kΩ, 100kΩ, 1MΩ, 10MΩ
Resolution	0.1Ω in lowest range
Accuracy	± (0.5% of rdng ±0.1% of rng) up to 100kΩ ± (1% of rdng ±0.1% of rng) over 100kΩ
Max. open circuit voltage	4V
Measuring current	range — current 1KΩ — 1nA 10KΩ — 100μA 100KΩ — 10μA 1MΩ — 1μA 10MΩ — 0.1μA
Protection	up to 265V
Temperature coefficient	< 300ppm/°C up to 1MΩ < 500ppm/°C over 1MΩ

Diode measurements

Measuring system	diode forward resistance at 1mA current.
Protection	up to 265V

DC-current

Ranges	100mA, 10A
Resolution	10μA in lowest range
Accuracy	± (0.5% of rdng ±0.1% of rng)
Voltage drop	< 200mV
Protection	fuse protected up to 265V in 100mA range. 10A range unprotected; max. current 16A
Temperature coefficient	< 300ppm/°C

AC-current

Ranges	100mA, 10A
Resolution	10μA in lowest range
Accuracy	± (0.8% or rdng ±0.1% of rng) at 50/60Hz
Voltage drop	< 200mV
Protection	fuse protected up to 265V in 100mA range. 10A-range unprotected; max. current 16A
Temperature coefficient	< 300ppm/°C

Temperature

With optional probe PM 9248	
Range	−60°C...200°C
Resolution	0.1°C
Accuracy	± (1% of rdng ±2°C) up to 100°C +1 to −3% of rdng ±2°C over 100°C

HF-voltage

With optional probes PM 9210 or PM 9213

General

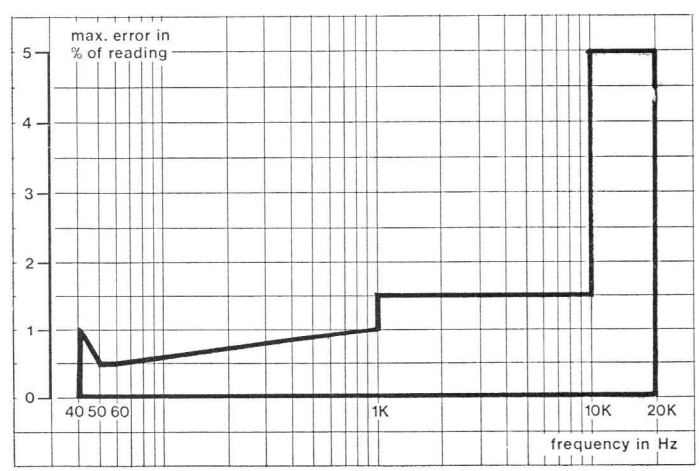
Type of input	floating
ADC system	Integrating
Recalibration interval	1 year
Read rate	3 readings/s
Overflow indication	.0..
Data hold facility	with optional datahold probe PM 9263
Reference conditions	23°C ±2°C
Limit range operating	0°C...45°C
Storage temperature	−40°C...70°C for 'E' version −20°C...70°C for 'X' version
Rel. humidity	20%...80%
Power supply	battery supply 4 × 1.5V cells (type TR 14 or equivalent) battery life time 200h for X-version and E-version when used in 'stand by' position. External $9V_{DC}$ supply with mains adapter PM 9218
Dimensions mm (w × h × d)	118 × 170 × 62mm (4.6 × 6.7 × 2.4-in)
Weight	0.8kg (1.7lb)

Accessories supplied

Set of testleads
Operation manual
Set of spare fuses
Mains adapter (E-version only)

Optional accessories

PM 9244	Shunt for 30A
PM 9245	Current transformer 100A
PM 9246	High voltage probe 30kV
PM 9210	HF probe set 700MHz
PM 9213	HF probe 100MHz
PM 9248	Temperature probe
PM 9263	Data hold probe
PM 9218	Mains adapter
PM 9278	Heavy duty case



General purpose digital multimeter PM 2522

0.1% reading ±0.1% of range DC voltage accuracy

Full circuit protection

LED display

AC line powered — optional rechargeable batteries

This DMM is suitable for laboratory and general purpose applications, including radio and TV servicing. LSI circuitry is used throughout, providing high accuracy and reliability. The analog/digital conversion is obtained by a unique integrating pulse modulation technique developed and patented by Philips. The high 10MΩ input impedance eliminates any errors introduced by loading the circuit under test and accuracy is further improved by high common mode rejection, a floating input and excellent stability.
Foolproof overload protection is provided. The instrument is mains powered, but features a provision for optional rechargeable battery supply.
Optional accessories include HT and HF probes, a DC shunt and a current transformer, a rackmount unit and a carrying case.

TECHNICAL SPECIFICATION

Model PM 2522

Digits $3\frac{1}{2}$
Display 1999
Type LED
Range selection manual

DC-voltage

Ranges 200mV, 2V, 20V, 200V, 1000V
Polarity automatic '+' and '−' sign
Resolution in lowest range 100μV
Accuracy ±(0.1% of rdng +0.1% of rng)
Input resistance 10MΩ
SMRR 60dB
CMRR for DC signals 100dB
Maximum CM voltage $500V_{DC}$; $350V_{AC}$ 50/60Hz
Response time 0.6s
Maximum input voltage $1000V_{DC}$
Temperature coefficient ±0.02%/°C of rdng

AC-voltage

AC to DC conversion average responding
Ranges 200mV, 2V, 20V, 200V, 600V
Resolution in lowest range 100μV
Frequency range 30Hz...30kHz
Accuracy ±(0.3% of rdng +0.3% of rng)
for 100Hz...10kHz
±(0.5% of rdng +0.5% of rng)
for 30Hz...100Hz and
10kHz...30kHz
Input impedance 10MΩ//60pF
Response time 1.2s
Max. input voltage $600V_{AC}$ 50/60Hz
Temperature coefficient ±0.02%/°C of rdng

Resistance

Ranges 200Ω, 2kΩ, 20kΩ, 200kΩ, 2MΩ, 20MΩ
Resolution in lowest range 0.1Ω
Accuracy ±(0.2% of rdng +0.2% of rng)
Maximum open circuit voltage 12V

Measuring current range	current
0.2kΩ...2kΩ	1mA
20kΩ...200kΩ	10μA
2MΩ...20MΩ	100nA

Response time 0.9s
Protected up to $250V_{AC/DC}$
(with fuse for lowest ranges)
Temperature coefficient ±0.025%/°C of rdng

DC-current

Ranges 200μA, 2mA, 20mA, 200mA, 2A
Resolution in lowest range 100nA
Accuracy ±(0.25% of rdng +0.25% of rng)
Response time 0.6s
Voltage drop < 250mV at ranges 0.2mA...200mA
< 600mV at 2A range
Protected up to 250V (Fuse protection 2A)
Temperature coefficient ±0.02%/°C of rdng

AC-current

Ranges 200μA, 2mA, 20mA, 200mA, 2A
Resolution in lowest range 100nA
Accuracy ±(0.25% of rdng +0.25% of rng)
Response time 1.2s
Voltage drop < 250mV at ranges 0.2mA...200mA
< 600mA at 2A range
Protected up to 250V (Fuse protection 2A)
Temperature coefficient ±0.02%/°C of rdng
Frequency range 30Hz...1kHz

HF-voltage

With optional probe PM 9213 or PM 9210

General

Type of input floating
ADC system integrating
Recalibration interval 1 year
Read rate $2\frac{1}{2}$ read/s
Overflow indication .0...
Data hold facility
Reference conditions 23°C±2°C
Limit range operating temperature 0°C...+45°C
Storage temp. −40°C...+70°C
Rel. humidity 20%...80%
Power supply; line: $110V_{AC}$ or $220V_{AC}$ +10%, −15%
battery: via optional rechargeable battery unit
Dimension mm (w×h×d) 235×95×280
(9.2×3.7×11-in)
Weight 2kg (4.4lb)
Power consumption 12VA

Accessories supplied

Mains cable
Front cover
Set of test leads
Spare fuses
Oper. manual

Optional accessories

HF-probe PM 9213 or PM 9210
HT-probe PM 9246
Current shunt PM 9244
Current transformer PM 9245
Battery pack PM 9216
Carrying case PM 9672
Rackmounting unit PM 9669/01

Digital multimeter PM 2522A

Maximum reading +1.9999

Measuring V-A-Ω and temperature

Full circuit protection

Optional rechargeable battery unit

Data hold facility

Many optional accessories extending the instruments' application

A medium priced $4\frac{1}{2}$ digit multimeter, the PM 2522A gives high accuracy readings of voltage, current and resistance over a wide range. Temperatures can also be measured, using an optional probe, from −60°C to +200°C. The clear 11mm high LED display features automatic polarity indication and decimal point (set by the range selector). Overload conditions produce a '.0...' display to warn the user. The DATA HOLD facility allows the last reading to be continuously displayed, if required. This facility can be set in operation either by means of the push-button on the frontplate or remotely by means of an optional probe.

To avoid confusion when measuring AC/DC currents, the least significant digit is blanked in those ranges where its accuracy does not contribute to a meaningful result.

Selection of the required parameter and range is by pushbuttons. Normally AC-line operated, the PM 2522A can be powered from an optional rechargeable battery unit. Full circuit protection safeguards the instrument from almost any form of misuse.

TECHNICAL SPECIFICATION

Model	PM 2522A
Digits	$4\frac{1}{2}$
Display	1.9999
Type	LED
Range selection	Manual
DC Voltage	
Ranges	2V, 20V, 200V, 1000V
Polarity	Automatic '+' and '−' sign
Resolution in lowest range	100μV
Accuracy	± (0.03% rdng+0.01% rng)
Input resistance	10MΩ ±1%
SMRR 50 and 60Hz ±0.1%	60dB
CMRR for DC signals	100dB
for 50/60Hz ±1%	100dB
Maximum CM voltage	$450V_{RMS}$ or $630V_{pk}$
Response time	1.2 sec
Maximum input voltage	2V rng: $1000V_{DC}$ for 1 min or $250V_{RMS}$ cont. 20V–1000V rng: $1000V_{DC}$ or AC_p
Temperature coefficient	± (0.005% of rdng/°C+0.001% of rng/°C)
AC Voltage	
AC to DC conversion	Average responding
Ranges	2V, 20V, 200V, 600V
Resolution in lowest range	100μV
Frequency range	35Hz...30kHz
Accuracy	± (0.2% rdng+0.1% rng) for 35Hz–500Hz ± (0.5% rdng+0.5% rng) for 500Hz–30kHz

Input impedance	1MΩ/30pF
Response time	2.5 sec
Max. input voltage	$600V_{RMS}+400V_{DC}$
Temperature coefficient	0.02% of rdng/°C for 35Hz–500Hz 0.04% of rdng/°C for 500Hz–30kHz

Resistance

Ranges	2kΩ, 20kΩ, 200kΩ, 2000kΩ, 20MΩ
Resolution in lowest range	0.1Ω
Accuracy	± (0.3% rdng+0.1% rng) for 2kΩ–2000kΩ rng. ± (0.5% rdng+0.3% rng) for 20MΩ range
Maximum open circuit voltage	< 7 Volt
Measuring current	1mA–2kΩ 100µA–20kΩ 10µA–200kΩ 1µA–2MΩ 100nA–20MΩ
Response time	2kΩ–200kΩ rng: 1.2 sec 2MΩ rng: 2 sec 20MΩ rng: 3.5 sec
Overload protection	$250V_{RMS}$ or $350V_{pk}$
Temperature coefficient	0.01% rdng/°C for 2kΩ–2000kΩ 0.03% rdng/°C for 20MΩ

DC current

Ranges	2mA, 20mA, 200mA, 2000mA
Resolution in lowest range	1µA
Accuracy	± (0.3% rdng+0.1% rng)
Response time	1.2 sec
Voltage drop	< 600mV in 2000mA rng < 250mV in other rngs
Overload protection	$250V_{RMS}$
Fuse protection	2.5A fuse
Temperature coefficient	0.02% rdng/°C

AC current

Ranges	2mA, 20mA, 200mA, 2000mA
Resolution in lowest range	1µA
Accuracy	± (0.3% rdng+0.1% rng)
Response time	1 sec
Voltage drop	< 600mV in 2000mA rng < 250mV in other ranges
Overload protection	$250V_{RMS}$
Fuse protection	2.5A fuse
Temperature coefficient	0.02% rdng/°C
Freq. range	35Hz–1kHz

Temperature

Optional probe	PM 9248

HF Voltage

Optional probe	PM 9210 or PM 9213

Data hold facility

Last reading can be continuously displayed by use of push button on front panel or by switch on optional data hold probe PM 9263

General

Type of input	Floating
ADC system	Integrating
Recalibration interval	180 days
Read rate	3 meas/sec
Overflow indication	.0....
Reference conditions	23°C±1°C
Limit range operating temperature	0°C–+45°C
Storage temp.	−40°C...+70°C
Relative humidity	20%–80%
Warming-up time	Approx. 15 min
Power supply	Mains: 220V–12%+10% 110V–12%+10% Battery: with optional rechargeable batt. unit PM 9216
Dimensions mm (w×h×d)	235×95×280 (9.2×3.7×11-in)
Weight	1.9kg (4.1lb)
Power consumption	8VA

Accessories supplied

Mains cable
Front cover
Set of test leads
Spare fuses
Oper. manual

Optional accessories

HF-probe	PM 9210 or PM 9213
HT-probe	PM 9246
Data hold probe	PM 9263
Current shunt	PM 9244
Current transformer	PM 9245
Temp. probe	PM 9248
Battery pack	PM 9216
Carrying case	PM 9672
Rackmounting unit	PM 9669/01

Fully automatic ranging
High accuracy in all ranges
Effective circuit protection
Mains or battery operation
Range extensions with optional accessories

Autoranging V-Ω meter PM 2523

A truly professional class meter, the PM 2523 gives highly accurate AC and DC voltage plus resistance measurements. Maximum resolution of each measurement is ensured by the autoranging mode of operation. The decimal point is floating and the maximum reading is 1.999. Voltage and resistance inputs are via a common socket; polarity is automatically indicated. Individual measuring times can be reduced using the RANGE HOLD facility which bypasses the autoranging mode. A DATA HOLD button allows the last reading to held, if required.

Specially developed integrated circuitry plus the analog-to-digital conversion technique with pulse modulation ensures very high accuracy in all ranges. (Lower DC voltage ranges exhibit an accuracy of ±0.1% of range ±0.1% of reading.) A high 10MΩ input impedance eliminates any errors due to loading the circuit under test and accuracy is further enhanced by a high common and series mode rejection.
The input circuitry is fully protected from accidental misuse in service.

Rack mounting brackets are available for building the meter into an instrumentation or OEM cabinet. A rechargeable battery is also available for field use.

TECHNICAL SPECIFICATION

Model PM 2523

Digits $3\frac{1}{2}$
Display 1999
Type LED
Range selection automatic
Range limits up 1999 down 0180

DC-voltage

Ranges 0.2V, 2V, 20V, 200V, 1000V
Polarity automatic '+' and '−' sign
Resolution in lowest range 100μV
Accuracy ±(0.1% of rdng + 0.1% of rng)
Input resistance 10MΩ
SMRR 60dB
CMRR for DC signals 100dB
Maximum CM voltage $500V_{DC}$; $350V_{AC}$ 50/60Hz
Response time 0.6s
Maximum input voltage $1000V_{DC}$
Temperature coefficient ±0.02%/°C of rdng

AC-voltage

AC to DC conversion average responding
Ranges 0.2V, 2V, 20V, 200V, 600V
Resolution in lowest range 100μV
Frequency range 30Hz...30kHz
Accuracy ±(0.3% of rdng +0.3% of rng)
for 100Hz...10kHz
±(0.5% of rdng +0.5% of rng)
for 30Hz...100Hz and
10kHz...30kHz
Input impedance 10MΩ//60pF
Response time 1.2s
Max. input voltage $600V_{AC}$ 50/60Hz
Temperature coefficient ±0.02%/°C of rdng

Resistance

Ranges 0.2kΩ, 2kΩ, 20kΩ, 200kΩ, 2000kΩ
0.2MΩ, 2MΩ, 20MΩ
Resolution in lowest range 0.1Ω
Accuracy ±(0.2% of rdng +0.2% of rng)
Maximum open circuit voltage 9.5V
Measuring current range — current
0.2kΩ...2kΩ — 1mA
20kΩ...0.2MΩ — 10μA
200kΩ...2MΩ...20MΩ — 100nA
Response time 0.9s
Protected up to $250V_{AC/DC}$
(with fuse for lowest ranges)
Temperature coefficient ±0.025%/°C of rdng

HF-voltage

Optional probe PM 9213 or PM 9210

General

Type of input floating
ADC system integrating
Recalibration interval 1 year
Read rate $2\frac{1}{2}$ read/s
Overflow indication .0...
Data hold facility
Reference conditions 23°C±2°C; RH < 70%
Limit range operating
temperature 0°C...+45°C
Storage temp. −40°C...+70°C
Rel. humidity 20%...80%
Power supply line: $110V_{AC}$ or $220V_{AC}$ +10%, −15%
battery: via optional rechargeable battery unit
Dimensions mm (w × h × d) 235 × 95 × 280
(9.2 × 3.7 × 11-in)
Weight 2kg (4.4lb)
Power consumption 12VA

Accessories supplied

Mains cable
Front cover
Set of test leads
Spare fuses
Oper. manual

Optional accessories

HF-probe PM 9210 or PM 9213
HT-probe PM 9246
Current shunt PM 9244
Battery pack PM 9216
Carrying case PM 9672
Rackmounting unit PM 9669/01

Autoranging digital multimeter PM 2524

Measures V-A-Ω and Temperature

Extremely fast autoranging and manual ranging

Maximum reading + 1.9999

Full overload protection

Parameter indication on display

Data hold facility

Applications can be extended by various accessories

This autoranging digital meter measures voltage, current, resistance and temperature with high accuracy and reliability, plus excellent resolution with a $4\frac{1}{2}$ digit display. The desired parameter is push-button selected and the autoranging facility ensures maximum resolution for every individual measurement. The correct symbol for the parameter being measured is automatically indicated. The red, 11mm high LED's are very easy to read.

Autoranging may be switched off for manual selection of the range in which a large number of successive measurements are made. This instrument also allows the last reading to be kept on the display by means of the HOLD button.

All input circuitry is fully protected against accidental misuse. Normally AC-line powered, the PM 2524 can be provided with a rechargeable battery module if required. A range of optional accessories is available to extend the basic functions of the instrument. (See accessories chart at the end of this section.)

TECHNICAL SPECIFICATION

Model	PM 2524
Digits	$4\frac{1}{2}$
Display	1.9999
Type	LED
Range selection	Automatic and manual
Range limits	Up 1.9999 – Down 01800
DC Voltage	
Ranges	200mV, 2V, 20V, 200V, 1000V
Polarity	Automatic '+' and '−' sign
Resolution in lowest range	10μV
Accuracy	± (0.02% rdng + 0.005% rng)
Input resistance	10MΩ ±1%
SMRR 50 and 60Hz ±0.1%	60dB
50 and 60Hz ±1%	40dB
CMRR for DC signals	140dB
for 50/60Hz ±1%	120dB
Maximum CM voltage	$450V_{RMS}$ or $630V_{pk}$
Response time	0.5 sec; with ranging 0.7 sec
Maximum input voltage	200mV, 2V rng; $1000V_{RMS}$ for 1 min or $500V_{RMS}$ cont. 20V–1000V rng: $1000V_{RMS}$ cont.
Temperature coefficient	± (0.005% of rdng/°C)
AC Voltage	
AC to DC conversion	Average responding
Ranges	2V, 20V, 200V, 600V
Resolution in lowest range	100μV
Frequency range	40Hz...30kHz
Accuracy	± (0.2% rdng + 0.1% rng) for 40Hz–10kHz ± (0.5% rdng + 0.2% rng) for 10kHz–30kHz

Input impedance	1MΩ/25pF
Response time	< 1 sec; with ranging max. 2 sec
Max. input voltage	$600V_{RMS}+400V_{DC}$
Temperature coefficient	±0.02% rdng/°C
Min. meas. Volt.	100μV

Resistance

Ranges	2kΩ, 20kΩ, 200kΩ, 2000kΩ, 20MΩ
Resolution in lowest range	0.1Ω
Accuracy	± (0.3% rdng+0.005% rng) for 2kΩ–2MΩ rng ± (1% rdng+0.005% rng) for 20MΩ range.
Maximum open circuit voltage	< 8V
Measuring current	1mA–2kΩ 100μA–20kΩ 10μA–200kΩ 1μA–2MΩ 100nA–20MΩ
Response time	2kΩ–2000kΩ rng: 0.5 sec with rng max. 0.7 sec 20MΩ rng: 2 sec with ranging max. 5 sec
Overload protection	$250V_{RMS}$ or $350V_p$
Temperature coefficient	±0.01% rdng/°C for 20kΩ–200kΩ ±0.025% rdng/°C for 2kΩ–2000kΩ–20MΩ

DC current

Ranges	2000mA
Resolution in lowest range	100μA
Accuracy	± (0.2% rdng+0.005% rng)
Response time	0.5 sec
Voltage drop	< 500mV
Overload protection	$250V_{RMS}$
Fuse protection	2.5A fuse
Temperature coefficient	0.01% rdng/°C

AC current

Ranges	2000mA
Resolution in lowest range	100μA
Accuracy	± (0.2% rdng+0.005% rng)
Response time	1 sec
Voltage drop	< 500mV
Overload protection	$250V_{RMS}$
Fuse protection	2.5A fuse
Temperature coefficient	0.01% rdng/°C
Freq. range	40Hz...1kHz

Temperature

Optional probe	PM 9248

HF Voltage

Optional probe	PM 9210

General

Type of input	Floating
ADC system	Integrating
Recalibration interval	90 days
Read rate	4 meas/sec
Overflow indication	.0....
Reference conditions	23°C±1°C
Limit range operating temperature	0°C–+45°C
Storage temp.	−40°C...+70°C
Relative humidity	20%–80%
Warming-up time	Approx. 15 min
Power supply	Mains: 220V–12%+10% transformer can be altered to 92V, 110V, 128V, 202V, 238V Battery: with optional rechargeable batt. unit PM 9216
Dimensions mm (w×h×d)	235×95×280 (9.2×3.7×11-in)
Weight	2kg (4.4lb)
Power consumption	15VA

Accessories supplied

Mains cable
Front cover
Set of test leads
Spare fuses
Oper. manual

Optional accessories

HF-probe	PM 9210 or PM 9213
HT-probe	PM 9246
Current shunt	PM 9244
Current transformer	PM 9245
Temp. probe	PM 9248
Battery pack	PM 9216
Carrying case	PM 9672
Rackmounting unit	PM 9669/01

IEC-625

True RMS autoranging digital multimeter PM 2526

V_{DC} accuracy ±(0.02% rdng+0.01%)

True RMS measurements; DC-coupled

Maximum reading 19999

Extremely fast autoranging

Parameter indication on display

Facilities for HF-voltage and temperature measurements

Wired for IEC-Bus interface and for parallel BCD output

This true RMS digital multimeter is designed for a wide application field and offers a very attractive price/performance ratio. Voltage (including HF), resistance and temperature measurements can be made with a very high accuracy. True RMS values are displayed for V_{AC} and V_{AC+DC} measurements. Manual or autoranging modes can be selected as required. In the autorange mode only an extremely short time is needed for displaying the measured value. Maximum reading is 1.9999.

The 11mm LED's are easily read and the parameter being measured is visually indicated. Automatic decimal point is another feature and range overshoot is indicated by a '.0...' display pattern.

The instrument is wired both for IEC-Bus operation and a parallel digital output card. All basic circuitry is grouped on to individual plug-in modules to ease servicing and the use of LOC-MOS ensures excellent reliability and a long life-expectation.

TECHNICAL SPECIFICATION

Model	PM 2526
Digits	$4\frac{1}{2}$
Display	1.9999
Type	LED
Range selection	Automatic and manual
Range limits	Up 1.9999 – Down 01800
DC Voltage	
Ranges	200mV, 2V, 20V, 200V, 1000V
Polarity	Automatic '+' and '−' sign
Resolution in lowest range	10μV
Accuracy	±(0.02% rdng+0.01% rng)
Input resistance	10MΩ ±0.2%
SMRR 50 and 60Hz ±0.1%	60dB
50 and 60Hz ±1%	40dB
CMRR for DC signals	120dB
for 50/60Hz ±1%	100dB
Maximum CM voltage	$450V_{RMS}$ or $630V_{pk}$
Response time	0.5 sec; with ranging 0.7 sec
Maximum input voltage	200mV, 2V rng: $1000V_{RMS}$ for 1 min/ $750V_{RMS}$ cont. 20V–1000V rng $1000V_{RMS}$ cont.
Temperature coefficient	±(0.005% of rdng/°C+ 0.0005% rng/°C)
AC Voltage	
AC to DC conversion	True RMS; V_{AC} and $V_{AC}+V_{DC}$
Ranges	20mV, 200mV, 2V, 20V, 200V, 600V
Resolution in lowest range	10μV
Frequency range	30Hz...100kHz
Accuracy	±(0.2% rdng+0.2% of rng) for DC component and 40Hz–30kHz ±(0.4% rdng+0.2% of rng) for 30Hz–40Hz and 30kHz–100kHz in 20mV range ±(0.3% rdg+0.2% of rng) for 30Hz–40Hz and 30kHz–100kHz in all other ranges

Input impedance	1MΩ/50pF
Response time	1.5 sec; with ranging max. 5 sec
Max. input voltage	$600V_{RMS}$ or $600V_{DC}$
Temperature coefficient	±0.01% rng/°C
Crest factor	2.4 at full scale
Min. meas. volt.	9% of range end value
Max. V Hz	10^7

Resistance

Ranges	200Ω, 2kΩ, 20kΩ, 200kΩ, 2000kΩ, 20MΩ
Resolution in lowest range	0.01Ω
Accuracy	± (0.05% rdng + 0.05% rng) for 200Ω rng. ± (0.05% rdng + 0.02% rng) for 2kΩ–20kΩ rng ± (0.05% rdng + 0.05% rng) for 200kΩ–20MΩ range
Maximum open circuit voltage	< 10V
Measuring current	10mA–200Ω 1mA–2kΩ 100µA–20kΩ 10µA–200kΩ 1µA–2MΩ 100nA–20MΩ
Response time	kΩ rng max. 0.5 sec with ranging max. 0.7 sec MΩ rng: max. 1.5 sec with rng. max. 5 sec
Overload protection	$250V_{RMS}$ or $350V_p$
Temperature coefficient	±0.01% rdng/°C for 200Ω–20kΩ ±0.02% rdng/°C for 200kΩ–20MΩ

Temperature

Optional probe	PM 9248
Optional temperature unit	PM 9257

Note: PM 9257 and PM 9256 can both be placed in one instrument.

HF Voltage

Optional probe	PM 9211
Optional HF unit	PM 9256

Data output

BCD parallel	PM 9232
IEC bus output	PM 9239

Note: Only one of these units can be placed in the instrument.

General

Type of input	Floating
ADC system	Integrating
Recalibration interval	90 days
Read rate	4 meas/sec
Overflow indication	.0....
Reference conditions	23°C±1°C; RH 45–75%
Limit range operating temperature	0°C–+50°C
Storage temp.	−40°C...+70°C
Relative humidity	20%–80%
Warming-up time	Approx. 30 min
Power supply	Mains: 220V–12%+10% transformer can be altered to 92V, 110V, 128V, 202V, 238V
Dimensions mm (w × h × d)	279 × 88 × 328 (11.7 × 3.5 × 13-in)
Weight	±4.1kg (9lb)
Power consumption	22VA

All instruments tested according to IEC 359 and IEC 348 prescriptions

Accessories supplied

Mains cable
Front cover
Set of test leads
Spare fuses
Oper. manual

Optional accessories

HF-probe	PM 9211
HF-plug in card	PM 9256
HT-probe	PM 9246
Current shunt	PM 9244
Temp. probe	PM 9248
Temp. plug-in card	PM 9257
Digital output (BCD)	PM 9232
IEC Busline output	PM 9239
Rackmounting unit	PM 9669/03

IEC-625

Digital RMS precision multifunction meter PM 2527

Wide voltage, current and resistance ranges with high accuracy and resolution

HF voltages or temperature measurement using optional probes and plug-in units

True RMS measurements

Extremely fast autoranging

Optional IEC-Bus line, digital (BCD) or analog outputs

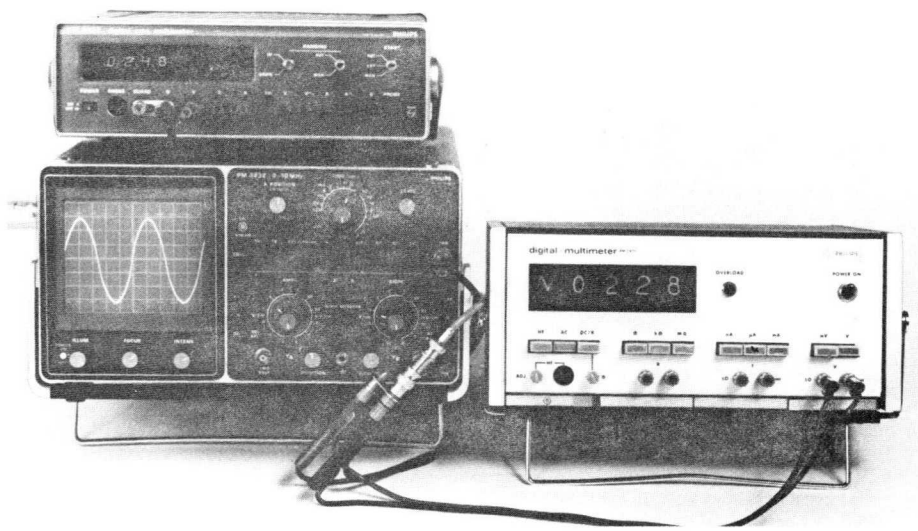
Double-guarding system

The PM 2527 is a high accuracy $4\frac{1}{2}$ digit instrument, having wide voltage, current and resistance ranges *plus* the facility to measure true RMS voltages, with a high, 10μV resolution. The desired parameter is push-button selected both for auto or manual operation and the V_{AC} frequency range extends to 100kHz. This can be further extended to 1GHz using an optional HF probe. The easy-to-read display shows the parameter being measured as well as its value. Overload conditions are indicated by a '.00..' reading.

For operation in automatic measuring systems an optional IEC-Bus compatible serial output module is available; also included in the optional accessories are a parallel BCD output and an analog output.

All conventional multimeters measure the average value and multiply it by 1.11 to arrive at the RMS value. This is no problem provided the measured waveform is a pure sinusoidal one, however, this method introduces considerable error if applied on non-sinusoidal waveforms. The PM 2527 has been specially designed to make true RMS measurements by means of a specially developed integrated circuit.
Fig. 1 shows, how an apparently pure sinusoidal waveform would be incorrectly measured on a conventional multimeter. The same measurement is also shown simultaneously on a PM 2527. It will be seen that the conventional method shows a reading of 2.28V. But the true RMS reading on the PM 2527 shows the correct figure of 2.48V. The difference is due to the fact that the apparently pure sine wave was in fact exhibiting a 6% distortion, introducing a considerable reading error when measured on a conventional instrument. The error becomes magnified by the square when the power level is calculated (V^2 is actually 6.15, but becomes 5.2 when derived from the conventional meter).

A special guarding system has been designed to give very high common mode rejection and protection against electromagnetic influences.



TECHNICAL SPECIFICATION

Model	PM 2527
Digits	$4\frac{1}{2}$
Display	1.9999
Type	LED
Range selection	Automatic and manual
Range limits	Up 1.9999 - Down 01800

DC Voltage

Ranges	200mV, 2V, 20V, 200V, 1000V
Polarity	Automatic '+' and '−' sign
Resolution in lowest range	10μV
Accuracy	±(0.02% rdng+0.02% rng)
Input resistance	10MΩ ±1%
SMRR 50 and 60Hz 0.1%	60dB
50 and 60Hz ±1%	40dB
CMRR for DC signals	140dB
for 50/60Hz ±1%	100dB
Maximum CM voltage	250 V_{RMS} between '0' and guard
Response time	0.5 sec; with ranging 1 sec.
Maximum input voltage	200mV, 2V rng; 1000V_{RMS} for 1 min/ 750V_{RMS} cont.
	20V–1000V rng: 1000V_{RMS} cont.
Temperature coefficient	0.005% of rdng/°C

AC voltage

AC to DC conversion	RMS; AC coupled
Ranges	20mV, 200mV, 2V, 20V, 200V, 600V
Resolution in lowest range	10μV
Frequency range	30Hz...100kHz
Accuracy	±(0.2% rdng+0.2% rng) for 30Hz–100kHz in ranges up to 2V and 30Hz–1kHz in 20V range and higher
	±(0.4% rdg ±0.2%) rng for 1kHz–100kHz in 20V range and higher
Input impedance	10MΩ/100pF
Response time	1.5 sec; with ranging max. 6 sec
Max. input voltage	600V_{RMS} or 1000V_{DC}
Temperature coefficient	±0.01% of rng/°C
Crest factor	2.4 at full scale
Min. meas. Volt.	9% of range end value
Max. V Hz	10^7

Resistance

Ranges	200Ω, 2kΩ, 20kΩ, 200kΩ, 2MΩ, 20MΩ, 200MΩ, 2000MΩ
Resolution in lowest range	0.01Ω
Accuracy	±(0.05% rdng+0.05% rng) – 200Ω
	±(0.05% rdng+0.02% rng) – 2kΩ–200kΩ
	±(0.1% rdng+0.05% rng) – 2MΩ–20MΩ
	±(0.3% rdng+0.2% rng) – 200MΩ
	±(1% rdng+0.5% rng) – 2000MΩ
Maximum open circuit voltage	<10V
Measuring current	10mA–200Ω
	1mA–2kΩ
	100μA–20kΩ
	10μA–200kΩ
	1μA–2MΩ
	250nA–20MΩ
	25nA–200MΩ
	2.5nA–2000MΩ

Response time	kΩ rng max. 0.5 sec with ranging max. 1 sec MΩ rng: max. 1.5 sec with ranging max. 5 sec (excl. 2000MΩ)
Overload protection	$250V_{RMS}$ or 350 V_p
Temperature coefficient	±0.01% rdng/°C for 0.2kΩ–20kΩ ±0.02% rdng/°C for 200kΩ–20MΩ ±0.05% rdng/°C for 200MΩ ±0.1% rdng/°C for 2000MΩ

DC current

Ranges	2μA, 20μA, 200μA, 2mA, 20mA, 200mA, 2000mA
Resolution in lowest range	100pA
Accuracy	±(0.1% rdng+0.05% rng)
Response time	0.5 sec; with ranging 1 sec
Voltage drop	<500mV in 2000mA rng <250mV in other rngs
Overload protection	$250V_{RMS}$
Fuse protection	3.15A fuse
Temperature coefficient	0.01% rdng/°C

AC current

Ranges	2μA, 20μA, 200μA, 2mA, 20mA, 200mA, 2000mA
Resolution in lowest range	1nA
Accuracy	±(0.3% rdng+0.2% rng)
Response time	1 sec; with ranging max 6 sec
Voltage drop	<500mV in 2000mA rng <250mV in other ranges
Overload protection	$250V_{RMS}$
Min. meas. current	9% of range end value
Fuse protection	3.15A fuse
Temperature coefficient	0.01% rdng/°C
Freq. range	30Hz...1kHz

Temperature

Optional probe	PM 9248
Optional temperature unit	PM 9257

Note: After adaptation for temperature measurements HF measurements cannot be made.

HF Voltage

Optional probe	PM 9211

Data output (optional)

BCD parallel	PM 9237
IEC bus output	PM 9238
Analog output	PM 9255

Note: Only one of these units can be placed in the instrument.

General

Type of input	Guarded
ADC system	Integrating
Recalibration interval	90 days
Read rate	3.3 meas/sec
Overflow indication	.00...
Reference conditions	23°C ±1°C; R.H. 45–75%
Limit range operating temperature	0°C–+50°C
Storage temperature	−40°C...+70°C
Relative humidity	20%–80%
Warming-up time	Approx. 30 min
Power supply	Mains: 220V–12% +10%; transformer can be altered to 92, 110, 128, 202 and 238V
Dimensions mm (w×h×d)	279×88×328 (11.7×3.5×13-in)
Weight	5.6kg (12.3lb)
Power consumption	30VA

All instruments tested according to IEC 359 and IEC 348 prescriptions

Accessories supplied

Shielded meas. cable
Mains cable
Front cover
Set of test leads
Spare fuses
Oper. manual
Interconn. strip

Optional accessories

HF-probe	PM 9211
HT-probe	PM 9246
Current shunt	PM 9244
Current transformer	PM 9245
Temp. probe	PM 9248
Temp. plug-in unit	PM 9257
Digital output (BCD)	PM 9237
IEC Busline output	PM 9238
Analog output	PM 9255
Rackmounting unit	PM 9669/03

Accuracy 1% of reading ±0.5% of fsd

Automatic polarity indication

Excellent AC and common mode rejection

Overload protected from 500V to 1.5kV

Recording output completely separated from input

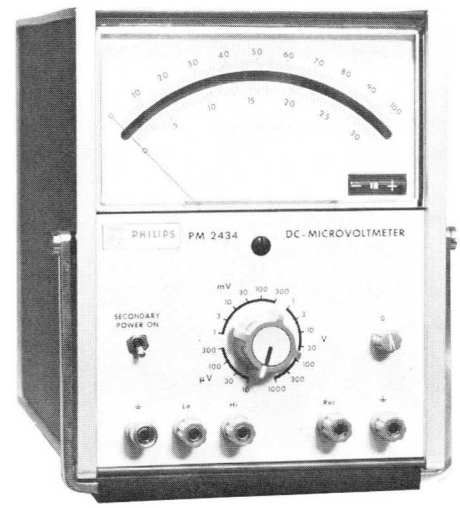
Optional re-chargeable battery unit

Tautband moving-coil meter

DC microvoltmeter PM 2434

This high-precision general purpose microvoltmeter is intended for laboratory or field use. The tautband moving-coil meter gives good, lifelong linearity without backlash and provides a display system that can be used vertically or horizontally without influencing the accuracy. The very stable electronic input circuitry gives a maximum sensitivity of 10μV fsd. The instrument features a high 100MΩ input resistance and excellent AC and common mode rejection.
The specified accuracy is maintained for hum signals of 40dB; even at 60dB over full scale, the error is less than 2%. Full overload protection is provided.

A socket is provided which gives 1V output for full scale deflection of the meter, for driving a chart recorder. Signal accuracy is 1%. The PM 2434 can also be used as a sensitive preamplifier; a 10μV input appears as a 1V output, giving a gain of 100000 max. Using an optional battery unit the instrument can be employed in field work, for up to 70 hours per charge.



TECHNICAL SPECIFICATION

DC-voltage

Ranges	10μV...1000V in 17 ranges
Polarity	'+' or '−' indication by extra meter
Sensitivity	1μV
Accuracy	1% of rdng ±0.5% of FSD for 100μV and higher 1% of rdng ±1% of FSD in the 10μV and 30μV range
Pre-deflection	< 5% in most sensitive range (10μV)
Input resistance	1MΩ ±2% up to 30mV 10MΩ ±3% at 100mV and 300mV 100MΩ from 1V to 1000V
CMRR	160dB at DC and 1kHz
Max. input voltage	500V from 10μV to 300mV; 1500V from 1V to 1000V 500V between low and ground
Temperature coefficient	< 0.08%/°C
AC-rejection	90dB at 50Hz

Output

Recorder output	1V at full scale deflection. Accuracy: approx 1% Output is separated from input and always grounded Output resistance: 1kΩ Risetime: 1s (0–90%) from 10mV range on; < 4s in 10μV range

General

Calibration	Calibration voltage of 1mV at the rear of the instrument; Accuracy 0.2% over 6 months
Temperature range	15°C...40°C; 0°C...15°C and 40°C...50°C with an extra tolerance of 1%; Drift: 0.2μV/°C at short circuited input
Power supply	Line supply: 115 or 230V ±15%; 50/60Hz Battery supply optional with PM 9204 rechargeable unit
Dimensions mm (w × h × d)	140 × 190 × 250
	(5.5 × 7.5 × 9.8-in)
Weight	3.5kg (7.7lb)

Accessories applied with instrument

Measuring leads
Mains cable
Manual

Optional accessories

Battery supply unit	PM 9204
HF-probe	PM 9210 or PM 9213
30A-shunt	PM 9244
HT-probe	PM 9246

Wide bandwidth AC millivoltmeter PM 2554

Sensitivity 1mV (fsd) to 300V
Bandwidth 2Hz-12MHz
High accuracy up to 1% fsd ±1% of reading
140dB CMRR at 50Hz (1mV range)
DC recorder output or AC output

PM 2554 combines good accuracy with an extremely wide bandwidth (12MHz) and voltage range (100μV–300V). It is therefore ideal for all measurements from audio frequencies to the HF and beyond. All ranges are protected from overloads of up to $300V_{RMS}$ ($400V_{DC}$). Mains voltage variations of ±10% give no more than 0.1% change in accuracy.

TECHNICAL SPECIFICATION

Measuring ranges
0–$300V_{RMS}$ in 12 ranges from 0–1mV to 0–300V
dB scale ranging from −80dB to +52dB (0dB = 1mV into 600Ω)

Frequency range
2Hz–12MHz

Input
Floating
Input impedance 1MΩ//33pF
Max. voltage low-ground $500V_{peak}$
Impedance low-ground 1GΩ/1.4nF
For reduction or capacitive loading, PM 2554 can be used with PM 9336 Oscilloscope Probe, input impedance 10MΩ//11pF
Common mode rejection 140dB at 1kHz in 1mV range
120dB at 100kHz in 1mV range.

Accuracy
1% f.s.d. +1% of reading
Additional error for frequencies outside flat part of bandwidth – see graph.

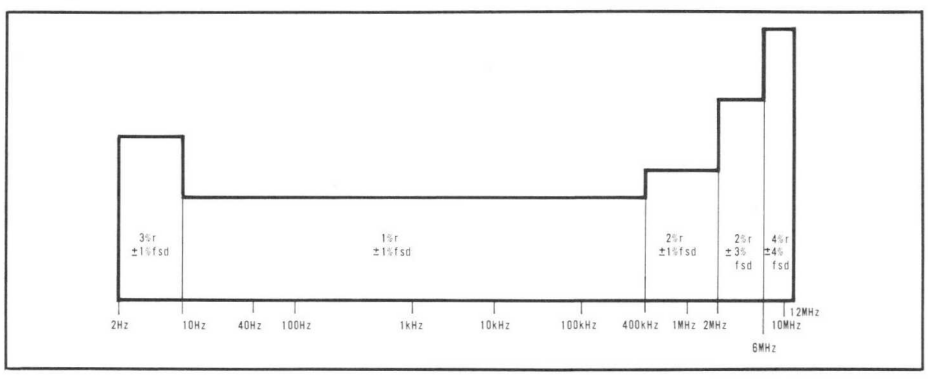
Stability
A line voltage variation of ±10% will give an additional error of 0.1% max.
Long term stability ±0.1% over 90 days

Noise
At short-circuited input < 30μV.
Influence of noise on measuring accuracy less than 0.5% at 10% of full scale deflection

Overload
Protected against overloads up to $300V_{RMS}$ or $400V_{DC}$

Measuring system
Measurement: average value
Reading: RMS value for pure sine wave

Recorder output
DC voltage: 1V at full scale
Output impedance 1kΩ
Accuracy as specified for voltmeter



AC output
Output impedance 600Ω in serial with 47μF
Output voltage 50mV short-circuit proof

Supply
Mains: 90V...132V or
180V...265V
50/60Hz

Temperature range
Accuracy guaranteed for 23°C ±5°C ambient
Temperature dependence 0.1%/°C, 0–45°C

Dimensions and weight
(w × h × d) 236 × 145 × 298mm
(9.3 × 5.7 × 11.7-in)
3.5kg (7.7lb.)

ACCESSORIES

Supplied with instrument
Mains Connection Cable
Measuring cable
Manual

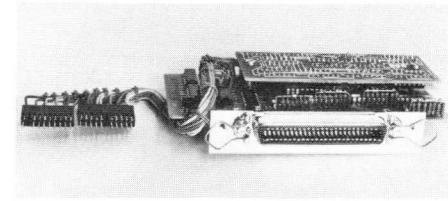
Optional
PM 9072 Measuring cable Banana–BN 135Ω
PM 8925 Passive probe 10:1
PM 9051 Adapter BNC–Banana
PM 9064 Adapter BNC–GR
PM 9062 Adapter BNC–N

Multimeter Accessories

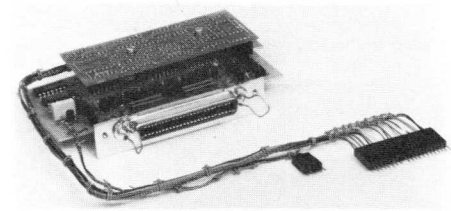
● Included in delivery
○ Optional

			PM 2412A	PM 2434	PM 2441	PM 2503	PM 2504	PM 2505	PM 2517	PM 2522	PM 2522A	PM 2523	PM 2524	PM 2526	PM 2527	PM 2554
Measurements cables	PM 9071	Banana-Banana 135		○		○	○		○	○	○	○	○	○	○	
	PM 9072	Banana-BNC 135		○		○	○		○	○	○	○	○	○	○	○
	PM 9074	BNC-BNC 50														○
Adapters	PM 9051	Adapter BNC-Banana														○
	PM 9061	Adapter BNC-BNC														○
	PM 9062	Adapter BNC-N														○
	PM 9063	Adapter N-BNC														○
	PM 9064	Adapter BNC-GR														○
	PM 9065	Adapter GR-BNC														○
	PM 9067	T-piece BNC														○
Test leads	PM 9260	Pair of testleads	●	●		●	●	●	●	●	●	●	●	●	●	
	5322 321 24116	3 pole testlead			●											
	5322 321 24168	measuring cable														●
Probes	PM 8925	10 : 1 passive probe														○
	PM 9263	Hold probe							○		○					
HF accessories	PM 9256	HF unit												○		
	PM 9210	HF probe		○		○	○	○	○	○	○	○	○			
	PM 9211	HF probe set (linear)												○	○	
	PM 9212	Accessory set for PM 9210		○		○	○	○	○	○	○	○	○			
	PM 9213	Low cost HF probe		○		○	○	○	○	○	○	○	○			
H.T. probe	PM 9246	30kV probe	○	○		○	○	○	○	○	○	○	○	○	○	
Temp. probes	PM 9248	Temp. probe −60 ... +200°C							○		○		○	○	○	
	PM 9257	Temp. option												○	○	
Current accessories	PM 9244	30 A shunt		○	○	○		○	○	○	○	○	○	○	○	○
	PM 9245	100 A transformer	○			○	○	○	○	○	○		○		○	
Supply units	PM 9204	Rechargeable batt. unit		○												
	PM 9216	Rechargeable batt. unit								○	○	○	○			
Mains supplies	PM 9218	Mains supply unit					○		○							
Ever-ready cases	PM 9273	Ever-ready case	○			○										
	PM 9276	Protection ring				○										
	PM 9672	Carrying case								○	○	○	○			
	PM 9278	Ever ready case						○	○							
Rack mount	PM 9669/01	Rack mount unit								○	○	○	○			
	PM 9669/03	Rack mount unit												○	○	
	PM 9706	Rack mount cabinet			○											
	PM 9722	Blank panel			○											
Parallel outputs	PM 9230	Remote control input			○											
	PM 9231	BCD output			○											
	PM 9232	BCD output												○		
	PM 9237	BCD output													○	
Serial outputs	PM 9238	Bus-line interface													○	
	PM 9239	Bus-line interface												○		
	PM 9280	Bus-line cable												○	○	
	PM 9282	Bus-line cable												○	○	
	PM 9284	Bus-line interface			○											
Analog outputs	PM 9255	Analog output													○	
Mains cables	PM 9011	Mains cable Europe		●	●					●	●	●	●	●	●	
	PM 9016	Mains cable U.S.A.		○	○					○	○	○	○	○	○	
	5322 321 14001	Mains cable Eur														●

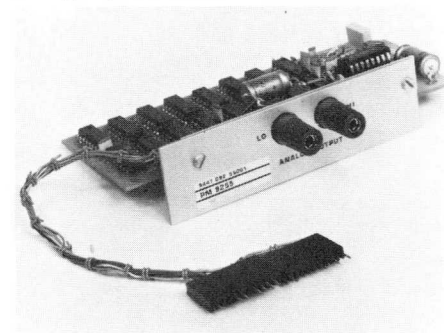
BCD output PM 9237



BCD output PM 9232



Analog output PM 9255



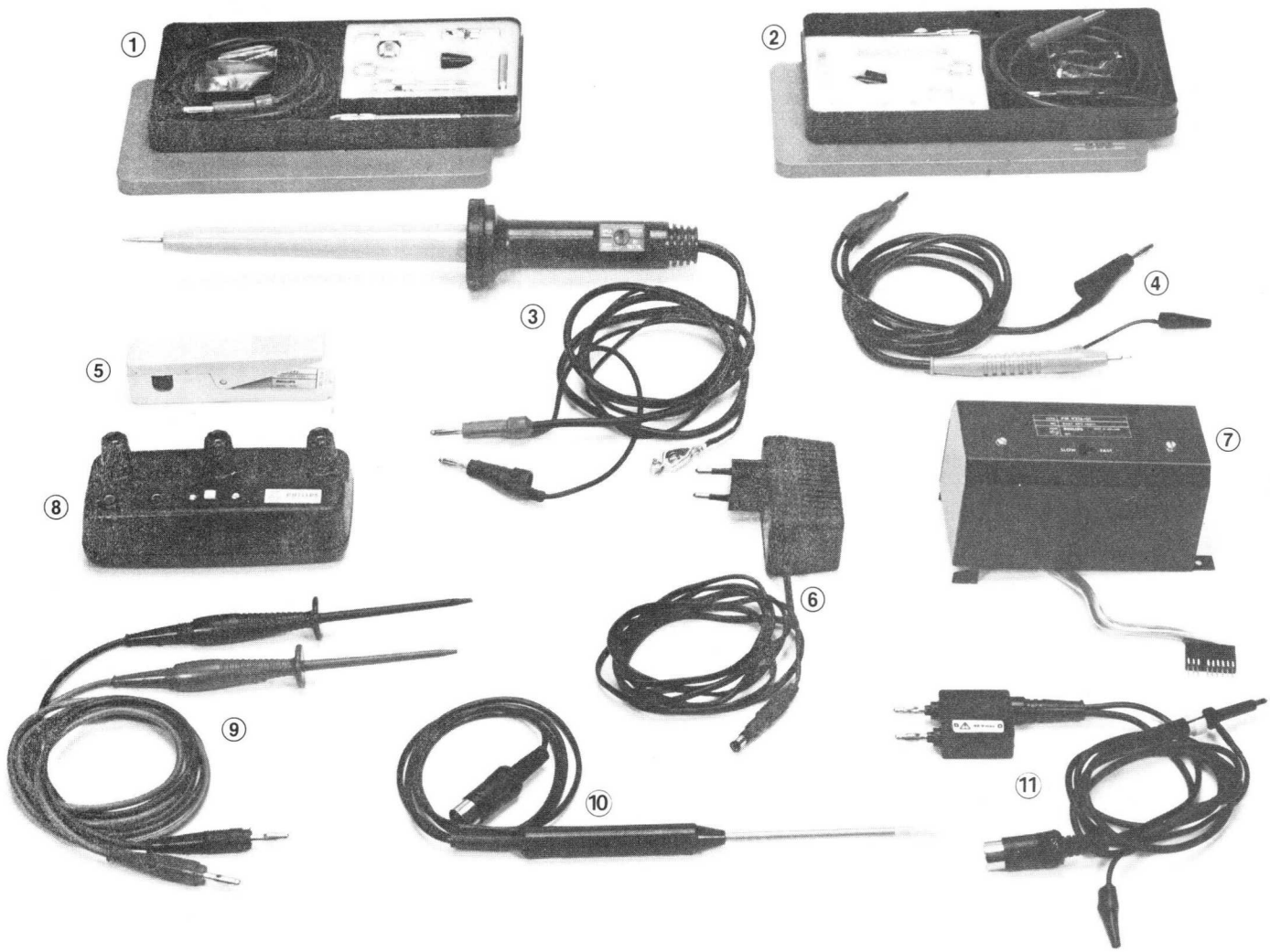
Basic technical specifications for optional outputs

BCD Parallel outputs PM 9231 + PM 9232 + PM 9237	IEC Bus outputs PM 9238 and PM 9239	Analog output PM 9255	Temperature probe PM 9248
Output syst.: word par. bit par. Output code. pos. BCD Zero level 0...0.4V One level +5V or if ext. supplied and switched by int. jumper +15V Isink: 5mA; output R: 82Ω	In-/output system Bit parallel-char. serial. In-/output code. 150-7 bit code 150 646 (similar to asc. II) In-/output levels L = −0.5V... +0.8V H = +2V... +5.5V Logic levels for D 10-lines L = 1 H = 0 According IEC-Bus, TC 66.	Output Imp. 200 Ω Response time < 500msec Linearity 0.3% Resolution 0.05% Temp. coeff. 0.5%/°C Output voltage 2V (end of rng).	Range: −60°C−+200°C Resolution: 0.1°C Accuracy: −60°C−+100°C ± (1% rdg ±2°C) +100°C... +200°C +1%... −3% rdg ±2°C

Technical specifications for PM 9210, PM 9211, PM 9212 and PM 9213

	PM 9211	PM 9211 + att.	PM 9210	PM 9210 + PM 9212	PM 9213
Frequency range	100kHz–1GHz	100kHz–1GHz	100kHz–1GHz	100kHz–1GHz	10kHz–100MHz
Straight line within 5%	100kHz–6MHz	100kHz–6MHz	100kHz–6MHz	100kHz–6MHz	30kHz–30MHz
Max. deviation	3dB	3.5dB	3dB	3.5dB	3dB
Voltage ranges (f.s.)	2mV–2V	2V–200V	*150mV–15V	15V–200V	10mV–15V
Max. voltage AC	30V	200V	30V	200V	30V
Max. voltage DC	200V	500V	200V	500V	350V
Input capacitance	2pF	2pF	2pF	2pF	40pF
T-piece	Included in delivery		Optional in PM 9212		Not available
Frequency range	100kHz–1.2GHz			100kHz–1.2GHz	
Impedance	50 Ω			50 Ω	
Standing wave ratio	1.25 at 700MHz	1.15 at 1GHz		1.25 at 700MHz With attenuator 1.15 at 1GHz	

* using calibration chart below 150mV



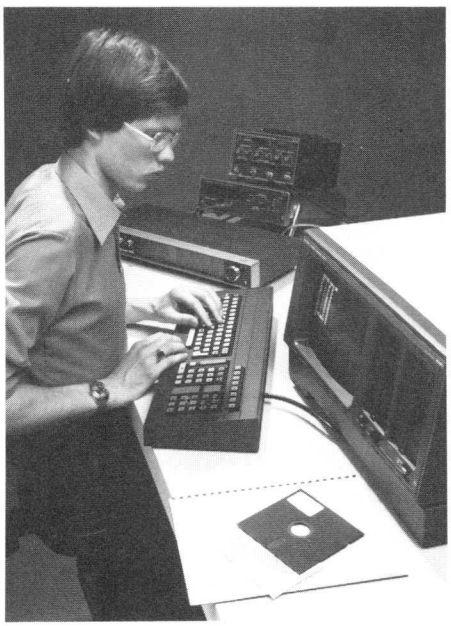
① **HF probe PM 9211.** Provides instruments with an increased frequency range of 100kHz to 700MHz for measuring voltages between 2mV and 2V.
② **HF probe PM 9210.** Provides instruments with increased frequency range of 100kHz to 700MHz for measuring voltages between 150mV and 15V.
③ **HT probe PM 9246.** Allows measurement of DC-voltage up to 30kV.
④ **HF probe PM 9213.**
⑤ **Current transformer PM 9245.** Extends the AC current ranges to 100A.
⑥ **Battery eliminator PM 9218.** Provides mains operation for the PM 2504, PM 2517.
⑦ **Rechargeable battery supply PM 9216,** for the PM 2522, PM 2523, PM 2522A and PM 2524. Plugs into a cavity at the rear of the instrument and provides 8h mains-independent operation.
⑧ **Current shunt PM 9244.** Extends the AC/DC current ranges to 31.6A.
⑨ **Test leads and test pins PM 9260.** Highly flexible (512 wires). Silicone rubber insulation for temperatures between −100°C and +300°C. Test voltage 4kV; specified for 1kV.
⑩ **Temperature probe PM 9248** for temperature measurements between −60°C and +200°C.
⑪ **Data hold probe PM 9263.**

Automatic test and measuring

Introduction

The need for automation

Skilled labour and the making available of information in the right form at the right place and time form a major part of todays high cost factors in all aspects of modern society, be they industrial, educational, medical, scientific or commercial. Automation in its many and varied forms can provide an answer by undertaking extremely high work volumes in very short times. But frequently the sophisticated systems required can be costly to install, operate and maintain and are only useable by specialists. Thus, the initial advantages are minimized by new constraints in the form of high capital costs, high salaries, restriction of use by experts only, due to technical complexities.



What is really needed?

Obviously, a need has developed for automated systems which do *not* introduce such problems. Systems which can be used by a wide cross-section of any semi-skilled work force without specialist knowledge and *certainly* without computer knowledge. These systems should be compact, versatile, reliable, relatively inexpensive when compared with their costly counterparts, yet capable of undertaking a wide variety of functions.
Such devices will immediately be of wide general interest, either in continuous (dedicated) operation, unchanging routines or in new or rapidly changing situations. Which demands that they must be speedily adaptable to any new role, without loss of time or extra financial investment.

Philips has the answer

The Philips programme of automation systems meets these requirements precisely. Advantages include simplicity of operation, compact styling, considerable versatility and expandability. There is also an in-built compatability allowing any system to be latterly integrated into other computer-based operations, should this become necessary at some future date. Thus, capital expended is not only of a significantly lower order, but is never wasted.

The basic family of systems is designed around the PM 4000 compact data logger and the PM 4400 compact computer system. These systems are desk-mounted and occupy minimal space. The basic easy-to-use units can be operated simply and can be used in conjunction with several other complementary units to cope with a wide variety of tasks.

No programming knowledge necessary

Fully interactive keyboard/display input

Rejects incomplete or impossible instructions

Full linearization of TC inputs

Internal cold junction compensation

Optional interfaces for peripherals, IEC-bus

100-hour batteries for memory and internal clock back-up

IEC-625

Compact data logger PM 4000

No technical or programming knowledge is required to operate the PM 4000 datalogger. Input is by a keyboard/display conversation in everyday language. The logical sequence of the programme is clearly and progressively indicated on the display until the logger is ready to go 'on-line'. Impossible or incomplete instructions will not be accepted so that the process cannot start without correct loading of the memory.

Used programs can be included in a library by means of the dump-in/dump-out facility which transfers a complete program on to a tape cassette in seconds.

The basic mainframe will accommodate up to 50 channels and the logger capacity can be extended up to a maximum of 950 channels using add-on/satellites (PM 4010) holding up to 100 channels each. Inputs are fully protected against common-mode and noise effects allowing the system to maintain a very high resolution and accuracy for all measurements. High/low alarm monitoring is possible on all channels and operates a panel warning lamp and contact closure for triggering other alarm systems if required. Measurements can be taken at speeds from 4 to 30 channels per second; up to 100 channels per second for digital inputs.

Inputs include:
- DC voltages: 40mV, 400mV and 4V full scale
- DC currents: 0...20mA, 4...20mA, 0...5mA and 4...50mA
- Thermocouples: Types J, K, T, E, R, S and B; results are in °C
- Pt100 resistance thermometers; results in °C
- Transducers: most normal types, results in %
- Digital: Status signals, binary and BCD
- Strain gauge (1/4, 1/2 and full bridge)

Thermocouple and Pt100 inputs are linearized by the logger and cold junctions of thermocouples can be connected to an isothermal input block. Where the thermocouple is a long distance from the datalogger, a compensation cable is used for the interconnection: up to four different external reference junctions allow four groups of cold junction temperatures to be programmed.

A 5-way security check indicates any human error or hardware failure. Memory is retained for up to 100 hours by battery, during transportation, or in the event of the AC line failure.

It is possible to operate the PM 4000 by remote control via its two I/O interfaces. The whole program or memory content can be checked if required and printed out via the internal printer. In this mode it is also possible, for example, to select a monitor channel, which gives a single-step scan back via the interface. The appropriate commands are given by a peripheral or computer, via the I/O interfaces.

The PM 4000 can be used in simple, stand-alone automated set-ups, in conjunction with a mini-computer, or as part of a large, complex system employing mini-computer control plus a large number of peripherals. A typical application described on P 134.

SPECIFICATIONS

Datalogger main frame includes:
Cabinet
Key-board
Fluorescent-display
Strip-printer
Power Supply
2K RAM
Printer control
Clock
Analogue Sub-system control

Physical
Table top and rack mount
High 3E, width 19-in, depth 53.5cm
220V ±10%, 50–60Hz ±5%
Operating temperature: +5 to +40°C
Storing: −40 to +70°C (excl. battery)
IEC 348 and VDE 0871 standards > 100 hours rechargeable, NiCd battery back-up
Weight: ca. 13kg

SOFTWARE

PM 9490 Standard software package (incl. CPU and 8K prom)
DC voltages in 4 ranges; 40mV, 400mV, 4V, and 40V
DC currents in 4 ranges; 0–20mA, 4–20mA, 0–50mA, and 10–50mA
Temperatures via thermocouples and/or resistor thermometers (outputs in °C)
Outputs from voltage/current producing transducers
Resistance measurements

PM 9491 Extended software package (incl. CPU and 11K prom)
As Standard software package PM 9490 plus:
Digital input possibility in 3 modes: BCD, binary and status signals
Additional engineering unit outputs (up to 63 types)

PM 9492 All purpose software package (incl. CPU and 14K prom)
As extended software package PM 9491 plus: complete power supply facilities and measuring system for strain gauges and transducers based on strain gauges connected as 1/4, 1/2 and full bridge 4mV DC Voltage range.

AVAILABLE OPTIONS

PM 4010 Scanner extension unit
Includes: cabinet, power supply, analog subsystem control and cable driver

PM 9410 General purpose ADC
Sampling rate: 16 measurements/sec maximum
Measurement: Dual slope (PLL)
Full scale capability: 4096 points
Ranges/resolution:
4V/1mV
400mV/100μV
40mV/10μV

PM 9411 High performance ADC
Sampling rate: 30 measurements/sec maximum without inversion of bridge supply
15 measurements/sec maximum with inversion of bridge supply
Measurement: Dual slope method (PLL)
Dynamic range: 4096 points
Ranges/resolution:
4mV/1μV
40mV/10μV
400mV/100μV
4V/1mV

PM 9412 High resolution ADC
Sampling rate: 4 measurements/sec maximum
Measurement: Dual slope (PLL)
Dynamic range: 16.384 points
Ranges/resolution:
4V/250μV
400mV/25μV
40mV/2.5μV

PM 9414 Scanner card for Pt 100
Input channels: 8 with 4 contacts per channel

PM 9415 Analog general purpose scanner
Input channels: 10
Poles per channel: 2+guard

PM 9416 Digital input card
50 pole amphenol input connector type 57–50
3 INPUT MODES:
STATUS SIGNALS
Number of lines: 40 with common return
Logic: short circuit=0, open circuit=1
Energising voltage: 5 or 12V
Overload immunity: ±50V, channel to common
BCD SIGNALS
2 operating modes +4 status signals may be used in parallel
A. Dynamic
2×4 digit sources:
Each source is independent of the other
Number of lines: 2×16 plus common return
Maximum value of each source: 9999
1×9 digit source:
Number of lines: 36+common return
Maximum value: A 9 digit input of 999999999 may be displayed.
B. Static
1×9 digit source
Number of lines: 36+common return
Maximum value
A 9 digit of 999999999 may be displayed
BINARY INPUTS
2 input modes +4 status signals, may be used in parallel
A. 14 bit+sign-bit
B. 15 bit in two's compliment representation
Number of lines: 36+common return

PM 9417 Analog high resolution scanner
Input channels: 10
Poles per channel: 2+guard

PM 9418 Half and full bridge scanner
Input channel: 5
Poles per channel 6+guard

PM 9419 Quarter bridge scanner
Input channels: 10+dummy
Poles per channel: 2 (+5 for common dummy per card)

PM 9420 DC-voltage input block
Input channels: 10
Terminals per channel: 2+guard
Kind of terminals: screw
Connectable to: PM 9417, PM 9415
DC currents are measured with shunt resistors supplied

PM 9421 Input block for Pt 100
Intput channels: 8
Terminals per channel: 4
Kind of terminals: screw
Connectable to: PM 9414

PM 9422 Isothermal input block
Input channels: 10
Terminals per channel: 2+guard
Kind of terminals: screw

PM 9423 40V input block
Input channels: 10
Terminals per channel: 2
Kind of terminal: screw
Connectable to: PM 9415, PM 9417

PM 9428 Half and full bridge input block
Input channels: 5
Terminals per channel: 6+guard
Kind of terminals: screw
Connectable to PM 9418

PM 9429 Quarter bridge input block
Input channels: 10+common dummy
Terminals per channel: 2 (+5 for common dummy per card)
Connectable to PM 9419

PM 9450 IEC-Bus Interface
Operating modes: Listen only; talk only, addressable listener, talker with SRQ
Data transfer: BYTE serial, BIT parallel
Interface: handshake interface in accordance with DIN–IEC 66.22
To be applied with cables
PM 9480 1 meter
PM 9481 2 meters
PM 9482 4 meters
or PM 9483 IEC–IEEE adapter cable

PM 9453 FACIT Interface
8 bit parallel byte serial with handshake
To be used for:
FACIT 4070 Paper-tape punch or Data dynamics 1133
Connector: 15 pole, Philips series F 161.

PM 9456 Serial interface
Operation mode: transmitter, receiver, active or passive selectable
Data transfer: BYTE-serial/bit serial
Charater length: ISO-7 bit code/ASC II
7 data bit
1 parity bit (even)
1 start bit
1 stop bit (which can be switched to 2 stop bits)
Interface: current loop, fully duplex
Line current: 20mA
Data transfer speed: 110 Baud can be switched to 135.5; 150; 200; 300; 600; 1200; 1800; 2400; 4800; 9600 Baud)
Connection: 9-pole
type: Philips serie F 161
To be used for: Teletype ASR 33
Texas Instruments silent 700
Minicomputer

PM 9460 Alarm relay card
2 relays (24V, 6A)

PM 9470 Memory extension 292 channels
(for use with standard software package PM 9490)

PM 9471 Cable drive card
For interconnection of extension unit
PM 4010 to mainframe PM 4000
(digital transmission)

IEC-625

Data logging systems

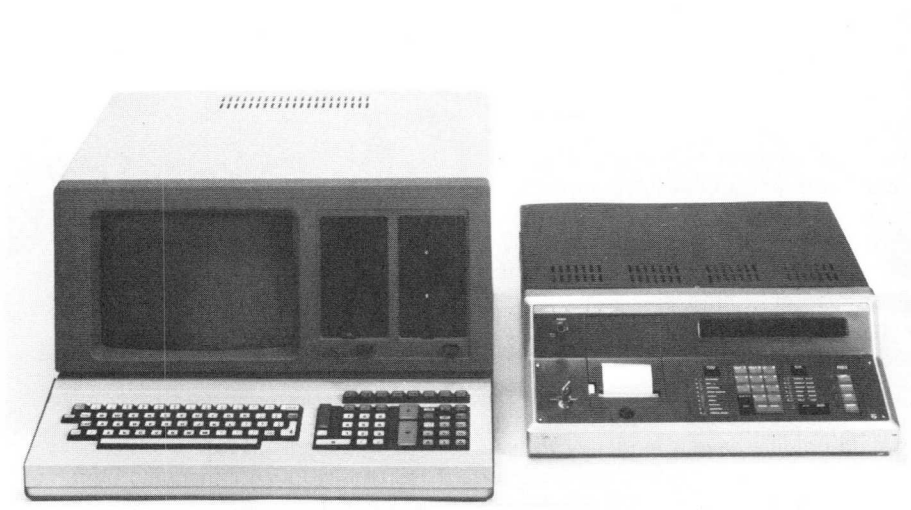
Data acquisition systems operate either in an active or passive mode. The PM 4000 operating in a stand-alone function can be generally regarded as taking the passive role, as a straight-forward data logger. However, it is also designed for participation within an active system. In the combination of the PM 4000 and PM 4400 shown, the PM 4000 is operating as an ordinary IEC-bus instrument, coupled to the IEC-bus controller.

This set-up could be used for example, in an automated chemical, pharmaceutical or general manufacturing plant. Any type of computer supporting a serial or IEC-bus compatible interface can be used to control and accept data from the PM 4000.

It is important to emphasize the facilities offered by the 'Remote control' command set on the PM 4000, which are as follows:

- keyboard functions are available as remote commands
- the built-in strip printer on the PM 4000 can be used to print out **any form of data** coming from the serial or IEC-bus interfaces.
- The complete parameter memory content can be overwritten very quickly by another version of the parameter program, previously stored within the controlling computer.

The major advantage of using the PM 4000 in an active role is that its output data is 'clean', fully compensated where necessary and expressed in everyday engineering units. All these tasks are performed independently of the computer and do not occupy any of its valuable memory space or time.

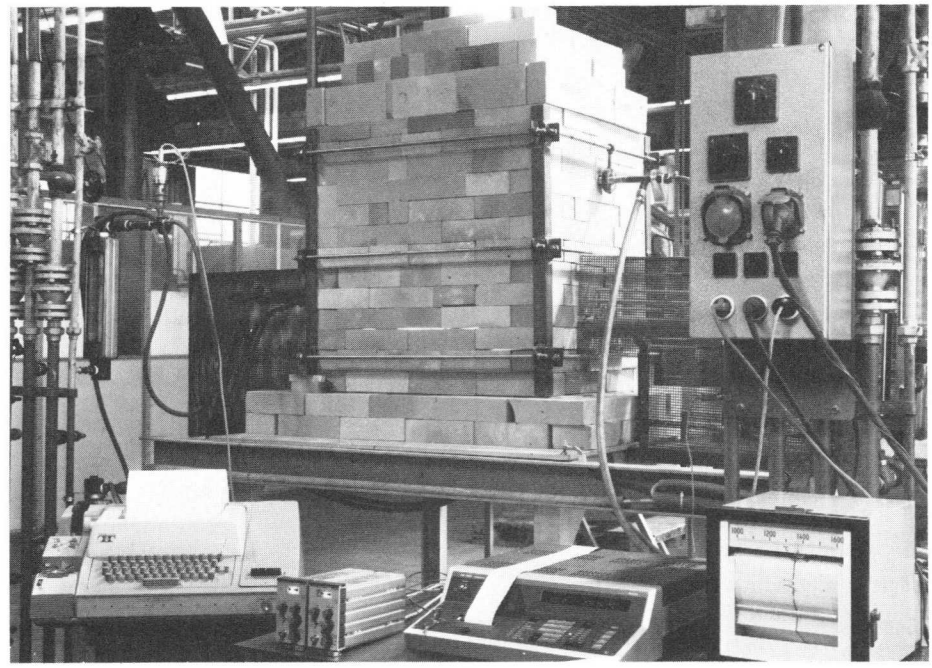


PM 4000 Data logger operating in conjunction with PM 4400 IEC-bus controller.

PM 4000 data logger operating in conjunction with a Philips P 800 series minicomputer.

IEC-625

Data logging applications



Oven temperature logging

The Central Development Laboratory of a leading glass manufacturer uses a PM 4000 to monitor the operating conditions in and around a small furnace. The laboratory works closely with research and production departments to improve the quality and raise the efficiency of the glass making process. Over 300 types of glass pass through the laboratory for testing and analysis in a normal operating week.

A current project is to develop an improved water-cooled holder for the electrodes of an electric furnace.

Existing holders have a tendency to leak due to the extremes in temperature over a small area, causing serious production problems.

The furnace shown in the photograph is scaled-down from a production version, and is subjected to similar temperatures, pressures and stresses etc. Initially the furnace is gas fired. When the glass becomes molten, heavy current is passed through it via the molybdenum electrodes. Element holders are of two-piece construction with high-pressure water cooling. A combination of thermocouples, pressure transducers and transformers enable the PM 4000 to log 16 channels of data.

The following parameters are measured:

Furnace temperatures around 1400°C in six zones using S-type thermocouples of Platinum and Rhodium connected to an isothermal input block.

Cooling water temperature of between 15–30°C entering and leaving element holders and ambient using K type thermocouples and isothermal input block.

Cooling water pressure via resistive strain-gauge pressure transducers and separate amplifiers, typical pressure 2.5/3 atmospheres.

Both heating element currents of about 150A, reduced to 5mA by a transformer.

Both heating element voltages of about 100V, reduced to 5mA.

Total energy in VA consumed by furnace and converted to 5mA by 3-winding transformer.

Conductance (MHO) of molten glass using own developed measuring method.

A secondary objective of the project is to study the conductance of molten glass to develop a heating method by passing a current directly through the glass. This process offers many benefits including low leakage and higher energy conversion factors. This application has also given considerable experience to the development staff in applying modern data-logging techniques to a traditional manufacturing process.

Frequent temperature measurement from the six thermocouples would be very difficult with a single operator and the additional checks on water pressures and temperatures would have been impossible. All channels are now automatically scanned every 30 minutes except when an alarm condition is reached. Scan times are then at 5 minute intervals with the monitor channel being used to show the highest temperature continuously.

Measurements are taken from the logger via the serial interface to an ASR 33 teletype, via the parallel interface to a Facit high speed punch and the alarm relay enables both audible and visual signals to be given, as the furnace and data logging system are now unmaned, except for removal of data. Results may be seen as a continuously record on the logger's internal printer or in three-column form on the teletype. Tape is used for comparison with previous results taken and stored in an off-line computer.

Checking the efficiency of an experimental central heating system

This application is for a new type of domestic central heating system.

A PM 4000 compact data logger monitors air temperatures in 30 different locations, water inlet and outlet temperatures and pulse counter outputs from the gas and electricity supply meters. Data is recorded both on the built-in printer and on magnetic tape for processing by computer.

A combination of measuring programs enables parameters to monitored on:

- a continuous basis
- at 5 minute intervals
- at 24 hour intervals
- at weekly intervals

The outcome of this particular experiment will allow direct comparison between the efficiency of conventional domestic central heating using a gas-fired boiler with that of a system employing a stirling engine driving a heat pump.

IEC-625

IEC-bus controller PM 4400

Based on PM 4400 compact computer

IEC-bus interface and 'Instrumental' BASIC

High computing power

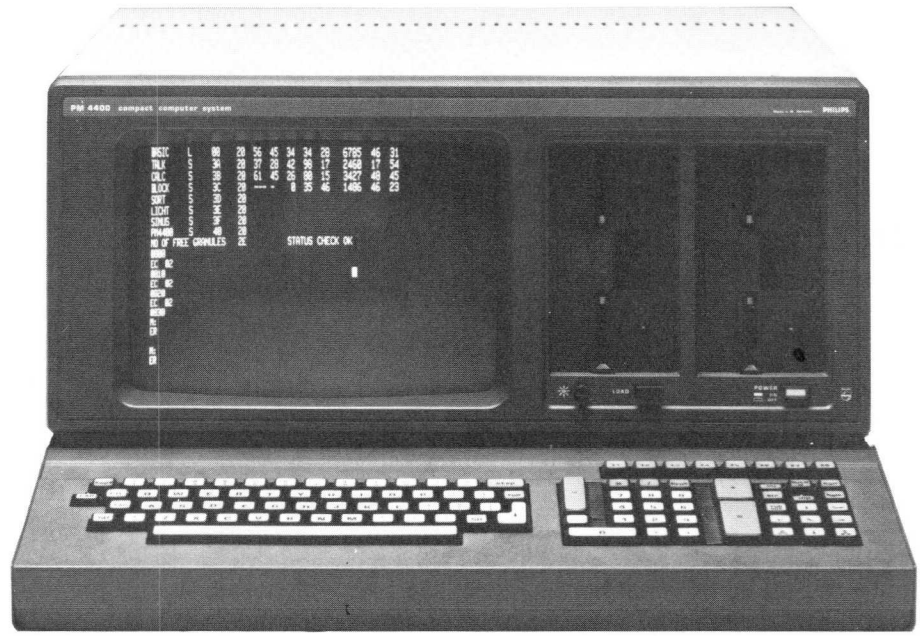
Computer experience unnecessary

12-in video display

Mini-floppy disk memory

Compatible with P800 Philips minicomputer range

Contained in compact desk unit



The PM 4400 IEC-bus controller is part of the family of products based on the PM 4400 compact computer system. The basic facilities of the PM 4400 are first described, followed by data and applications of the IEC-bus controller.

PM 4400 compact computer system

The PM 4400 compact computer system has been designed to provide considerable, low-cost computing power, without extensive hardware or operational complexity. Its extreme versatility allows it to be used for a very wide range of applications within industry, engineering and science.

Operation is extremely simple, extending its use to personnel other than those having specialized computer knowledge. This fact further extends the range of applications.

Easy to program

Simple programming, due to the conversational-style BASIC language makes it possible to start work quickly. Program steps are entered as simple statements which are easy to understand and check. An instructional program is available to let new users teach themselves how to start programming in BASIC.

Because PM 4400 is based on well-proved Philips P 851 mini-computer technology, all the special programs that users may develop for their own applications are compatible with P 800 mini-computers in the Philips range. So, any investment in time and manpower is protected if it is ultimately required to move up to a bigger system and existing programs can still be used.

For the first-time user, a PM 4400 system is the optimum entry level. It offers real computing power and versatility for a moderate cost. Its simplicity allows existing manual tasks to be converted quickly and efficiently.

For the experienced user, PM 4400 can form a valuable and powerful addition to an existing large computer system – for example for data aquisition and pre-processing.

Easy to use

The PM 4400 system makes computing simple. It is very convenient and easy to use because all necessary functions are integrated into a single low-cost desktop computing facility. Keyboards, video display and compact 'mini-floppy disk' memory units for data and programs are all built into a single neat, well-designed unit. Everything is correctly located for efficient operation.

Working alone, the PM 4400 is an easy-to-use calculator. Using the standard IEC-bus interconnection facility, it's a programmable controller for automatic operation of instruments and test equipment. Application programs are used to carry out engineering and design analysis functions. And for scientific and industrial administration, it can take care of tasks like documentation, project control and analysis.

Integrated functions for convenience and simplicity

Because the PM 4400 is a unique, fully integrated compact computer it has all the facilities needed to start work directly, without having to connect it to additional units.

Keyboard facilities include a calculator-format panel for quick and convenient arithmetical entries. 16 user definable functions can be selected at the touch of a key. And the specific keyboard area for BASIC control functions greatly simplifies the entry of program steps and instructions. Fast-access memory with high capacity for data and programs is provided by the new mini-floppy disk units. Disks are very low-cost and instantly interchangeable allowing quick transfer of programs – written by the user and stored on disk – for other applications or operating modes. PM 4400's versatility means the ability to be connected directly to many different types and brands of peripheral units, instruments and test equipment – both for automatic operation under program control, and for data acquisition, processing and storage. This facility is provided by the standard IEC-bus interface, to provide simple, plug-in connections.

A real-time clock is included to provide interval time facilities, such as date/time and to prevent the system from 'hanging-into' a faulty device.

A fast hard-copy printer PM 4490 is available as an option, which will give a printout of the screen display, the program in use, or of output data – all on normal paper. Also available is an intelligent digital plotter PM 8151 to present measurement results graphically.

Many applications

Examples of the many applications of the PM 4400 include measurement and adjustment, data acquisition and operation as a stand-alone calculator.

These particular examples can all be performed using an integrated system which is a combination of

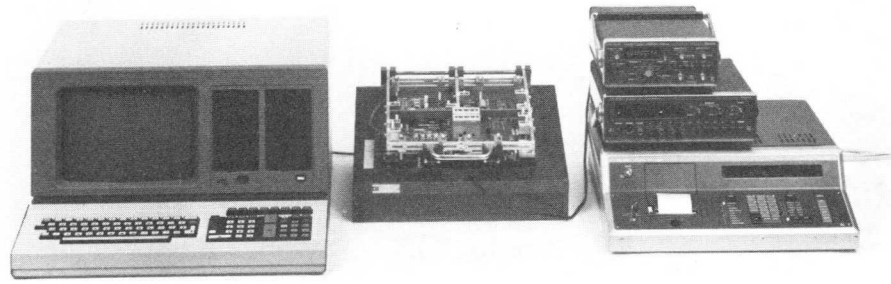
– PM 4400 compact computer
– IEC-bus interface
– Appropriate system software

This ready-to-use system exists as an integrated package and is designated PM 4400 (IEC-bus controller).

The following examples are all based on the use of the PM 4400.

Measurement and adjustment with PM 4400

Adjustment/calibration of measuring instruments or other electronic equipment at final production stage to replace manual measuring and adjustment. Multitesting facility means many interdependent adjustments can be made quickly. Tests carried out under program control from PM 4400 – eliminates manual reading of instruments, calculation and entry of values.



PM 4400 controlling test and measuring instruments for automatic testing via the IEC-bus interface.

Data acquisition with PM 4400

Quality-control tests of products and equipment. Testing under program control from PM 4400 and automatic data collection for recording on mini-floppy disk. Data can be statistically processed and 'condensed' if necessary for efficient storage. Eliminates bulky paper printouts needing manual search to find any particular data.

Stand-alone calculator

Powerful, easy-to-use calculator functions, available when used on its own. Special 'calculator-format' keyboards allows convenient arithmetical entries. E.g. mechanical engineering calculations.

BASIC is a powerful, yet easy to use language

The BASIC programming language used in the PM 4400 is the computer language most like normal English. That means that it is unnecessary for the user to be an experienced programmer to use it. In fact, a user with mathematical knowledge but no specific programming experience can generally learn to use PM 4400's 'instrumental' BASIC language and begin to write his own programs within half a day. An instructional program is available to help new users understand and apply BASIC quickly.

PM 4400 BASIC contains an extensive range of built-in error messages designed to help the user and guide him in program fault-finding. These messages display errors in individual program steps and in program structure, and errors arising during program execution.

When the PM 4400 is operated as a powerful calculator, the normal arithmetic

One line sample testing of component board using PM 4400.

functions are available at the touch of a key on the 'calculator' panel, and the BASIC language contains a full range of other mathematical and trigonometric functions.
PM 4400's BASIC language can work in three modes:

- Conversational programming – the user communicates with the system via the keyboard. Programs are entered step by step with prompting if necessary for assistance. Each step is checked as it is entered, and errors are displayed straight away.
- Execution mode – a program which may already be written and stored on a mini-floppy disk is 'read' by PM 4400 and put into action. Using this mode, you can simply select the program you need from your own 'library' and run it.
- Direct mode – allows PM 4400 to be used as a desktop calculator with direct uncomplicated entry of calculations in normal arithmetic style.

TECHNICAL SPECIFICATION

CENTRAL PROCESSOR UNIT (CPU)

Type
LSI miniprocessor (Philips P 851) 16 bit capability microprogrammed for divide/multiply routines

MAIN STORE (RAM)

Fast dynamic MOS-RAM (16k-1 LSI chip)
up to 64k-bytes on one card memory sizes available:
32k-bytes
48k-bytes
64k-bytes

Access time
450ns for 16 bits. Low power consumption.

MASS STORAGE

Type
Mini-floppy disc drive type SA 400 controlled by bipolar micro-processor based control unit

Hard error rate
1 in 10^{11} bits read

Transfer rate
125k bits/s

Average access time
463m s

Track to track access time
40m s

Media life
30×10^6 passes per track
Software sectored format

Nett capacity
80k-bytes approx.

KEYBOARD

Free-standing unit

Type
Alphanumeric, numeric and miscellaneous
Generates 128 ASCII-characters, with cursor-control and function codes
Serial data transmission allows input of up to 800 characters/sec. to mainframe
Error checks
Indicators for I/O, Input and CAP/LOCK

Keyboard groups
typewriter part 53 keys
special functions 8 keys
numeric pad 18 keys
cursor control/editing 9 keys
user-definable 2 × 8 keys
indicators 3 LED's

MONITOR

Type:
Video display, P 4 white

Screen size
12-in diagonal

Alphanumeric representation
24 lines of 80 characters each

Graphical representation
7 × 9 dots

Character set
128 ASCII characters

INTERFACES

IEC-bus interface
In conformity with DIN IEC 66.22
Transmission byte-serial/bit-parallel
Logic compatible with IEEE 488/75

Maximum data transmission rate
5M byte/sec
Up to 15 devices
Up to 32 addresses
Easily programmed by 'BASIC' language
Serial poll
All controller functions

Serial interface
V 24-bit serial or current loop (20mA)
Baud rate selectable within 50-9600 baud input/output independent
Word length 5-8 bits
Parity check
Cable lengths of up to 300M

PHYSICAL DATA

Dimensions and weight
(w × h × d) 540 × 300 × 500mm
(22.7 × 11.8 × 19.7-in)
35kg approx.

Power supply
110-220V (±10%)

Power frequency
48...63Hz

Power consumption
Approx. 250W, dependent on configuration

Operating temperature
+4°C to +40°C

Peripheral equipment

HIGH-SPEED LINE PRINTER

Type
PM 4490

Printing rate
160 characters/s

Printing width
132 characters max.

Paper
Fan fold forms

Paper width
Adjustable between 4 and 15-in

Paper transport
Tractor feed mechanism

Character style
7 × 7 dot matrix

INTELLIGENT DIGITAL PLOTTER

Type
PM 8151

Effective drawing surface
280 × 388 mm, DIN A3
(297 × 240 is accepted)

Internal buffer
800 bytes expandable with additional 1k byte

Plotting rate
30cm/s (can be preset to 10cm/s)

IEC-625

IEC-bus control application

The application is concerned with the measurement and recording, both in alphanumeric and graphical form, of the efficiency of a bandpass filter. The complete programme involves:

- continuous measurement of the performance of the device under test
- printing out the individual measurements taken on a serial alphanumeric printer type PM 4490
- drawing the actual performance curve on a linear/log scale using the digital X-Y plotter PM 8151
- printing and drawing of: frequency, bandwidth, efficiency (calculated), upper and lower frequency limits

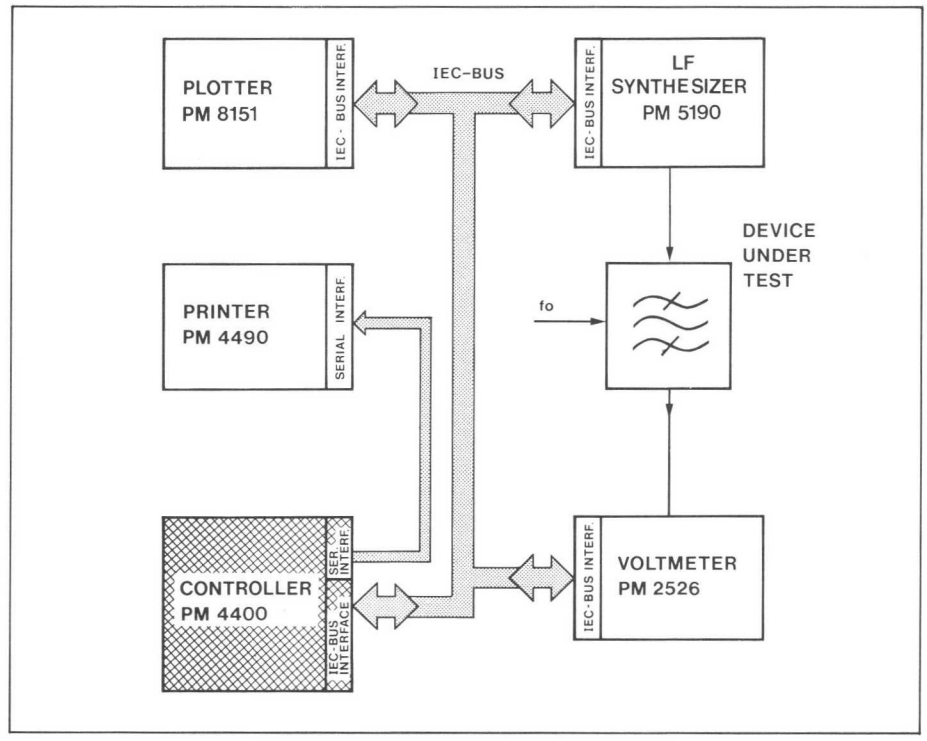
The following instruments are required.
1. IEC-bus controller PM 4400
2. Digital X-Y plotter PM 8151
3. Line printer PM 4490
4. LF-synthesizer PM 5190
5. Digital multimeter PM 2526

Programme sequence
The sequence is as follows:
1. First comes the preparation stage. This involves layouting, drawing the grid for the log/linear graph, labelling, printing out the desired table headings, etc., ready for the test run.
2. Measuring the frequency response of the filter by progressive sampling and computing the results.
3. Drawing the curve and overprinting the measured values (in alphanumerics).
4. Calculation, printing and drawing of
- frequency
- voltage
- bandwidth
- efficiency
- upper and lower limits
5. Where repeat 'runs' are made for the purposes of averaging the results, calculating, printing and drawing of the average of several runs.

The set-up described is shown in block diagram form.

Using this set-up, test times will be considerably reduced, whilst the overall test procedure itself in terms of batch accuracy and unit throughput, will be substantially improved.

This example of automatic testing using the PM 4400 IEC-bus controller therefore demonstrates the opportunity to achieve higher efficiencies and improved quality output, in electronic testing laboratories.



Block diagram shows how the various instruments are inter-connected, with the appropriate interfaces and the IEC-bus line, clearly defined.

Low frequency equipment

Unit	Description	Frequency	Special features	Page
Introduction				140
PM 5107	Sine/square RC oscillator	10Hz...100kHz	5 V_{p-p} output Very low distortion	142
PM 5108L	Function generator	1Hz...1MHz	Sine/square/triangle with 50Ω and 600Ω output and output meter	143
PM 5129	Function generator	0.001Hz...1MHz	Sine/square/triangle outputs with burst, int. sweep	144
PM 5165	LF sweep generator	0.1Hz...1MHz	Digital frequency display 4-decade log internal sweep	145
PM 5171	Amplifier, AC/DC and linear/log converter	DC...1MHz	Amplifier plus AC/DC and linear/log conversion; dynamic range 80dB	146
PM 5167	Function generator	0.001Hz...10MHz	Sine/square/triangle, burst, ramp/pulse outputs, single shot	147
PM 5131	Function generator	0.1Hz...2MHz (logarithmic)	Sine/square/triangle with $30V_{p-p}$ output	149
PM 5132	Function generator	0.1Hz...2MHz (linear)	Sine/square/triangle/pos. pulse/neg. pulse, DC	151
PM 5190	LF synthesizer with μP control	0.001Hz...2MHz	Feather-touch keyboard frequency selection with LED indicator	153
Miscellaneous service equipment				
SM 103	Multitester		AC-DC voltage AC-DC current Resistance	156
UTS 001	Multitester		AC-DC voltage AC-DC current Resistance	156

Introduction

Which low frequency instrument?
Even the most experienced technician needs to carefully analyze the performance of to-days' low frequency instruments before making a purchase. Frequency range, wave shapes, output voltage levels and impedances will probably head the selection list. Equally important will be duty cycle, availability of sweep facilities, DC offset and so on.

Then, the more sophisticated features associated with digital generators, such as remote control possibilities, may need to be considered.
All the major features applying to each of the instruments described in this chapter are grouped together in an easy-to-read chart, below, with the object of easing the decision-making process.
Some suggested applications for these instrument groups follow, with the object of further helping the reader in making the most suitable choice of a signal generator for a particular measurement problem. More detailed specifications appear in each individual instrument description.

Three groups
There are several basic concepts employed to produce specific performance features, which help to classify these instruments.

RC oscillators (frequently in the form of Wien Bridge) produce a virtually pure sine wave output, exhibiting very low distortion characteristics. Combined with an excellent cost/performance ratio, these factors make this group popular for service workshop use and education or training.

Voltage-controlled sine oscillators are normally employed to produce square and triangle outputs. In addition to sine waves, a feature of the VCO principle is the elimination of 'bounce' whilst maintaining a favourable distortion characteristic when compared with the Wien Bridge method. The term 'Function Generator' is normally applied to this group. A sweep mode is frequently required and this facility is provided on some function generators, either for external sweep control or with an internal sweep facility.

Function generators can be used therefore in a wide variety of applications, R&D labs, service workshops, education. More sophisticated features are incorporated in low frequency digital generators (synthesizers) which offer very accurate frequency setting.
Very high frequency stability is derived from a basic crystal – controlled oscillator.

An important aspect of the digital concept is the programming facility, for applications in, say, fully automated systems, on modern production lines.

LOW FREQUENCY INSTRUMENTS SURVEY

Classification	Type nr.	Frequency range Hz												Output V					Waveforms			Variable duty cycle	DC offset	Output characteristics			Sweep			
		0.001	0.01	0.1	1	10	100	1k	10k	100k	1M	10M		0	10	20	30	40	∿	⎍	Λ			600Ω	50Ω	TTL	Ext.	Int.	FM	AM
RC oscillator	PM 5107																		●	●				●		●				
Function generators	PM 5108L																		●	●	●		●	●	●		●		●	
	PM 5129																		●	●	●	●	●		●	●	●	●	●	●
	PM 5131																		●	●	●		●		●	●	●	●		
	PM 5132																		●	●	●	●	●	●	●	●	●	●		
	PM 5167																		●	●	●		●		●		●			
LF Synthesizer	PM 5190																		●	●	●		●		●	●	●			●
Sweep generators	PM 5165																		●	●	●		●		●		●	●	●	
Amplifier/converter	PM 5171																		●	●				●		●				

Confidence in your choice

All models meet the high standards of Philips test and measuring instruments. Design motivation, components, materials, manufacturing techniques are of a very high order. The purchaser may therefore expect excellent performance and a long, trouble-free operating life, whatever the choice.

With the backing of applications advice and a world-wide sales service, any instrument may be selected with complete confidence.

Typical application

A typical application is testing audio equipment and the example is described in detail.

Testing audio equipment

A set-up consisting of a sweep generator PM 5165, a logarithmic converter PM 5171 and a flat-bed X-Y recorder such as the PM 8040 forms a highly versatile tool for audio development and quality-control work. It is invaluable for such tasks as determining the frequency characteristic of the various amplifiers or filters in an audio mixer or testing the quality of various acoustic control systems for auditoria.

Measuring set-up

The basic measuring set-up is shown in fig. 1. The power supply PE 1509 may be needed to extend the DC offset range of the set up if a recorder such as the PM 8040 is used. A more sophisticated recorder such as the PM 8141, however, has a wide enough DC offset range itself to meet all normal requirements.

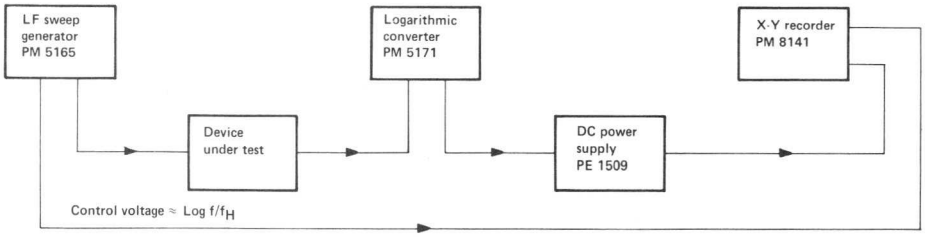


Fig. 1. Block diagram of measuring set-up.

Testing audio mixers

Professional audio mixers such as the Philips LDC 25 contain a large number of input channel modules consisting basically of an amplifier and a filter.
The frequency characteristic of such an input module can be varied within wide limits by the mixer panel controls, and one of the main tasks involved in the development is to ensure that the form of these characteristics is compatible with the application on hand; this involves ideally measuring the frequency response at various frequencies to an accuracy of better than 1dB. Plotting such curves by hand would be very time-consuming; commercial equipment is available on the market for this purpose, but the charts used for recording the frequency characteristic are so narrow that it is often impossible to read the curves off to the desired accuracy. This is where the set-up of fig. 1, with an X-Y recorder taking an A4 format chart (or even A3 if desired), comes into its own. It is equally suitable for development work on individual input modules and for output testing of the completed audio mixer. In the Breda works of Philips Ela division, where these audio mixers are developed and made, such a measuring set-up has been mounted on a trolley so as to have it all at hand where and when it is wanted.

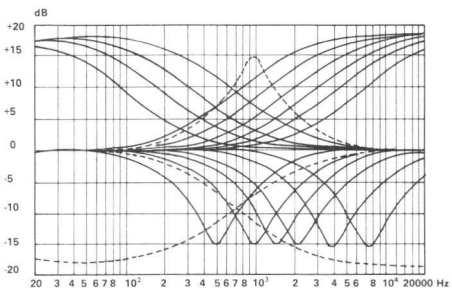


Fig. 2. Input channel equalizer curves.

Testing acoustic equalization installations

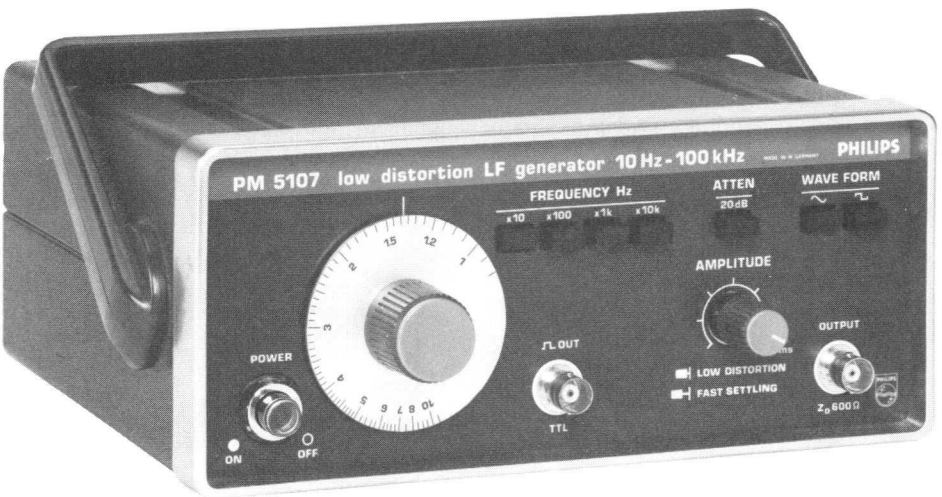
This application is similar to the above. A cluster of K and Q filters can be used to build up a frequency characteristic which is the mirror image of that of a given auditorium, in order to reduce the effect of acoustic feedback of the microphones in the auditorium's sound installation. It goes without saying that development of such an 'acoustic equalization' installation requires a set-up for accurate measurement of the frequency characteristics of both auditorium and the installation.

Fig. 3. Basic measuring set-up.

Low distortion LF generator PM 5107

Frequency range 10Hz . . . 100kHz
Very low distortion 0.02%
Sine and square wave signals
Compact dimensions and low weight
Separate TTL output
Switchable 20dB and continuous attenuation

The PM 5107 has been designed for both educational applications and service workshops. It provides square and sine wave signals, the latter having a special 'low distortion' position for use on HiFi development as well as alignment and maintenance. Another useful service feature is the switchable 20dB attenuation.
The generator is 1kg light and has very compact dimensions. The layout of the front panel is attractive and functional, a feature which is of particular value for educational applications. A typical application in service and education is the combination of the PM 5107 and oscilloscope PM 3226 which represents a versatile and professional measurement set-up that is easy to use.



TECHNICAL SPECIFICATION

Frequency range
10Hz...100kHz in 4 ranges to be selected by push-buttons. Continuous tuning with scale indicated 1...10
Accuracy: better than 4% ±1Hz
Temperature stability: $<0.05\%/°C$ at f=1000Hz
Long term drift: $<1.5\times10^{-3}$ at f=1000Hz

Signal output (sine/square waves)
Impedance: 600Ω
Output: BNC socket (short circuit proof)
Attenuation: continuously adjustable 0...40dB
20dB step attenuator.
Output: switch – two positions
1. Normal
2. Fast settling

Sine wave output
Amplitude: $0...2V_{RMS}$ on open circuit
Frequency response: better than 2% referred to 1kHz

Distortion
Position: Low distortion
0.02% at 1kHz
0.03% from 300Hz...20kHz
Position: Normal or fast settling 0.5% in range 300Hz...20kHz.

Square-wave output
Amplitude: $0...4V_{p-p}$
Rise-time: $<0.5\mu s$
Sag: <1% at 50Hz
Duty cycle: 50%

TTL output
Amplitude: high level 4.5V±0.7V
low level <0.3V
Sag: <1%
Freq. response: 2% (1kHz ref.)
Rise time: <30nsec
Fall time: <15nsec
Fan out: 20

Power supply
Line voltage: 115, 230V ±15%
Frequency: 50–100Hz ±5%
Consumption: 4W

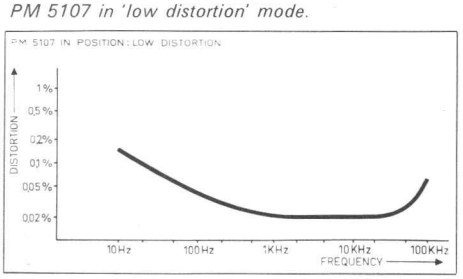
Ambient temperature
Reference value: 23°C
Operating range: +5...+40°C
Storage temperature: −40...+70°C

Dimensions and weight
(w×h×d) 230×110×210mm
(9×4.3×8.3-in)
1.25kg (2.75lb)

Accessories supplied
– mains cable
– manual

Optional accessories
Coaxial cable BNC-BNC
(PM 9075)

Curve demonstrating low distortion characteristic of PM 5107 in 'low distortion' mode.



Sine, square, triangle signals

External sweep

Monitored output level (meter)

Two outputs 50Ω and 600Ω

Vernier control for frequency setting

Function generator PM 5108L

This compact bench instrument provides sine, square and triangle waveshapes over the frequency range 1Hz to 1MHz with an accuracy of ±2% (up to 100kHz). In special situations, the output frequency can be expended down to 0.1Hz.

The two outputs will supply $20V_{p-p}$ max. at 60Ω or $4V_{p-p}$ max. at 50Ω. Both outputs are monitored on the front panel meter. Attenuation is in steps, 0-20-40-60dB (±0.1dB) with a 35dB continuous overlap facility. Very accurate frequency settings are achievable by the vernier control.

The variable DC-offset can be used simultaneously on both outputs. An external sweep facility is provided which allows for a positive sweep of 1 :50.

TECHNICAL SPECIFICATION

Waveforms
Sine, triangle, square

Frequency range
1Hz...1MHz
0.1Hz...1MHz (special conditions)

Vernier frequency adjustment
Yes

Accuracy
±2% at 1kHz...100kHz

Temperature coefficient of frequency setting
< 0.08%/°C from 1Hz to 100kHz

Short term drift < 15 min
< 0.06%

Long term drift > 7hrs
< 0.1%

OUTPUT

Maximum (open circuit)
$20V_{p-p}$

Impedance
$20V_{p-p}$ max (600Ω) $4V_{p-p}$ max (50Ω)

Frequency response
±1% up to 100kHz

Attenuation
Continuous 35dB
Stepwise 0-20-40-60dB (±0.1dB)

DC offset
±5V at 600Ω } can be used
1±1V at 50Ω } simultaneously

SINE WAVE

Distortion
< 0.25% up to 100kHz

SQUARE WAVE

Rise/fall time
< 100ns

Overshoot and ringing
< 3%

FIXED OUTPUT

Fan out
20

Rise time
> 25ns

LINEAR SWEEP MODES

Sweep range – external sweep only
Pos sweep 1 :50

Max. sweep frequency
500Hz

Max. modulation frequency
60kHz (3dB point)

POWER REQUIREMENTS

Voltage
115; 230V ±15%

Power consumption
< 12W

Frequency
50...100Hz

DIMENSIONS AND WEIGHT

(w × h × d) 240 × 145 × 300mm
(9.4 × 5.7 × 11.8-in)
3.4kg (7.5lb)

Frequency range 1mHz . . . 1MHz
Sine/square/triangle/pulse/ramp signals
$30V_{p-p}$ output
Internal linear sweep and FM
External linear sweep
Large linear scale
Single shot
Burst

Function generator
PM 5129

The PM 5129 covers the frequency range 1mHz (see specification) to 1MHz and produces sine, square, triangle, pulse and ramp signals. It also provides burst and single-shot facilities.

Accurate frequency setting is ensured by the large linear scale. There is a choice of internal, single-shot, linear sweep (0.5 to 50s) and FM, or external sweep up to a maximum frequency of 500Hz. Attenuation is either continuous or stepwise in 20dB steps from 0 to 60dB.

The output is $30V_{p-p}$ max at the 50Ω front panel socket. The instrument is TTL compatible and pen-lift is available.

TECHNICAL SPECIFICATION

Waveforms
Sine, triangle, square, pulse, ramp (variable width)

Frequency range
10mHz...1MHz
1mHz...1MHz
(special conditions)

Vernier frequency adjustment
From −5% to +5% of the frequency setting

Accuracy
For time symmetrical waveforms 2%+0.2% of full scale

Temperature coefficient of frequency setting
< 0.08% per °C in range 1Hz to 100kHz

Short term drift < 15 min < 0.05%

Long term drift > 7 hrs < 0.01%

OUTPUT

Maximum (open circuit) $30V_{p-p}$

Impedance 50Ω

Frequency response
±1% up to 100kHz

Attenuation
Continuous 20dB
Stepwise 0–20–40–60dB

DC offset
0...±10V

SINE WAVE

Distortion
< 0.4% up to 100kHz

Variable duty cycle
From 10% to 90%

TRIANGLE WAVE

Variable duty cycle
From 10% to 90%

SQUARE WAVE

Rise/fall time < 70ns

Variable duty cycle From 10% to 90%

Overshoot and ringing < 2%

FIXED OUTPUT

TTL compatible Yes

Fan out 20

Rise time < 25ns

LINEAR SWEEP MODES

External sweep
Pos and neg sweep 1 : 1000

Max. sweep frequency
500Hz

Max. modulation frequency
60kHz (3dB point)

Internal sweep
Single shot with 0.5...50s sweep

FM 0...10% variable

Pen lift available Yes

Sweep voltage output max. 5V

POWER REQUIREMENTS

Voltage 115; 230V
±15%

Power consumption < 30W

Frequency 50...100Hz

DIMENSIONS AND WEIGHT

(w × h × d) 240 × 145 × 300mm
(9.4 × 5.7 × 11.8-in)
3.6kg (7.9lb)

Frequency range: 0.1Hz . . . 1MHz

Very accurate frequency setting using 3½-digit display

Four decades in one sweep

Variable sweep width and speed

Single cycle sweep with hold and reset

External sweep and FM

Analog output

Pen lift

LF Sweep generator PM 5165

The PM 5165 provides swept signals over several decades making it ideal for such applications as response testing of amplifiers, filters and servo loops, vibration studies and those applications in geophysical and biomedical research where swept signals are useful over several decades.

The new sweep generator PM 5165, providing an output signal with frequencies between 0.1 Hz and 1MHz has three selectable waveforms – sinusoidal, triangular and rectangular.

An internal sawtooth generator offers a 4-decade sweeping facility with adjustable sweep range and sweep period. The low and high end frequencies of the sweep range can be set with very high accuracy because the frequencies are indicated by a digital display with $3\frac{1}{2}$ digits. Single sweep, sweep hold and external frequency modulation are additional features, increasing the versatility of the instrument.

A voltage proportional to the logarithm of the frequency is available to drive the X-input of an X-Y recorder. A pen-lift output can be used to control the writing system of a recorder during fly-back in order to prevent double writing.

TECHNICAL SPECIFICATION

Frequency
0.1Hz...1MHz (7 decades)
Ranges: 0.1Hz...1kHz
10Hz...100kHz
100Hz...1MHz
Setting: by means of a coarse and a fine control separately for the two end frequencies of the sweep range
Display: four LED's indicating $3\frac{1}{2}$ digits floating decimal point.
range indication by means of 3 LED's
Frequency setting error: ±1% ±1 digit at reference conditions
Short term drift (15 minutes): ±0.05%

Output
Waveform: Sine, square or triangle
Max. output voltage: $6V_{p-p}$
Attenuation: 0...30dB
Internal resistance: 50Ω
Sinewave frequency response: ±1% up to 100kHz *(reference 1kHz)*: ±3% up to 1MHz
Triangular waveform linearity: 1% of max. amplitude
Square-wave rise and fall time: 50ns
Square-wave aberrations: 2%
Max. DC offset: 50mV

Logarithmic frequency output (Log f/fH)
Output voltage: 0...4V (1V/decade)
Output resistance: < 1Ω
Max. current: 5mA

External sweep input
Sensitivity: 1V/decade
Input resistance: 10kΩ
Maximum sweep frequency: 400Hz
Upper 3 dB point at FM: 2kHz

Sweep facilities
Sweep selection: internal or external
Internal sweep: 1:1 to 10^4:1 continuously adjustable (4 decades)
Sweep speed: 1...100s continuously adjustable
Sweep control voltage: saw tooth
Sweep modes: continuous, single period
Manual controls: sweep hold, sweep reset to low frequency

Pen lift output (adapted to X-Y recorders PM 8120 and PM 8125)
Max. current: 0.5A (electronic switch closed)
Output voltage: 15V } (electronic
Internal resistance: 15KΩ } switch opened)

General characteristics
Temperature range: +5°C...+40°C
Reference temperature: 23°C ±1°C
Power supply voltage: 115/230V ±15%
Power supply frequency: 50...100Hz
Consumption: 27W

Dimensions and weight
(w × h × d) 240 × 145 × 300mm
(9.4 × 5.7 × 11.8-in)
3.4kg (7.5lb)

Amplifier:
Gain 60dB
Rise/Fall time 100ns
Distortion 0.2% at 60dB

Amplifier, AC/DC and linear/log converter PM 5171

Log Converter:
Dynamic range 80dB
Slewing speed 100dB/s
Error 1dB at 60dB

AC/DC Converter:
Dynamic range 80dB
Response time 0.35s
Error ±0.5dB at 1kHz

This versatile laboratory instrument combines the three distinct functions – wideband amplifier, AC-to-DC converter and linear-to-logarithmic converter, in a single instrument.

Measuring amplifier

The measuring amplifier covers the range from DC to 1MHz and will accept an AC- or DC-coupled input. Maximum permissible input voltage is $100V_{p-p}$ and the output is between 0 and $10V_{RMS}$. Gain is adjustable in switchable 10dB steps, between 0 and 60dB, with an accuracy of 0.1dB at 1kHz.

AC-to-DC converter

The DC output for a $10V_{RMS}$ input is 10V. With a dynamic range of 80dB, the conversion error is only 0.5dB at 1kHz. A good response time of 0.35 seconds has been achieved and the frequency range is between 10Hz and 100kHz for an output of $10V_{RMS}$ and between 10Hz and 20kHz for an output of $1V_{RMS}$.

Linear-to-logarithmic converter

This has a dynamic range of 80dB, with a slewing speed of 100dB/second. Output voltage is, typically, 2V for a $10V_{RMS}$ amplifier output. A continuously adjustable DC shift from 0 to 2V is provided. Conversion factor is 1V/20dB and frequency ranges are as for the AC-to-DC converter.

TECHNICAL SPECIFICATION

MEASURING AMPLIFIER

Input: AC or DC coupled (switchable)
Input impedance: 1MΩ//20pF
Maximum operating: $30V_{p-p}$
Maximum permissable input voltage: $100V_{p-p}$
Output voltage: $0...10V_{RMS}$ (open circuit)
Internal resistance: 50Ω
Gain: 0–10–20–30–40–50 or 60dB (switchable)
Inaccuracy: ±0.1dB at 1kHz
Bandwidth: at G=20dB; R load=600Ω;
DC coupling: 0...1MHz
(0.5dB points): at G=60dB; R load=600Ω; DC coupling=0...10kHz
Bandwidth: at G=60dB; R load=600Ω;
DC coupling=0...30kHz
(3dB points): at G=60dB; R load=
600Ω; AC coupling=2Hz...30kHz
Rise and fall time: 100ns at R load 600Ω and a gain of 20dB
Distortion: 0.2% at R load 600Ω and a gain of 60dB (f 50kHz)
Drift: 50μV/°C
Noise: 15μV

AC TO DC CONVERTER

DC output voltage: 10V at $10V_{RMS}$ at amplifier output (load resistor 10kΩ)
Internal resistance: 10Ω
Conversion error: ±0.5dB at 1kHz
Dynamic range: 80dB
Response time: 0.35s
Frequency range: 10Hz...100kHz at $10V_{RMS}$ at amplifier output
10Hz...20kHz at $1mV_{RMS}$ at amplifier output

DC TO LOG CONVERTER

Output voltage: +2V at $10V_{RMS}$ at amplifier output −1V at $10mV_{RMS}$ at amplifier output
DC shift: 0...−2V continuously adjustable
Conversion factor: 1V/20dB
Conversion error: 1dB (at 1kHz from 0 to 60dB)
Dynamic range: 80dB
Slewing speed: 100dB/s (from 0 to −60dB)
Frequency range: 10Hz...100kHz at $10V_{RMS}$ at amplifier output
10Hz...20kHz at $1mV_{RMS}$ at amplifier output

OPERATING CONDITIONS

Reference temperature: 23°C±1°C
Operating temperature: 5°C...40°C

DIMENSIONS AND WEIGHT

(w×h×d) 230×110×200mm
(9×4.3×7.9-in)
1.6kg (3.5lb)

POWER SUPPLY

Line voltage: 115/230V±15%
Line frequency: 50...100Hz
Consumption: 8W

Function Generator
PM 5167

Wide frequency range, 1mHz-10MHz

Sine, triangular, square wave; sawtooth and pulse signals

High output voltage, 40V_{p-p}

Low distortion (0.2% from 100Hz to 100kHz)

DC-offset

Sweep input
single shot mode with variable start phase and hold

Overrange indication

50Ω output

The PM 5167 function generator has a wide frequency range and extremely high output voltage (40V_{p-p} open circuit). A wide variety of wave forms, excellent specifications, features like e.g. single shot mode with adjustable start, phase, sweep- and hold facilities and DC-offset and its compact construction make the PM 5167 a versatile tool for electronic laboratories, production groups and engineering design groups.

TECHNICAL SPECIFICATION

Frequency
Range: 1MHz...10MHz (10 ranges)
Offset: −5%...+5% relative variation
Accuracy: for time symmetrical waveforms
range 1mHz: ±6%
10mHz: ±5%
0.1Hz...10kHz: 2% ±0.2% of max.
100kHz: ±3% ±0.2% range
1MHz: ±4% ±0.2% value
Temperature coefficient: < 0.3%/°C to 8MHz
Long term drift in 7 hours after 4 min. warming up: < 0.2%

Waveforms
Sine wave
Square wave
Triangular wave
Sawtooth 1:9 and 9:1 } to 1MHz
Pulse 1:9 and 9:1 }

OUTPUTS

One with selectable waveform
AC voltage: 40V_{p-p} max. (open circuit)
DC offset: 0...±10V
Impedance: 50Ω (short circuit proof)
Attenuator: continuous > 30dB steps 0/20dB

One fixed output with square wave
Voltage: 2V_{p-p} (open circuit)
Impedance: 50Ω

Frequency response
to 10kHz: ±1% for all waveforms
to 100kHz: ±3% for sine wave ±6% for triangle, sawtooth
to 1MHz: ±3% for sine wave ±10% for triangle, sawtooth
to 10MHz: ±10% for all waveforms

Distortion of sine wave
to 1Hz: < 1%
1Hz...10kHz: < 0.5%
10kHz...100kHz: < 1.0%
100kHz...1MHz: < 2.0%
1MHz...10MHz: < 5.0%

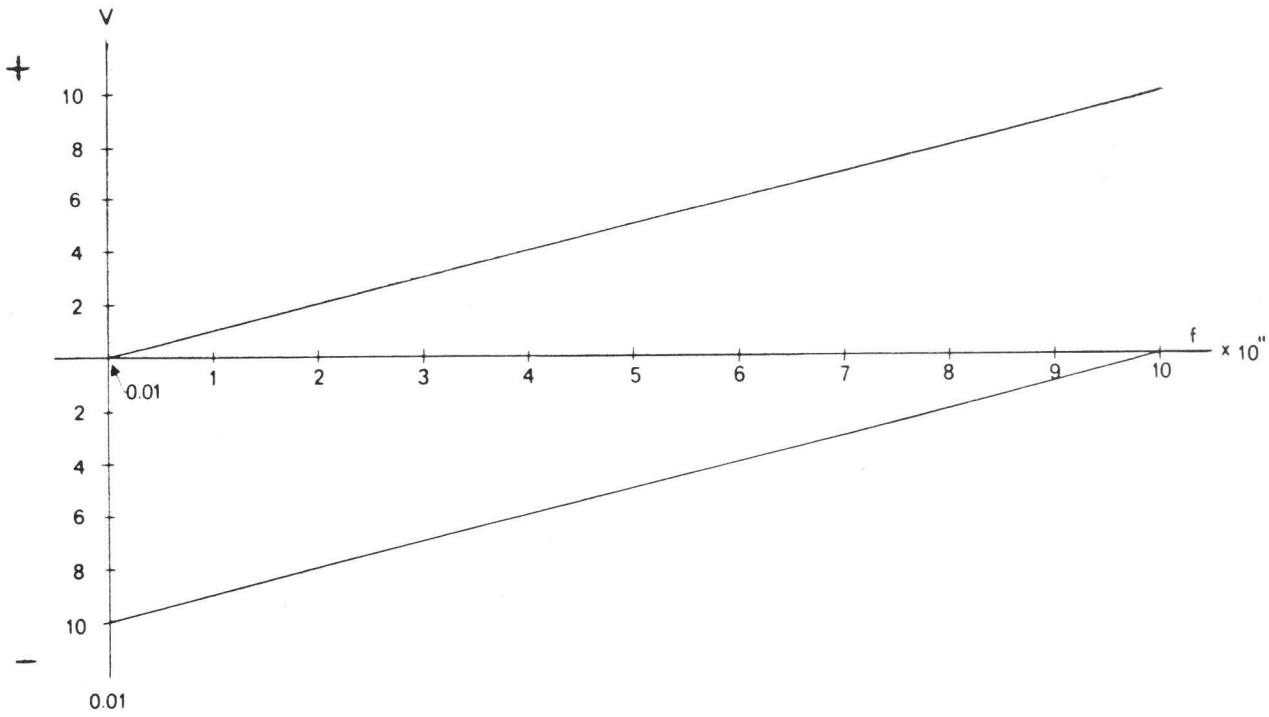
Rise/fall time of square wave
of variable output: < 25ns to 10V_{p-p}
< 30ns to 20V_{p-p}
of fixed output: < 18ns

Ramp linearity
– error
(in frequency range 1MHz... < 1% to 40V_{p-p} 100kHz) < 0.25% to 4V_{p-p}

SPECIAL FUNCTIONS

Frequency control
Via sweep input max. 3 decades linear relationship between voltage 10V/3 decades (see graph)
– input impedance 1kΩ
– max. permissible voltage ±15V

Hold
In frequency range ×1MHz... ×1Hz. Operation via 'Hold/Run' switch via 'Control Input' in switch position 'RUN'. Input voltage for electronic 'HOLD' via



Sweep range PM 5167

'CONTROL INPUT' ±5V. Input resistance 10kΩ. Max. permissible voltage on 'CONTROL INPUT' ±10V

Single shot mode
- in frequency range ×1MHz...100Hz
- triggering by means of switch 'OFF/SET PHASE/START' in position 'START'
- choice of startpoint by menas of control 'SET PHASE'
- position of startpoint
- on the positive going ramp for triangle and sawtooth
- on negative going side of the sine wave
- adjustable between positive and negative peak-value
- trigger voltage – negarive pulse of 5V fall time < 1μs on 'CONTROL INPUT'
- input resistance of 'CONTROL INPUT' 10kΩ
- max. permissible voltage on 'CONTROL INPUT' ±10V 'OVERRANGE'. Light 'OVERRANGE' indicates when due to positions of DC and AC controls clipping in the output amplifier may occur.
- controlled values ±20V (open circuit) attenuator −0dB). ±2V (open circuit) attenuator −20dB.

POWER REQUIREMENTS

Voltage
110, 128, 202, 220, 238V ±10%

Frequency
47.5Hz...105Hz

Consumption
Max. 53.2W (64.7VA)

Temperature range
+5...+40°C

DIMENSIONS AND WEIGHT

(w × h × d) 230 × 145 × 285mm
(9 × 5.7 × 11.3-in)
7.5kg (16.5lb)

0.1Hz–2MHz frequency range, logarithmical sub-ranges

Sine, triangle or square wave signal generator, plus DC

$30V_{p-p}$ maximum output

Stepped & variable output attenuation over wide range

Variable DC offset

Vernier frequency adjustment

Internal & external sweep facility

TTL output

new

Function generator
PM 5131

The PM 5131 function generator is an instrument designed for applications extending from educational to the broad general purpose area. Its many features make it an extremely versatile instrument for a modest price. Among these are the high, $30V_{p-p}$ output voltage and the facilities for both internal and external sweep. This latter feature covers the audio frequency range in a single shot. The frequency is adjustable in three logarithmical sub ranges from 0.1Hz to 2MHz. The frequency vernier allows the frequency setting to be varied from −20% to +20%. The maximum output voltage is $30V_{p-p}$ on the main outlet with open circuit having a 50Ω impedance. The attenuation can be set over a wide range, either in calibrated steps of 10dB to a maximum of 60dB or in combination with the 20dB continuous attenuator.

A sine, triangle or square wave signal is selected by simply pressing the appropriate push-button. DC voltage can be selected separately without any wave form or whenever used as DC offset can be varied between −10V and +10V.

PM 5131 also provides a $3\frac{1}{3}$ decade internal sweeping facility with adjustable sweep range and a variable sweep period from 10 to 150 seconds.
This is especially useful when sweeping in the audio range to cover the frequency range of 20Hz–20kHz in a single sweep. Adding to the versatility of this instrument are an external sweep facility and a TTL output.
Good ergonomic design makes operation simple while the dimensions of the instrument occupy minimal bench space.

TECHNICAL SPECIFICATION

Waveforms
Sine, triangle and square

Frequency range
0.1Hz to 2MHz
in 3 overlapping logarithmical ranges

Type of frequency indication
Dial

Vernier frequency adjustment
from −20% to +20%
of frequency setting

Accuracy
±10%

Temperature coefficient of frequency setting
< 0.5% per °C

Short term drift < 15 min.
< 0.5%

Long term drift < 7hrs
< 0.7%

OUTPUT

Maximum output voltage for sine, triangle, equare on main output with open circuit
$30V_{p-p}$

Impedance
50Ω

Frequency response of sine wave ampl.
< 0.1dB–0.1Hz up to 20kHz
< 0.3dB–0.1Hz up to 1MHz
< 1.0dB–0.1Hz up to 2MHz

Attenuation
Continuous 20dB
0-60dB in 10dB steps

DC offset
0 ⩾ ±10V

Short circuit proof
Yes

SINEWAVE

Distortion
< 0.5% up to 20kHz
< 3.0% up to 2MHz

TRIANGLE WAVE

Linearity
Better than 99%

SQUARE WAVE

Rise/fall time
< 75nsec

Frequency response
See 'output'

Overshoot and ringing
< 2%

FIXED OUTPUT

TTL compatible
Yes

Duty cycle
50%

Fan out
> 20

SWEEP FACILITIES

INTERNAL SWEEP

Sweep characteristics
Logarithmic

f stop/f start
1 ⩾2.10³ continuously adjustable (3⅓ decades)

Sweep time
< 10s...150s, continuously adjustable

Frequency analogue voltage
1V/frequency decade

EXTERNAL SWEEP

Voltage/frequency characteristic
Logarithmic

Max. sweep range
3⅓ decades

Sensitivity
1V/frequency decade

Input resistance
1kΩ

Max. sweep frequency
About 5kHz

POWER REQUIREMENTS

Voltage
115; 230V
±15%

Power consumption
21W

Frequency
50...100Hz

DIMENSIONS AND WEIGHT

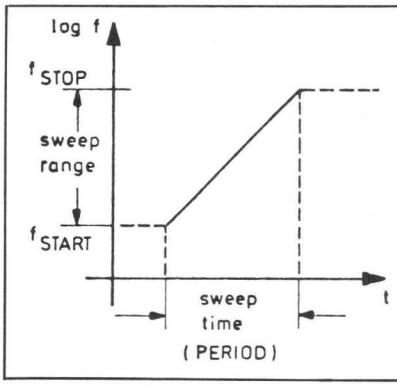
(w × h × d) 310 × 140 × 330mm

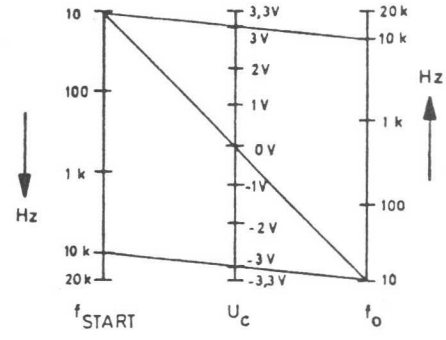
ACCESSORIES SUPPLIED

Operating manual

OPTIONAL ACCESSORIES

PM 9075 Coaxial cable BNC-BNC





Example of internal single sweep
Internal single sweep from the start- to the stop-frequency is started by pressing the button SGLE SWEEP. The characteristic is exponential following the relation

$f_o = f_{START} \cdot 10^{U_c}$

where

f_o = instantaneous signal frequency at the output

f_{START} = frequency at the beginning of the sweep represented by the frequency setting

U_c = voltage at the socket SWP VOLTAGE IN/OUT.

Thus a control voltage difference of 1V results in a frequency ratio of 10 : 1.

At the end of the sweep the output remains at the stop frequency which can be set by the SWP STOP/START control. Resetting the SGLE SWEEP button effects the frequency to fly back to the start frequency. The sweep time is adjusted the SWP PERIOD potentiometer.

Pre-adjustment of the stop frequency may be performed at the end of the sweep with minimum period, prior to setting the final sweep operation.

The example shown is for the ×10k frequency range; the other two ranges should be regarded similarly, with U_c scale reading unchanged.

A typical educational application with PM 5131 being used in conjunction with oscilloscope PM 3226.

0.1 . . . 2MHz in 7 overlapping ranges

Sine, triangle, square, positive- and negative-going pulses, DC

Output: $30V_{p-p}$ (sine, triangle, square)
$15V_{p-p}$ (pulses)

Stepped and variable attenuation over a wide, 80dB range

Variable DC-offset

Internal and external linear sweep

Variable duty cycle

TTL output

NEW

Function generator
PM 5132

The PM 5132 function generator is a general-purpose instrument that will be very attractive for educational applications as well as for laboratory use. It is an extremely versatile generator and produces sine, triangle and square waveforms plus positive and negative pulses, plus DC. It exhibits a high, $30V_{p-p}$ output for all waveforms and $15V_{p-p}$ for pulses. Output impedance is switchable with a choice of 50Ω or 600Ω.

The duty cycle for all waveforms is variable between 10% and 90% and DC-offset can be selected independently for any waveform. This is adjustable from −10V to +10V.

The frequency range of 0.1Hz to 2MHz is adjustable through 7 overlapping sub-ranges and the vernier control allows dial settings of ±2% of the maximum sub-range frequency setting.

Sweep facilities are varied and include:
- choice of linear single or continuous sweep
- adjustable start frequency in the selected sub-range which is independent of stop frequency
- maximum linear sweep range of $2\frac{1}{2}$ decades
- sweep period setting between 50ms and 100s
- control functions with HOLD or RESET by push-button or electronic triggering

A pen lift output is provided and the instrument is short-circuit proof.

Good ergonomic design makes the operation simple while the dimensions of the instrument occupy minimal bench space.

TECHNICAL SPECIFICATION

Waveforms
Sine, triangle, square, positive pulse, negative pulse, DC, variable duty cycle 10%...90%

Frequency range
0.1Hz to 2MHz in 7 overlapping linear sub-ranges

Type of frequency indication
Linear dial

Vernier frequency adjustment
From −5% to +5% of frequency setting

Accuracy
±2% ±0.2% of max. sub-range frequency

Temperature coefficient of frequency setting
< 0.15%/K

Short term drift < 15 min
< 0.2%

Long term drift < 7h
< 0.25%

OUTPUT

Maximum AC open-circuit voltage
$30V_{p-p}$ for sine, triangle, square
$15V_{p-p}$ for pulses

Impedance
50Ω or 600Ω selectable

Frequency response of sine wave amplitude
< 0.1dB–0.1Hz up to 20kHz
< 0.3dB–0.1Hz up to 1MHz
< 1.0dB–0.1Hz up to 2MHz

Attenuation
20dB continuously
0...60dB in 10dB steps

DC offset
0...±10V, open circuit

Short circuit proof
Yes

SINEWAVE

Distortion
< 0.5% up to 20kHz
< 1.0% up to 200kHz
< 3.0% up to 2MHz

TRIANGLE WAVE

Linearity
Better than 99% for frequency < 100kHz

SQUARE WAVE

Rise/fall time
< 75ns

Overshoot and ringing
< 2%

FIXED OUTPUT

TTL compatible
Yes

Duty cycle
Same as main output

Fan out
> 20

SWEEP FACILITIES

INTERNAL SWEEP

Sweep characteristic
Linear

Sweep modes
Single or continuous, selectable

Start frequency
Adjustable in selected frequency sub-range independently from stop frequency

Stop frequency
Corresponds to frequency dial setting

Sweep period
50mS...100S
In 3 sub-ranges continuously adjustable

Control functions
Hold, reset, push button or electronic triggering

Terminals
– SWEEP OUTPUT
– PEN LIFT OUTPUT
– SWEEP TRIGGER INPUT

Frequency control voltage
0V (start freq.) ...+5V (stop freq.) at SWEEP OUTPUT

EXTERNAL SWEEP

Input terminal
SWEEP INPUT

Voltage/frequency characteristic
Linear

Max. sweep range
$2\frac{1}{2}$ decades

Sensitivity
5V for maximum range

Input resistance
47KΩ

Max. sweep frequency
About 15kHz

POWER REQUIREMENTS

Voltage
110, 128, 220, 238V ±10%

Power consumption
25W

Frequency
50–110Hz

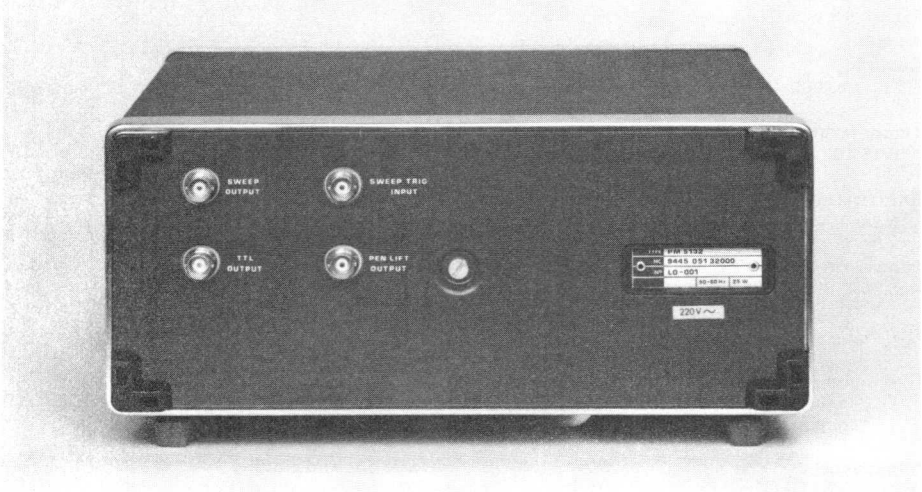
Dimensions and weight (w × h × d)
310 × 140 × 330mm

ACCESSORIES

Supplied with the instrument
Operating manual

Optional
Coaxial cable BNC-BNC (PM 9075)

Rear view of PM 5132 showing location of sweep, TTL and pen lift outputs and the sweep trigger input.



IEC-625

0.001Hz ... 2MHz frequency range

Microprocessor-controlled with LED indication

Extremely accurate frequency setting to within $\pm 1 \times 10^{-6}$

Very high short- and long-term stability

Fast "feather-touch" parameter selection

Sine, triangle, square waveforms plus TTL output

External (AM) modulation facility

IEC-bus interface standard for total remote control in automatic test systems

NEW

LF synthesizer PM 5190

This microprocessor-based LF synthesizer includes many unique features that lift it into a special class of medium-priced signal sources for most professional applications, including instrument calibration. Typical design criteria include $\pm 1 \times 10^{-6}$ frequency setting error and an ageing characteristic of $< 1.5 \times 10^{-6}$/year, which clearly underwrites the inherently high accuracy and stability of this instrument.

It will thus be of interest to design or research laboratories seeking such a highly accurate, stable signal source in the range 0.001Hz to 2MHz for both routine bench use and inclusion in automatic test systems. Its high-grade, virtually zero-error performance, plus simplicity and speed of operation make it equally attractive for use in advanced educational programmes.

The excellent 6 digit resolution of the crystal-controlled oscillator is shown on a bright LED display panel (max. reading 200000) together with the AC ($2\frac{1}{2}$ digits) and DC (2 digits) outputs. DC polarity is also displayed.

In addition, the preselected waveforms and external amplitude modulation characteristics are indicated on this panel.

The user has a choice of sine, square and triangle waveform outputs which are available from a 50Ω front panel socket (BNC connector).

In addition, there is an adjacent TTL socket. External amplitude modulation signals, from 0... > 90% modulation depth can be connected via a rear input socket.

A very clear, simply designed front panel makes operation extremely easy. Fast selection of the desired parameters is assured by 'feather-touch' input push buttons. An 'erase' facility allows equally fast correction of any input errors.

Maximum AC output, for all waveforms is $19.9V_{p-p}$. A DC offset voltage of up to 9.9V max., is available for setting this output to the desired DC level, up to 19.9V total, amplitude. Voltage levels can be set in minimum increments of 1mV.

All functions are fully remotely controllable via the built-in IEC-bus interface, enabling the unit to be used within an automatic testing system, if desired, (no modifications or extra accessories are needed). This facility is further enhanced by the generally high switching speeds resulting from a direct digital signal synthesis technique.
All these comprehensive facilities are contained in a very compact, portable package.

Typical applications in an automated system include, for example:
- accurate testing of audio filters when checking bandpase curves.
- as a standard, when checking, servo motor speed control systems or for audio/video tape stress testing, etc.

Also, when employed as a signal source for calibrating instruments (e.g. frequency meters) its highly accurate and stable output signal may itself be used as a modulation source. Another of the many further uses of the PM 5190 includes the checking of phase-locked loops and servo control systems.

TECHNICAL SPECIFICATION

FREQUENCY AND CHARACTERISTICS

Nominal range
1mHz-2MHz

Measuring range
0.001Hz-2000kHz for sine wave, square ware
0.001Hz- < 100kHz for triangular wave

Setting
- local: via front panel keyboard
- remote: via IEC bus interface

Resolution
6 digits

Display
6-digit 7-segment LED display; 6 decimal points; 2 LEDS for dimension Hz, kHz

Setting error
$\pm 1 \times 10^{-6}$ at 23°C

Temperature coefficient
$< 1 \times 10^{-6}$/K

Aging
$< 1.5 \times 10^{-6}$ per year

Duty cycle
50%

Tolerance
< 0.5% (f = 1kHz)

WAVEFORMS

Sine wave
Square wave
Triangular wave,
All time-symmetrical,
All with or without DC offset;
DC voltage without AC.

Selection
– local: via front panel keyboard
– remote: via IEC bus interface

Indication
LEDs for the selected wave forms

SINE WAVE

Total harmonic distortion
< 0.4% for frequencies 1mHz to 50kHz
< 1.5% for frequencies 50kHz to 2MHz

Non-harmonic components at max. amplitude
< –46dB

Phase noise
< –50dB within 30kHz bands, centered to the output frequency; (frequencies > 50kHz)

SQUARE WAVE

Rise time, fall time
< 50ns

Duty cycle
50%

Tilt
< 3% (f < 100kHz)

Overshoot
< 3%

TRIANGULAR WAVE

Frequency range
1mHz- < 100kHz

Linearity error
< 1% for frequencies < 10kHz

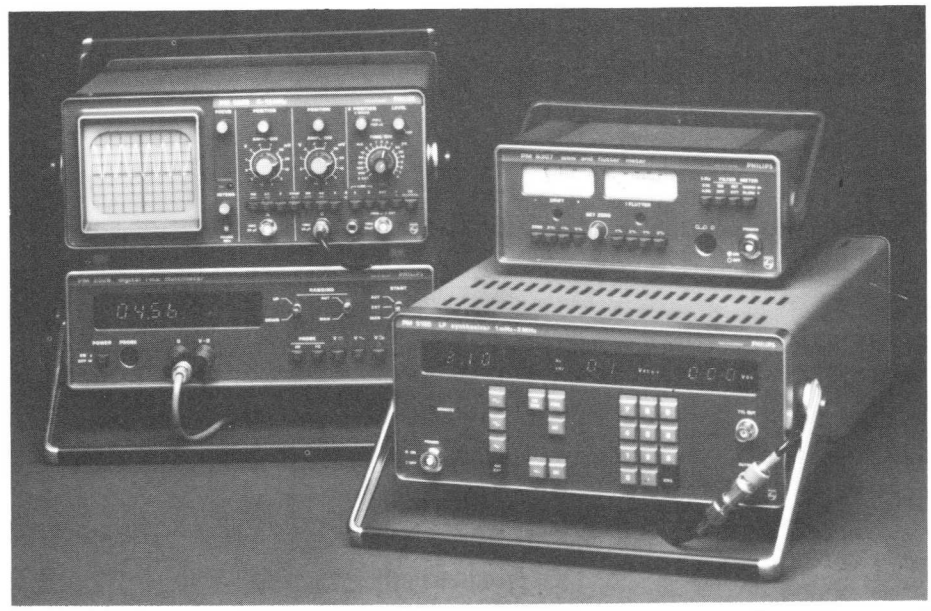
MODULATION

Mode
Amplitude modulation, external

Mode indication
LED

Carrier
– waveform sine wave, triangular waveform
– frequency > 10Hz

Modulation frequency
DC...20kHz



The PM 5190 provides a very accurate and stable signal source to e.g., check and calibrate this wow and flutter meter.

Modulation coefficient
0.1V per 10% AM

Modulation depth
0...90%

Connector
BNC input socket AM EXT, (rear side)

Input impedance
20kΩ

Max. external voltage
±30V

Reference potential
External contact of BNC socket

OUTPUT CHARACTERISTICS

Connector
BNC socket (front side)

Impedance
50Ω, ±2%

Load capacity
Short-circuit proof

Max. external voltage
±5V

Reference potential
External contact of BNC socket

AC VOLTAGE

Range
$0\text{-}19.9V_{ACp-p}$, open circuit

Sub-ranges
I .000-.199V_{AC}
II 0.00-1.99V_{AC}
III 00.0-19.9V_{AC}

Minimum increments
1mV in sub-range I
10mV in sub-range II
100mV in sub-range III

Setting
– local: via front panel keyboard
– remote: via IEC bus interface

Resolution
$2\frac{1}{2}$ digits

Display
$2\frac{1}{2}$ digit, 7-segment LED display

Setting error
±3% for settings 2.0V < AC < 19.9V, for frequencies < 100kHz

Temperature coefficient
< 0.1%/K

DC OFFSET VOLTAGE

DC voltage range
$0\text{-}9.9V_{DC}$, open circuit

Sub-ranges
I .000-.099V_{DC}
II 0.00-0.99V_{DC}
III 00.0-09.9V_{DC}

Sub-range selection
Determined by AC sub-range setting

Minimum increments
1mV in sub-range I
10mV in sub-range II
100mV in sub-range III

Polarity
Positive or negative.
Selectable via keyboard

Setting
– local: via front panel keyboard
– remote: via IEC bus interface

Resolution
2 digits

Display
2-digit, 7-segment LED display: decimal point, position determined by AC decimal point setting

Setting error
±4% from 10% to 100% of each sub-range

Temperature coefficient
< 0.1%/K from 10% to 100% of each sub-range

Max. DC voltage setting
Depending on AC voltage setting;
DC indication ≤ 100 – (AC indication) ÷ 2;
decimal points ignored

TTL OUTPUT

Connector
BNC socket TTL OUT

Duty cycle
50%

Fan out
$\geqslant$ 10 TTL inputs

Level
Standard TTL level: high > 2.4V, low < 0.8V

OUT-OF-RANGE INDICATION

Display flashes, if
– frequency setting > 2000kHz
– frequency setting $\geqslant$ 100kHz for ~
– frequency resolution < 1mHz
– DC voltage exceeds in max. DC voltage setting

REMOTE CONTROL

Conformity
IEC-625: interface system of programmable measuring apparatus

Interface
Built-in IEC bus interface

Remote state indication
Front panel LED

Programmable parameters
– frequency
– AC voltage
– DC voltage
– wave form

Response time
5ms for wave form
6ms for AC voltage
7ms for frequency
14ms for DC voltage

Interface functions
– AH1: acceptor handshake
– L2: listener only
– RL1: remote-local capability

Connector
25-pole standard interface connector, rear side

Max. external voltage
−0.5 – +5.5V, standard TTL level

Reference potential
Measuring earth

Connector housing
Connected to protective conductor

POWER REQUIREMENTS

Line voltage
110, 128, 220, 238V ±10%

Line frequency
50-60Hz

Power consumption
47W

OPERATING CONDITIONS

Reference temperature
23°C±1°C

Operating temperature
5°C to 40°C

DIMENSIONS AND WEIGHT

(w × h × d) 310 × 140 × 365mm
(12.2 × 5.5 × 14.5-in)
6kg (13.2lb)

ACCESSORIES SUPPLIED

Instruction manual

OPTIONAL ACCESSORIES

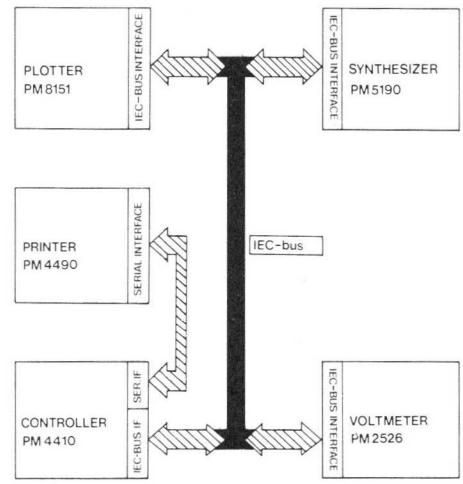
PM 9075 coaxial cable BNC-BNC
PM 9480 IEC bus cable (length 1m)
PM 9481 IEC bus cable (2 meter)
PM 9482 IEC bus cable (4 meter)
PM 9483 IEC/IEEE cable adapter (1 meter)

PROGRAMMING EXAMPLE

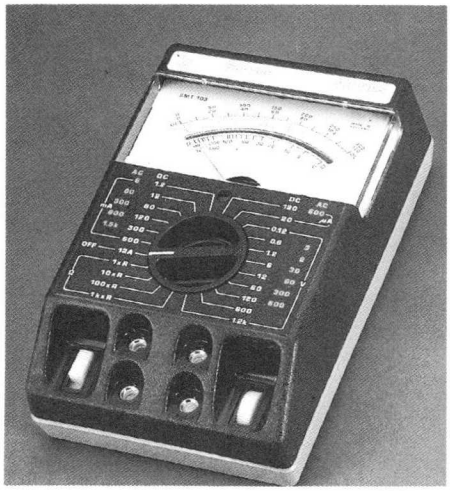
F 1.25 A 10.0 D 05 W 1 EXT

- end of text'; character no. 3 of ASCII code
- sine wave
- wave form indication
- DC value (0.5V)
- DC voltage identification
- AC value (10.0V)
- AC voltage identification
- frequency value (1.25kHz)
- frequency identification

Automatic measuring and plotting of frequency response is made easier using the PM 5190.



Multitester SM-103



- 50,000 Ω/volt input impedance ensures accurate DC voltage measurements, even with high impedance circuits.
- 120mV DC voltage range for measuring transistor circuits.
- AC ranges printed both on scale and range selector in red.
- Large scale and coated window for easy reading.
- Built in scale mirror eliminates parallax error.
- Indicator movement and circuit boards overload-protected.

TECHNICAL SPECIFICATION

ELECTRICAL

DC voltage
Measuring ranges 0-120-600mV
1.2-6-12-60-120-600-1200V
Accuracy f.s.d. ±2.5%
Sensitivity 50,000 Ω/V

AC voltage
Measuring ranges 0-3-6-30-60-300-600V
Accuracy ±3.5% f.s.d.
Sensitivity 10,000 Ω/V

DC current
Measuring ranges
0-20-120 μA
0-1.2-12-60-120-300-600mA
0-12A
Accuracy ±2.5% f.s.d.
Voltage drop
...600mA < 400mV
0–12A < 100mV

AC current
Measuring ranges
0–600 μA
0-6-60-300-600-1500mA
Accuracy ±3.5% f.s.d.
Voltage drop ...1500mA < 1.5V

Resistance
Measuring ranges
1 Ω...1 kΩ
×1, ×10, ×100, ×1000
Accuracy ±2.5%

GENERAL

Indicator
High quality measuring system with four scales and mirror. Coated dial window.

Protection
Printed circuit board is protected with a fuse 1.6A (20 × 5mm).
Measuring system is protected by:
a: diodes (2 × 1N4148) to overload
b. selection knob in OFF position during transport

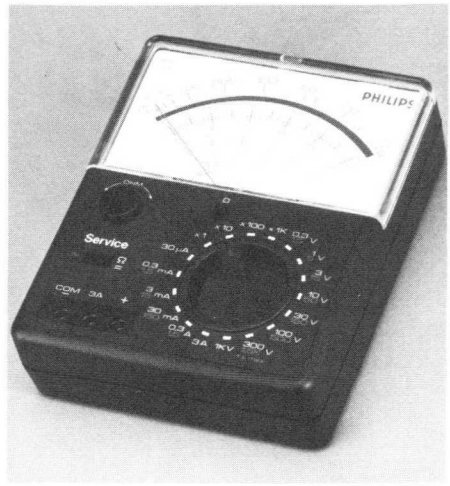
Battery supply
1 × 1.5V penlite (type R6 or UM3)

Dimensions and weight
(w × h × d) 106.5 × 162.5 × 45.7mm
(4.2 × 7 × 1.8-in)
0.68kg approx.
(1.5lb)

Direction for use
Direction for use is language independent

Accessories
Carrying case 4822 600 30006

Multitester UTS-001



- 50,000 Ω/volt input impedance ensures accurate DC voltage measurements, even with high impedance circuits.
- 300mV DC voltage range for measuring transistor circuits.
- One direct reading linear scale for AC and DC voltages and currents.
- AC ranges are red printed on scale plate and around selection knob.
- Large, clear scale which is very easy to read.
- Paralax errors eliminated due to the scale's built-in mirror.
- Overload-protection. The measuring system is protected by diodes. Printed circuit board is protected with a fuse 3.15amp. inside the pointer of the red lead. During transport the measuring system is protected with selection knob in 30μA position.

TECHNICAL SPECIFICATION

ELECTRICAL

DC voltage
Measuring ranges
0-0.3-1-3-10-30-100-300-1000V
Accuracy ±2.5% f.s.d.
Sensitivity 50,000 Ω/V

AC voltage
Measuring ranges 0-1.5-5-15-50-150-1500V
Accuracy ±3% f.s.d.
Sensitivity 10,000 Ω/V

DC current
Measuring ranges
0-30-300 μA
0-3-30-300-3000mA
Accuracy ±2.5% f.s.d.

AC current
Measuring ranges 0-1.5-15-150-1500mA
Accuracy ±3% f.s.d.

Resistance
Measuring ranges
10 Ω...10 kΩ
×1, ×10, ×100, ×1000
Accuracy ±2.5% f.s.d.

Decibels
Measuring ranges
−20+5, −10+15, 0+25dB,
+10+35, +20+45, +30+55dB,
+40+65dB

GENERAL

Protection
Printed circuit board is protected with a fuse 3.15 Amp. inside the pointer of the red lead.
The measuring system is protected with diodes (1N4148, AA119) against possible overload due to wrong connections, except the 30, 100, 300, $1000V_{DC}$ and the corresponding V_{AC} ranges.

Battery supply
2 × 1.5V penlite battery (type R6 or UM3)

Dimensions and weight
(w × h × d) 105 × 130 × 35mm
(4.1 × 5.1 × 1.4-in)
0.24kg approx.
(0.5lb)

Direction for use
Direction for use is language independent

Accessories
Carrying case 4822 600 30011

Audio and video service equipment

Introduction

The reliability of modern electronic equipment has improved immeasurably over the years. However, time, intensive use, accidents, necessitate realignment or repair at some period in the life of most radio and HiFi set ups, black and white, colour TV, cable and closed circuit TV sets. Within industry production test equipment is subject to long, continuous use and must always be maintained at its peak performance. In education and training environments, electronic equipment is probably most liable to accidental misuse and needs to be well protected against such eventualities.
So, the test equipment especially designed to cope with all these situations must itself exhibit high orders of performance and reliability and be consistently accurate.

Philips, as one of todays largest manufacturers of radio, audio and TV equipment have had considerable, everyday experience of the special problems related to testing and servicing. Information on the practical aspects of employing test equipment has been fed back continuously from Philips' many in-house users to the design teams along with recommendations for improved product specifications.

It follows that the test and measuring equipment described in this section embodies the best practical features that will satisfy the most stringent demands of all service and educational requirements.
For field service – compactness and low weight: for industrial applications – consistency of performance over long periods: for education – simplicity of operation and physical robustness.

Whatever the application, whatever the environment, Philips audio and video service equipment will give longterm and absolutely reliable performance.

Choosing the right instrument
This survey is designed to assist the user to select the best combination of instruments related to a particular application and instrument performance.

It is subdivided into audio or video applications and proposes alternative instruments for some situations.

There follows a brief review of those instruments considered to be basic essentials for inclusion in the modern service departments inventory and which will complement the specialized audio and video equipment for education and service.

Audio and video service equipment

A: denotes alternative choice of instruments

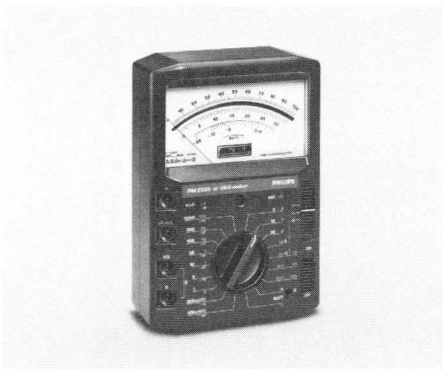
Description	Type No.	Audio		Video			Page
		Hi-Fi AM-FM Stereo	Record players Recorders	Colour TV	B/W TV CCTV	VCR/VLP	
Oscilloscope, dual trace 15MHz or,	PM 3226	•	•	•	•	•	34
Oscilloscope, dual trace 15MHz or,	PM 3226P	•				•	34
Oscilloscope, single trace 15MHz	PM 3225	•	•	•	•		34
Low distortion LF Generator	PM 5107	•	•			•	142
LF Sweep Generator, and	PM 5165	•	•				145
Amplifier/Log converter	PM 5171	•	•				146
RF Generator	PM 5326	•				•	161
TV Sweep/RF Generator	PM 5334			•	•	•	173
TV colour pattern Generator	PM 5501			•	A	A	167
PAL colour pattern generator*	PM 5519*			•	A	•	168
SECAM generator	PM 5215			•		•	171
SECAM/PAL generator	PM 5217			•		•	171
RCL Bridge	PM 6302	•				•	160
Wow and flutter meter	PM 6307		•			•	163
Stereo Generator	PM 6456	•					165

In addition to the above list there is a wide choice of complementary instruments including multimeters, voltmeters, recorders, power supplies, etc. details of which appear elsewhere in this catalog.

* Also for RTMA, NTSC-TV systems used e.g. in U.S.A., Canada, Mexico and Japan.

MULTIMETERS FOR RADIO AND TV

From the very wide selection of available multimeters (page 103) four general-purpose models will be of interest, the PM 2505, PM 2517E, PM 2517X and PM 2522. The PM 2505 is an analog meter for AC, DC and resistance measurement.



PM 2505

The very compact, low-cost, 4-digit multimeters PM 2517E and PM 2517X have the same basic design specification, but offer the choice of either LED or liquid crystal display systems. They will measure volts, current, resistance and temperature. Automatic ranging ensures maximum resolution and accuracy for each measurement. Both models employ a true RMS detector to avoid errors introduced by 'average detecting' systems and are fully overload-protected.

PM 2517E and PM 2517X

The PM 2522 is a more sophisticated digital multimeter, which, in common with the previously mentioned instruments, uses LSI circuitry. Thus its accuracy remains constant and the instrument never needs to recalibration, making it an ideal service workshop or industrial tool.

POWER SUPPLIES

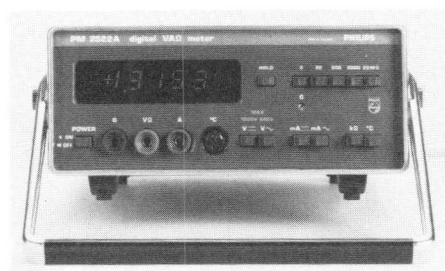
The Philips range of power supplies (page 227) offers a very wide choice of power sources for practically every servicing requirement – bench models, modular types, switched-mode and economy designs, all at competitive prices.
Typically, bench types PE 1535 and PE 1537 provide 0...40V/0...0.5A and 0...40V/0...1A respectively. These are both very compact instruments. For more sophisticated set-ups there are the high-power conventional designs and switch-

PE 1535

ed-mode types available both for standard 19-in or DIN 41494 rack mounting. A range of AC voltage stabilizers, DC/DC converters and constant voltage transformers is also available.

LF GENERATORS

One instrument in the LF equipment programme of most interest to service applications is the very compact PM 5107 which features a 'low distortion' setting for HiFi applications, development or alignment and maintenance requirements. It provides sine and square wave signals plus a separate TTL output. When used with oscilloscope PM 3226P it represents a very versatile service set-up.
Also, for measuring and recording audio response curves, the combination of LF generator PM 5165, Amplifier/log converter PM 5171 and an X-Y recorder is a versatile, practical, set-up.
Educational applications will be well suited by the function generators PM 5131, PM 5132 and PM 5129, whilst the PM 5108L, with its monitored output giving a choice of 50 or 600 Ω impedance is ideally suited to telecommunications.



PM 2522

SERVICE OSCILLOSCOPES

The single-trace PM 3225 and dual-trace PM 3226 are described fully on pages 36 and 37 and are especially recommended for use in servicing applications. For education use, the extra display facilities of the PM 3226P will be found invaluable in many training situations.
All three units are compact with well-designed front panels allowing quick familiarity with the controls.

PM 3226

The common bandwidth of 15MHz is more than adequate for the situations in which they will be involved, as is the high, 2mV sensitivity. Bright 8×10div screens give excellent displays. Triggering facilities include TOP, AC, LINE, plus TV at the touch of a button. The PM 3226 display modes include A, B, A and B chopped or alternate. In addition, the PM 3226P offers all these plus:
- inversion of Y_A signal
- addition or subtraction of Y_A and Y_B signals
- use of the Y_B amplifier as the X input

In addition to the foregoing list of instruments, the many other types covered in this catalogue will meet practically any audio or video testing requirement, however sophisticated the product may be.
All have been specially designed for ease of operation and employ advanced components to meet the demands of modern technology used in HiFi radio and TV.

PM 5107

RCL Bridge
PM 6302

Measuring ranges:
– resistance 0.1 Ω to 100MΩ
– capacitance 1pF to 1000μF
– inductance 1μH to 1000H

Linear scale

Loss factor measurements

Accuracy better than 2%

Special 'search mode' for range location

Automatic sensitivity control

The PM 6302 is a modern transistorised RCL bridge with wide measuring ranges. Facilities for loss factor measurements, DC polarisation of electrolytic capacitors, connection of an external AC source (up to 20kHz) further extend the versatility of the instrument.
A great deal of care has been taken to ensure that the PM 6302 can be operated quickly and easily. In this respect, a special 'search mode' is provided that enables quick location of the correct operating range. Furthermore, there is no time-consuming sensitivity control; sensitivity is adjusted automatically.
This ease of operation combined with reliable and accurate performance make the PM 6302 the perfect instrument for resistance, capacitance and inductance measurement.

TECHNICAL SPECIFICATION

Measuring ranges
Resistance: 0.1Ω–100MΩ
Capacitance: 1pF–1000μF } 9 ranges
Inductance: 1μH–1000H

Dial linear, 1–10

Loss factor
Capacitance D: 0.1–1.4 (100Hz); 0.01–0.14 (1kHz)
Inductance Q: 1–14 (1kHz)

$$Q = \frac{1}{0.01} = \frac{1}{0.14}$$

Accuracy
RCL measurements: < 2%, except extreme ranges
Loss factor measurements: < 5% from max. range value

Measuring signal frequency
– for resistance: DC
– for capacitance and inductance:
100Hz for capacitances with relatively high loss factor;
1000Hz (internal): 0.1Hz–20kHz (external)

DC polarisation
$60V_{max}$ (external battery)

Null indicator: meter

Sensitivity of indicator
Automatically controlled by bridge output voltage

Power
Line voltages: 115/230V; 48...60Hz,
Consumption: 3.5W

Dimensions and weight
(w × h × d) 230 × 145 × 285mm
(9 × 5.6 × 11.2-in)
3kg (6.6lb)

100kHz to 125MHz in 9 overlapping ranges

Built-in 5 digit counter displays RF-carrier, marker and external frequencies to $10^{-4} \pm 1$ digit

50mV RF output at 75Ω can be attenuated to over 100dB

Output level electronically stabilized

Wobbulator facility for IF amplifiers AM/FM, radio and TV receivers

RF signal generator PM 5326

The RF signal generator PM 5326 has been specially designed for radio and television development laboratories and those involved with receiver sensitivity and selectivity measurements. For service workshops and education the generator also provides four wobbulator ranges for the alignment of IF amplifiers and FM receivers.

Colour coded controls

The generator is divided into three functions: Main RF oscillator; sweeper; and marker generator. Controls for each function are differently colour-coded, being grouped for operator convenience.

Main RF oscillator

The output frequency extends from 100kHz to 125MHz in 9 push-button selected ranges amply covering the domestic AM/FM radio spectrum. A built-in 5-digit display enables frequencies to be easily set to 1 part in 10000, essential for precise alignment procedures, selectivity and filter tests. This counter can also measure frequencies from external oscillators to 999.99kHz, extendable to 99.999MHz by optional PCB. Typical uses for the counter include alignment of TV remote control units and checking line and frame timebase frequencies.

The output level is electronically stabilized for all ranges eliminating resetting and the need for meter reading and can be continuously attenuated to over 80dB from the maximum of 50mV into 75Ω. This may be set to levels calibrated at −3dB and −40dB with a separate attenuator. A particular feature of the generator is the special attention given to spurious RF radiation. A 'double-box' construction gives a high degree of screening keeping RF radiation very low and ensuring that low level outputs in the region of 0.5μV can be used with full confidence.

AM/FM modulation

A choice of CW or MCW output AM or FM and internal or external modulation signals are quickly selected by push-buttons. All AM signals can be internally modulated by a 1kHz tone to a depth of 30% which is adequate for most applications. This can be increased to 100% over the range 20Hz to 20kHz (3dB) by an external source. Frequency modulation may be applied to the 10/11MHz and 75–110MHz ranges allowing complete alignment checks to be made on FM receivers. Internal frequency modulation at 1kHz is equivalent to a 22.5kHz deviation. External signals can be applied to a maximum deviation of 75kHz over the frequency range 20Hz to 60kHz (3dB).

A swept frequency oscillator (wobbulator) output is available to measure the dynamic response of intermediate frequency amplifiers in AM/FM and TV receivers. The operating parameters 1 to 4 are set by push-buttons and variable controls. The maximum sweep widths are 40kHz for AM/IF, 1.2MHz for FM/IF and Band II and up to 10MHz for the video IF ranges. Sweep rate is either by a linear saw-tooth between 3–30Hz or at a line frequency with phase adjustment.

Marker generator

Markers are available in each RF sweep range to indicate a precise frequency value and provide a calibrated frequency scale over the complete spectrum. The position of the variable marker is controlled by the main frequency control and the setting is displayed on the internal counter. Fixed markers at regular intervals may be added to the output signal by pulling the marker amplitude switch.

TECHNICAL SPECIFICATION

FREQUENCY

100kHz–125MHz in 9 push-button selected ranges.
Selected frequency ranges:
1. 100kHz–250kHz
2. 250kHz–500kHz
3. 500kHz–1000kHz
4. 1MHz–2.5MHz
5. 2.5MHz–5MHz
6. 5MHz–10MHz
7. 10MHz–25MHz
8. 25MHz–50MHz
9. 50MHz–125MHz

RF frequency display
Bright 11mm 5 digit LED display for all ranges varied by FREQUENCY SETTING knob.

Error display
$< 10^{-4}$ typical, ±1 digit

Temperature coeff.
5.10^{-6} at 25°C over ±20°C

Stability
1.10^{-6} short term

Temperature coeff.
$< 10^{-5}$/°C

RF OUTPUT

BNC-connector

Impedance
75Ω

Voltage
50mV at 75Ω

Frequency response
< 2dB (typical 1dB) in each RF range

Attenuation
80dB continuous with indication
40dB and 3dB calibrated and switchable
In total more than 100dB

MODULATION

AM (In all ranges)
Unmodulated
Internal 30%, by 1kHz sinewave
External 0...100% with signals 20Hz to 20kHz (3dB)

AM modulation coeff.
200mV per 10% modulation depth

FM
In the frequency ranges 10–11MHz and 75–110MHz, the carrier can be:
Unmodulated
Internally modulated with 1kHz sinewave (deviation ±22.5kHz)
Externally modulated with signals 20Hz –60kHz (3dB) (deviation 0 to ±75kHz.

FM modulation coeff.
200mV for ±7.5kHz deviation

AM-FM input
BNC-connector
MOD/IN

Input impedance
> 10kΩ

RF sweep ranges
400kHz–500kHz
10MHz– 11MHz
75MHz–110MHz
36MHz– 41MHz

Frequency response
< 0.2dB in sweep ranges

Sweep frequency
3–30Hz variable
50Hz or 60Hz mains, phase variable

Sweep widths (fully variable)
0–40kHz on sweep range 400kHz–500kHz
0–1.2MHz on sweep range 10MHz–11MHz
0–1.2MHz on sweep range 75MHz–110MHz
0–10MHz on sweep range 36MHz–41MHz

Linearity error
< 5%

Centre frequency
Fully adjustable between minimum and maximum

Output
BNC-connector, SWEEP OUT:
a. LF sweep (3–30Hz to 50/60Hz)
b. 1kHz (dependable on push-button selection)

Voltage
2–10V_{p-p} (varied by internal sweep) and 2V, 1kHz at: AM-FM internal.

Impedance
1kΩ

MARKER GENERATOR

Fully variable over all four RF sweep ranges and indicated by LED display.

Marker
Marker mixing, AF beat frequency markers

Amplitude
Adjustable to 2V_{p-p}

Output
Marker addition via loop through BNC connections
Y_{in}–Y_{out}

Impedance
> 500kΩ

FIXED MARKERS

Obtained by pulling marker amplitude switch. Distance between the fixed markers dependent on selected range.

Counter
Selected by COUNTER EXT push-button

Input
BNC-connector

Frequency range
1 999.99kHz

Input voltage
30mV...50V

Input impedance
1MΩ

POWER REQUIREMENTS

Line voltage
115–230V (±15%–10%)

Frequency
50–60Hz (±5%)

Power consumption
18W

DIMENSIONS AND WEIGHT (w × h × d)

230 × 140 × 310mm
9 × 5.5 × 12.2-in
6.5kg (14.3lb)

Optional
PM 5326X with counter facility up to 100MHz
PM 5326G with 5.5MHz fixed marker controlled in sweep range 31...46MHz

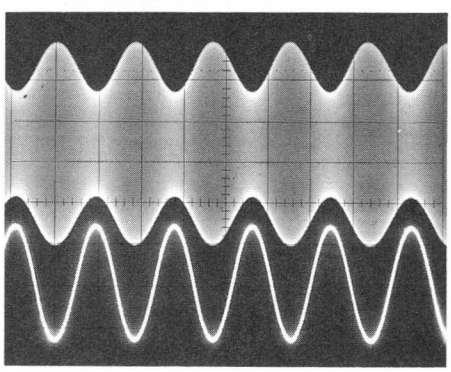
ACCESSORIES SUPPLIED

Mains cable
Manual

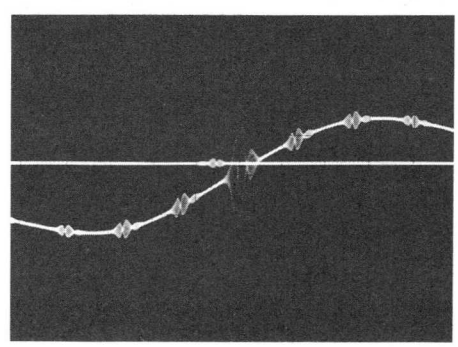
OPTIONAL ACCESSORIES

PM 9537 Cable with impedance transformer 75Ω/300Ω
PM 9072 Cable BNC – 4mm
PM 9075 Cable BNC – BNC

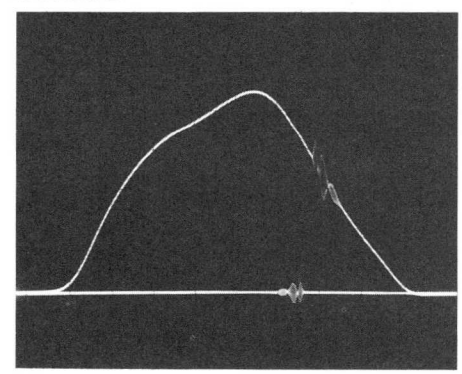
Internal AM signal, 1kHz and 30% modulation depth at a carrier frequency of 27MHz.



S curve with variable marker at 10.7MHz and fixed markers at regular intervals of 100kHz.



The luminance IF curve is aligned at its frequency of 38.9MHz.



X-tal controlled oscillator

High accuracy and frequency stability

3150Hz and 3000Hz selectable

Separate 'Drift' and 'Flutter' indication

In/Output connector to DIN 41 524

Easy to operate

Wow & flutter meter
PM 6307

Previously reserved as a special tool for the audio design laboratory, the wow and flutter meter has today become a must for every audio and video service workshop. The easy-to-operate PM 6307 is designed to identify and quantify unwanted speed variations in audio and video tape recorders, record players and movie projectors. With its X-tal controlled oscillator giving the choice of 3.15kHz or 3kHz DIN frequencies, it is possible to make very accurate wow and flutter checks and alignments.

Readout of speed fluctuations of, for example, a recorder, is indicated on two separate analog meters, one for drift and one for wow and flutter. Calibration of the drift indicator is simple, being achieved by depressing the ZERO button, while the SET ZERO control is adjusted for zero indication. The use of the X-tal oscillator eliminates the long warm-up time associated with normal RC types with the advantage that the instrument can be used immediately after switch-on. The measuring ranges for drift and flutter are separately selectable by pushbuttons.

There is also a convenient choice of three positions for wow and flutter measurements. With the filter switched ON, the frequency response is 'weighted', according to DIN Standard 45507.

In the filter OFF position a linear frequency response 0.5Hz to >500Hz (−3dB) is available and the 'unweighted' flutter is indicated.

For special measurements beyond the normal everyday usage there is a connector on the rear panel to apply any desired external filter.

Ideal for fast checks and alignment procedures, the PM 6307 is especially favoured in servicing applications, because it will differentiate between mechanical and electrical problems.

Generally, the wow/flutter meter indicates a mechanical failure whilst the drift meter is associated with electronically sourced faults.

Small in size, light in weight and extremely easy to operate thanks to good ergonomics design, this instrument is a real asset for today's audio and video service requirements.

To detect extremely slow speed variations, the SLOW RESPONSE setting is selected. A range of input and output connectors is available which will meet the requirements of service workshops and development laboratories alike. Because the majority of wow and flutter measurements are made on consumer HiFi, record players, tape and cassette recorders, the in/output standard DIN connector is conveniently located on the front panel.

TECHNICAL SPECIFICATION

Oscillator

Frequency: 3150Hz and 3000Hz. Selectable (X-tal controlled)
Accuracy: $<10^{-4}$ (ref. 23°C)
Stability: 1×10^{-5}

Output 1: DIN connector at front panel (DIN 41524)
Signal voltage: $400mV_{p-p}$ Open circuit
$100mV_{p-p}$ by 47kΩ load
$20mV_{p-p}$ by 10kΩ load
Internal resistance: R_i 430kΩ

Output 2: BNC connector at rear panel
Signal voltage : $1V_{p-p}$
Output impedance: 600Ω

Measurement section

Input 1: Same DIN connector as output 1 at front panel
Input 2: BNC connector at rear panel
Input voltage: 2mV...10V
Input impedance: 10kΩ
Test frequencies: 3150Hz or 3000Hz selectable
Calibration: With zero set pushbutton and control on front panel

Drift-measuring range: ±0.3% ±1% ±3%
Indication: Analog meter, with zero at midpoint
Flutter-measuring range: 0.1%, 0.3%, 1%, 3%
Indication: Analog meter

Frequency response flutter indication

Selectable
A. weighted: Position – Filter on According to DIN Standard 45507
B. unweighted: Position – Filter off 0.5Hz...500Hz (–3dB) bandpass
C. external: Position – Filter ext. Connector at rear panel for use of an external filter

Reading speed
Normal: According to DIN 45507
Slow: Slow response (e.g. to measure the average value of fast speed variations)

Output 3: BNC connector (on rear panel) 0.5Hz...500Hz (–3dB)
Bandwidth: (For fast recording or oscilloscope display)
Output impedance: 10kΩ
Frequency variation coefficient: For 'Drift' 1 Volt corresponds with 1%
For 'Flutter' $2V_{p-p}$=1%

Power supply
Line voltage: 115–230V (±15%)
Line frequency: 50/60Hz
Power consumption: 2W

PM 6307 being used to check a tapedeck for wow and flutter

Rear view of PM 6307 showing output/input sockets

Accessories supplied
– mains cable
– operating manual
– Cassette 3150Hz

Dimensions and weight
(w×h×d) 230×110×210mm
(9×4.3×8.3-in)
2kg (4.4lb)

Optional accessories
Record 3150Hz
Tape 4.75cm/sec (3150Hz)
Tape 9.5cm/sec (3150Hz)
Tape 19cm/sec (3150Hz)
All these items are to DIN 45507

Complete stereo signal with low crosstalk

Separate L and R signals

External modulation facility

X-tal controlled pilot

Adjustable multiplex signal

Tunable 100MHz RF signal

Stereo generator PM 6456

The PM 6456 meets the requirement for a fast and efficient method of checking and aligning FM tuners and receivers. What used to be a somewhat complex procedure has now been changed to a logical sequence of operations using professional signals (FCC and IBU).
Modern service establishments using the PM 6456 can also benefit from the external stereo modulation facility, which allows a record player or tape recorder to be used in order to demonstrate FM tuners. This is extremely useful as many areas suffer from poor FM reception and suitable transmissions are not always continuously available. This feature can also be used to make an audio check-out after alignment.
The multiplex signal to the decoder of the tuner or receiver has continuous amplitude adjustment and in addition to the external modulation facility, the generator also has two internal 1kHz and 5kHz signals for testing in the low and middle part of the audio spectrum. For complete receiver check-outs and to speed-up fault location the PM 6456 is supplied with a separate 100MHz RF signal that is tunable over ±1MHz.

TECHNICAL SPECIFICATION

Sequence of signals, selectable with pushbuttons

Pilot
Pilot of 19kHz
1kHz
Internal modulation of 1kHz
5kHz
Internal modulation of 5kHz
EXT
External modulation e.g. from stereo recorder or record player.
R
Only right channel
L
Only left channel
R = −L
S signal
RF
RF output of 100 MHz ±1MHz

LF MODULATION

Internal
Frequency: 1kHz or 5kHz switchable
Distortion: ≤3%

External
Modulation with signal from stereo recorder or record player.
Input: DIN socket 5 pins
Frequency range: 30Hz...15kHz
Input impedance: ≈500kΩ according to DIN 45500
Max. input voltage: $20V_{p-p}$
Pre-emphasis: 50μsec
Modulation coefficient: $0.1kHz/mV_{eff}$

The modulation coefficient can be altered by internal change of a resistor if required.

LF MULTIPLEX OUTPUT

Voltage
0–5 V_{p-p} ±10% continuously

Load resistance
2.5kΩ

Internal resistance
200Ω

Pilot
19kHz ±2Hz X-tal controlled

Subcarrier
38kHz ±4Hz

Phase difference between pilot and subcarrier
< ±3°

Subcarrier suppression
> 40dB

Crosstalk suppression between L and R signal
(At ambient temperature of 23°C)

For internal signals
1kHz and 5kHz: > 40dB

For external signals
Freq. response of 0.25–6.3kHz: > 40dB
Freq. response of 1kHz–10kHz: > 40dB

Suppression between M and S signal
At ambient temperature of 23°C
Internal signals of −1kHz and 5kHz: > 32dB

RF OUTPUT

Output
BNC connector 75Ω

Voltage
$3mV_{p-p}$ into 75Ω load

Frequency
100MHz tunable ±1MHz

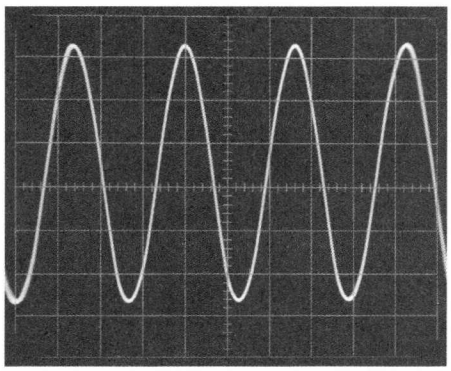


Fig. 1. Shows the 19kHz pilot tone from the PM 6456 applied to the input of the stereo decoder. Pilot tone and subcarrier frequency are checked and aligned.

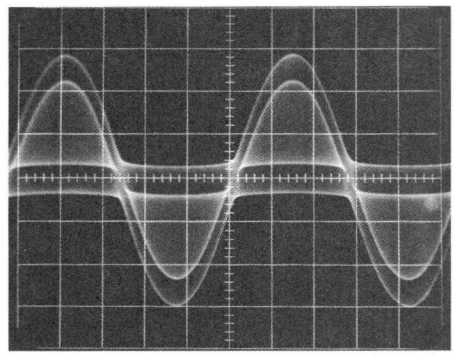


Fig. 2. To align for minimum crosstalk, the push-buttons for the R signal, a 1 or 5kHz tone and pilot are depressed. Shown is the resulting multiplex signal applied to the input of the decoder.

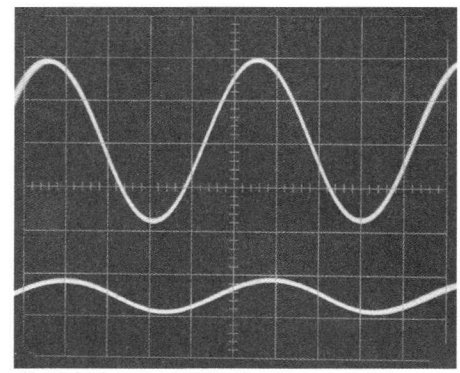


Fig. 3. At the output of the decoder crosstalk between the Left and Right channel is made visible using a dual beam oscilloscope. Displayed are: upper beam; right channel signal, lower beam; crosstalk on left channel.

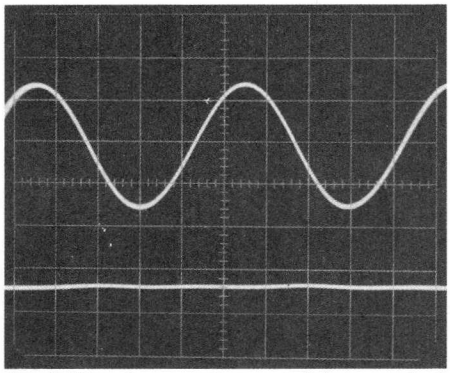


Fig. 4. After alignment, the crosstalk between the L and R channel has been minimized, as indicated by lower beam.

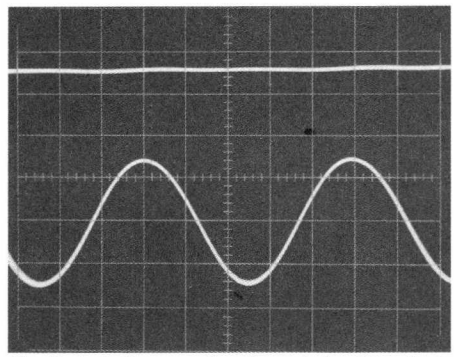


Fig. 5. A similar procedure is carried out to obtain minimum crosstalk between the R and L channel.

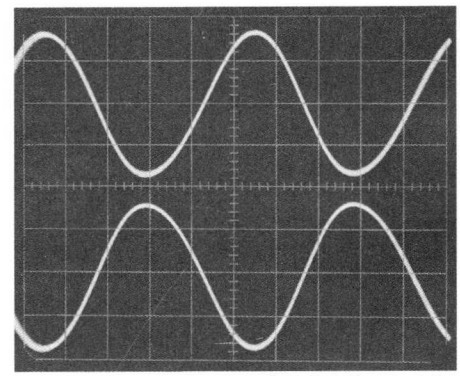


Fig. 6. Shows a full stereo decoded signal at the output of the decoder.
Note: Both signals have equal amplitude and opposite phase. To obtain this display, the pilot, 1 or 5kHz and R = −L push button are depressed.

INTERNAL MODULATION

FM

Freq. deviation
40kHz

Freq. deviation by Pilot tone
6.75kHz

EXTERNAL MODULATION

FM

Freq. deviation
0...75kHz

SYNCHRONISATION OUTPUT

Output
BNC connector

Voltage
$\approx 3V_{p-p}$

Internal impedance
10kΩ

Frequency
1kHz and 5kHz

POWER

Line voltage: 115/230V ±15%
Frequency: 50/60Hz
Consumption: 2.5VA

DIMENSIONS AND WEIGHT

(w × h × d) 210 × 145 × 280mm
(8.3 × 5.6 × 11-in)
3kg (6.6lb)

ACCESSORIES SUPPLIED

Mains cable
Manual

OPTIONAL ACCESSORIES

Cable PM 9538
BNC connector/Belling plug

Cable PM 9537
BNC connector/impedance transformer 75 to 300Ω

Extremely light and compact instrument for mobile maintenance

5 Different test patterns for colour and black/white TV installation and service

RF output signal switchable: VHF, Band III and UHF Band IV

1kHz tone for sound performance checks (sine wave)

Synchronisation according to standard

Colour bar pattern generator PM 5501

The PM 5501 colour pattern generator has been specially designed for black/white and colour TV alignment and service at the customer's house. The generator provides the 5 essential test patterns, necessary to make installations, fast checks and repairs on CTV and TV receivers possible. They are selected by push buttons.

The instrument is extremely light and portable and because of the small dimensions it can easily be carried in service or tool kit.

The PM 5501 operates according to the CCIR 625 line TV standard, system G, internally changeable to system I. The colour signals conform the PAL system. Synchronisation is also according to standard, which incorporates interlacing. To ensure fast operation, two fixed RF signals are selectable i.e. on VHF channel 7, and for UHF channel 30. When required this VHF channel 7 may be altered to any frequency in BAND III 170–230MHz. The same applies for UHF channel 30, which can be changed internally to any channel in the frequency range 470...600MHz. For accurate tuning and checking the sound performance of a CTV receiver, the generator has a 1kHz tone available. This tone also makes checks on interference between luminance and sound, as well as chroma/sound possible.

TECHNICAL SPECIFICATION

TEST SIGNALS

a) 8 bars, linearized, grey scale.
b) Cross-hatch pattern.
c) 100% white pattern (with burst).
d) Red pattern (50% saturation).
e) Standard colour bar with white reference 75% contract (internal changeable to full bars).

(Full colour patterns are reproduced in the catalogue sheet and brochure of the PM 5501.)

VIDEO CARRIER

Frequency
VHF BAND III: 170–230MHz. Fixed output at channel 7. (internally changeable to any required channel in selected range).
UHF BAND IV: 470–600MHz. Fixed output at channel 30 (internal changeable to any required channel in range).

RF output
BNC connector
Impedance
75Ω
Output voltage
$>10mV_{p-p}$
Video modulation
AM negative

SOUND CARRIER

Frequency
5.5MHz (or 6MHz by internal adjustment)
Modulation
FM
Internal signal
1kHz sine wave
FM sweep
approx. 40kHz on 5.5MHz
Ratio of sound vision carrier
approx. 12.5dB

CHROMA

System
PAL-G and I
Carrier frequency
X-tal controlled 4.433619MHz+2Hz
Burst
according to PAL system.

SYNCHRONISATION

Line frequency
15625Hz
Frequency tolerance
±5Hz
Lines
625
Field frequency
50Hz
Frame sync. signal
according to standard, interlacing

POWER

Voltage: 115V-230V ±15%
Frequency: 50–60Hz
Power consumption: 6W

DIMENSIONS AND WEIGHT

(w × h × d) 230 × 110 × 210mm
(9 × 4.3 × 8.3-in)
1.25kg (2.75lb)

ACCESSORIES SUPPLIED

Instruction manual, and mains cable

OPTIONAL ACCESSORIES

PM 9538 cable, BNC–TV connector 75Ω
PM 9539 cable, BNC–impedance transformer 75–300Ω
PM 9075 cable, BNC–BNC 75Ω

Colour pattern generator (PAL or NTSC) PM 5519

Over 20 combinations of test patterns (colour and b/w) for CTV, TV, VCR and VLP

All signals to TV standard CCIR, System G-I-M and N, Colour PAL (RTMA-NTSC version available)

Full RF coverage: TV IF, Band I - III - IV and V

Electronic tuning with six pre-set channels

Synchronisation according to TV standard, also obtainable as comp. and frame sync.

The versatile PM 5519 offers the extensive choice of more than twenty different b/w and colour test pattern combinations.

It can be used with CTV, TV, VCR or VLP operating with practically all international TV broadcast systems and standards.

The engineer is able to select a series of test patterns in the sequences he intends to use. This time-saving facility coupled with an inherently high quality output. plus the wide versatility make the PM 5519 ideal for fast, accurate video measurements almost anywhere in the world.

The generator normally operates in accordance with the CCIR TV standard, system G.I.M. or N, and colour PAL. Also another version is available for operating in accordance with the RTMA TV standard, system M and the NTSC colour system.

It is electronically tuned to almost any available TV channel (IF; band I, III, IV and V) and any one of six channel presettings can there after be selected by push button.

The high quality 10mV$_{RMS}$ RF output can be continuously attenuated over more than 60dB for sensitive checks on CTV and TV. The use of separate oscillators for VHF and UHF plus a special IC for RF modulation virtually eliminates harmonics and gives and excellent 12.5dB approx sound/vision ratio.

The video output is nominally 1V into 75Ω (adjustable 0...1.5V) and the RF carrier can be modulated with a signal from an external video source. Chroma and burst signals are selectable in calibrated steps of 0–25–50–75 and 100%.

An internal 1KHz sinewave is available for both sound performance and accurate tuning checks. The sound carrier can be switched off when not required or when selecting an externally applied signal (from cassette recorder, record player, etc.).
Nominally 5.5MHz, the sound carrier frequency can be operated at 4.5, 6, 6.5MHz by changing an internal soldered connection.

Line and frame synchronisation is achieved by a special IC which incorporates interlacing. A second IC ensures that the colour subcarrier and line frequency are locked according to the TV standard. The correct colour offset is thus applied to guarantee bright and interference-free colour test patterns.

Other features include special colour patterns to align the chroma delay line in amplitude and phase or to check the subcarrier phase. The combined eight step linear grey-scale pattern with five bars of multiburst in the frequencies 0.8, 1.8, 2.8, 3.8, and 4.8MHz achive maximum obtainable resolution. There is also a further special test pattern to meet the latest VCR requirements, with or without receiver recognition pulse.

TECHNICAL SPECIFICATIONS

Test signals
a. circle (white or black)
b. checker board (6 × 8 squares)
c. dots
d. cross-hatch
e. eight step linear grey scale multiburst: 0.8–1.8–2.8–3.8–4.8MHz
f. 100% white pattern (with or without burst)
g. purity patterns, red-green-blue +3 complementary colours
h. DEM pattern for alignment of the chroma delay-line, subcarrier and demodulators
i. VCR pattern, chroma staircase; eight bars of incresing saturation 3 bars of multiburst of 2.8, 3 and 3.2MHz 100% white horizontal bar
j. standard colour bar with white reference

Video carrier
Frequency
T.V. system CCIR (changeable to RTMA)
IF + Band I, 38–90MHz
Band III, 170–250MHz
Band IV/V, 470–820MHz
Option S channels for cable TV applications 6 preset channels with electronic tuning

RF output
RF output: BNC connector
Output voltage: > 10mV
Attenuation: > 60dB, continuous
Impedance: 75Ω

Video modulation
Video modulation: AM, negative (or positive, with internal change of soldered tag)

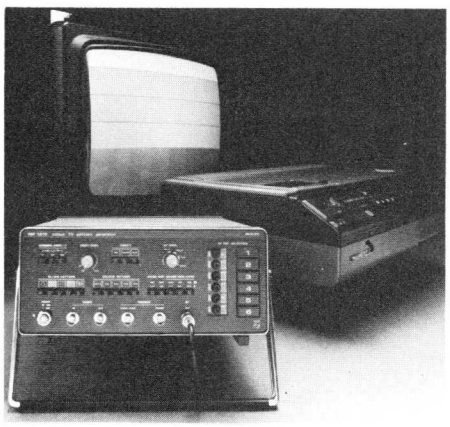
Video input
Video input: BNC connector (1)
Input voltage: $1V_{p-p}$
Polarity: negative
Max. permissable voltage: $\pm 10V_{p-p}$
Input impedance: 75 Ω

Video outputs (2)
BNC connector at front panel
Impedance: 75 Ω
Voltage: $1V_{p-p}$ fixed or
video amplitude variable between $0–1.5V_{p-p}$
Polarity: negative
DIN connector for VCR at rear panel pln 2.

Sound carrier
Frequency: 5.5MHz (or 4.5/6/6.5MHz by internal change of soldered connection)
Accuracy: < .2%
Sound switch: carrier on/off
Ration of sound/vision carrier approx. 12.5dB

Internal sound modulation
Modulation: FM (or AM by internal change)
Internal signal: 1kHz on 5.5MHz
FM sweep: approx. 40 kHz on 5.5MHz
AM modulation depth approx. 30%
Sound output: DIN connector for VCR at rear panel

External sound modulation
External signal: $0.2V_{RMS}$ for same modulation as internal signal
Bandwidth: 100Hz–10KHz
Pre-emphasis: 50 µs
Sound input: DIN connector (rear side)
Input impedance: 0.5M Ω
Modulation on/off (switch)
Modulation internal/external (switch)



Checking or aligning the white level, maximum resolution and linearity of the chroma amplifiers of a VCR. The PM 5519 offers a special VCR Test Pattern.

Chroma
Systems: PAL (according to system I-G-M or N)
Carrier frequency for TV system PAL: X-tal controlled 4.433619MHz ±2Hz
(For other versions see Table A)
Drift: $\pm 5.10^{-6}$
Burst: according to PAL system
Amplitude: (burst and chroma) in calibrated steps selected of 0–25–50–75–100%
System: NTSC (internally changeable)

Synchronisation
Line frequency: 15625Hz (or 15750 depending on TV system)
Frequency tolerance: ±5Hz
Lines: 625 or 525
Field frequency: 50Hz or 60Hz
Frame sync. signal: according to TV standard, interlacing

Composite TV synchronisation
Comp. sync. output
BNC connector (3)
Signal: frame and line sync pulses
Voltage: $> 4V_{p-p}$
Impedance: 10k Ω
Polarity: negative

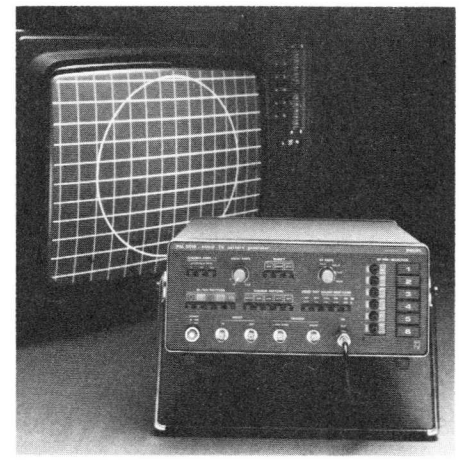
Frame synchronisation
BNC connector (4): frame sync.
Voltage: $> 4V_{p-p}$
Impedance: 10k Ω
Polarity: negative

Power supply
Voltage: 110–127–220–240V
Tolerance: ±10%
Frequency: 50...60Hz
Tolerance: ±5%
Power consumption: 18W

Dimensions and weight
(w × h × d) 305 × 140 × 300mm
(12 × 5.5 × 11.8-in)
4.8kg (10.6lb)

Standard accessories
Instruction manual and mains cable PM 9538 Cable, BNC-TV connector, 75 Ω

Optional accessories
PM 9075 Cable, BNC 75 Ω
PM 9339 Cable, BNC-impedance transformer, 75–300 Ω



For CTV the PM 5519 offers a wide variety of test patterns for on the screen alignments.

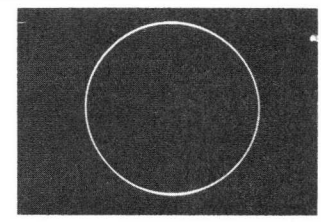
Table A: Performance details of various versions of PM 5519*

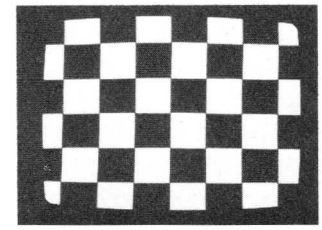
Series	–G	–I	–N	–M	–MM
TV standard	CCIR, PAL	CCIR, PAL	CCIR, PAL	RTMA, PAL	RTMA, NTSC
No. of lines per picture frame	625	625	625	525	525
Field frequency (Hz)	50	50	50	60	60
Line frequency (lines/5)	15625	15625	15625	15734	15734
Chrominance sub-carrier (MHz)	4.433618	4.433618	3.582056	3.575611	3.579545
Sound carrier to vision carrier (MHz)	5.5	6	4.5	4.5	4.5
Sound modulation	Fm	Fm	Fm	Fm	Fm
Pre-emphasis	50	50	75	75	75

* For cable TV the PM 5519S is available with a RF range covering channels S1 to S20.

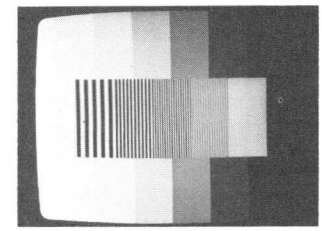
Pattern survey

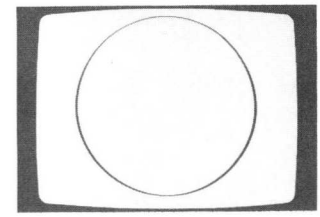
Signal content	B/W	Colour	VCR	For checking
1. **Circle**	○	○		Overall linearity
a. White circle on grey	○	○		Overall geometry
b. Black circle if combined with white pattern	○	○		Reflections
c. Combination with all patterns possible				
2. **Checkerboard**				
6 × 8 rows	○	○		Focus adjustment
	○	○		HOR/Vert. sync
	○	○		HOR/Vert. linearity
	○	○		HOR/Vert. deflection
	○	○		Amplitude/aspect ratio geometry ringing
	○	○		Bandwidth by observation of vert. transitions
	○	○		Mains hum interference in synchronisation
			⊙	Black/white transitions

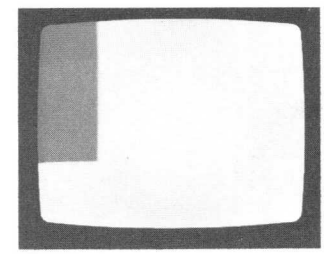


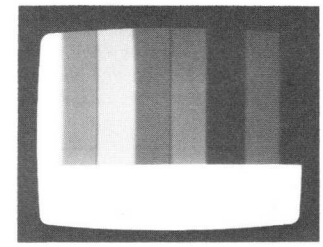


3. **Dots** 11 horizontal lines of 15 dots		○		Static convergence
4. **Crosshatch** 11 horizontal and 15 vertical lines		○	⊙	Dynamic convergence
	○	○		Pincushion correction
		○		E/W–N/S corrections in 110 CTV receivers
5. **Grey scale and**	○	○		Brightness and contrast circuit
Definition lines	○	○	⊙	Video bandwidth
Linear staircase signal	○	○		Grey signal tracking
with 8 identical steps	○	○	⊙	Linearity of video amplifier
combined with definition pattern of 5 vertical bars 0.8–1.8–2.8–3.8–4.8MHz				
6. **White pattern**	○	○		White
100% white signal		○		Constant brightness
(with or without		○		Beam current of picture tube
burst)			⊙	Adjustment of white level + writing current adjustment
7. **Purity patterns**		○		Purity checks and adjustment
Selectable are 3 primary colours:	○	○	⊙	Interference between sound and chromacarrier
a. red with 75% saturation				
b. green			⊙	Colour A.G.C.
c. blue			⊙	Writing currents of video head
or 3 complementary colours by selecting the various combinations:				
d. yellow				
e. magenta				
f. cyan				
8. **DEM Pattern**				
Special bars		○		PAL Delay-line (phase & Amplitude)
		○		Subcarrier to the (R-Y) and (B-Y) demodulators
4 vertical bars		○		90°C phase differences
+ white ref.		○		PAL switch
Special encoding		○		Subcarrier oscillator
Bar 1 (G-Y) = 0				
Bar 2 Y signal				
Bar 3 + (R-Y)				
Bar 4 ± (B-Y)				
9. **VCR pattern**				
a. *Saturation step*		○	⊙	Linearity of chroma amplifiers
Signal		○	⊙	Sensitivity colour amplifiers
8 steps of linear increasing saturation (red signal) combined with				
b. *Definition lines* 2.8–3–3.2MHz		○	⊙	Resolution of the VCR and other video recorders
c. *One horizontal bar* 100% WHITE			⊙	Adjustment of white level
10. **Colour Bar with**		○		Overall colour performance
white pattern		○		Burst keying
75% contrast, standard		○		Subcarrier regenerator
Colourbar with white		○		PAL identification circuit
reference field in		○		Matrix circuit
lower part of		○		RGB amplifiers
screen		○	⊙	Delay Colour versus B/W Signal
		○	⊙	Saturation check
			⊙	562.5kHz interference check









X-tal controlled RF output, single or multi-channel

Compatible for different TV systems (e.g. L, B, G, K and D)

Large choice of various test patterns

Synchronization according to TV standard

Automatic blinking for testing portier circuits

Choice of positive or negative video polarity and variable video amplitude

new

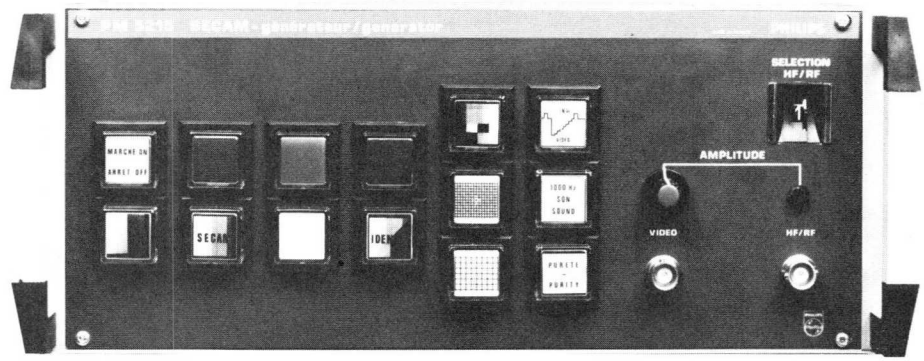
Colour pattern generators PM 5215 - SECAM PM 5217 - SECAM/PAL

Both generators PM 5215-SECAM and PM 5217-SECAM/PAL offer a wide choice of test patterns and are especially designed for after-sales service of CTV, TV, colour monitors and video recorders. The inherently high quality X-tal controlled RF output, plus their versatility, make these instruments ideal for fast, accurate video measurements both in professional areas as well as production and quality control.

Depending on the customer requirements both types can be fitted with one up to four different X-tal RF oscillators. In the VHF range band III there is a choice of the channels 5-12 and for UHF band IV-V the RF channels 21-69 can be chosen.
The instruments are designed for 2 different systems of sound modulation.
The 10 position selector permits to use e.g. the same RF channel for various TV systems having different sound/vision spacing.

For testing the portier circuits there is a pushbutton selector for automatic blinking. All sub-carrier frequencies are X-tal controlled and the rest frequencies f_0B and f_0R are gen. locked for SECAM functions.

The video output is adjustable from 0-2.4V (open circuit) and the video polarity can be changed by simply pressing the indicated pushbutton. The PAL/SECAM version PM 5217 has a continuously adjustable burst from 0-150%. Synchronization, according to TV standard, includes interlacing and a very good picture stability is obtained by digital techniques combined with memory circuits.



PM 5215

TECHNICAL SPECIFICATION

TEST SIGNALS

Standard colour bar
With 75% contrast

Grey scale
Linearized staircase of 8 steps

Dots
11 horizontal lines of 15 dots

Cross hatch
12 × 16 squares with center indication

Cross hatch
6 × 8 squares

White
White signal (with or without burst)

Black pattern
(With or without burst)

Purity patterns
Choice of 6 different colours

Primary colours
Red, green and blue

Complementary colours
Yellow, magenta and cyan

Combined testpattern
Standard colour bar (with −25% saturated horizontal bar for SECAM alignments) an 8 step grey scale, white/black and black/white transitions

VIDEO CARRIER

Dependable on requirements for the SECAM or SECAM/PAL version there is a choice of TV systems L, B, G, K, D etc.
Single or multi RF channels
Band III VHF channel 5 to 12 (X-tal controlled)
Band IV-V UHF channel 21-69 (X-tal controlled)

RF OUTPUT

RF output
BNC connector

Output voltage
25mV at 1 RF channel
5mV at 4 RF channels

RF attenuation
Continuous 0-25mV

Impedance
75Ω

VIDEO OUTPUT

Video output
BNC connector

Output voltage
1.2V (with 75Ω load)

Attenuation
Continuous 0 to 1.2V

Polarity
Positive or negative, selectable by pushbutton at front panel

Impedance
75Ω

SOUND CARRIER

Frequency (see Table A)
5.5MHz or 6MHz or 6.5MHz. Dependable of TV system

Accuracy
1×10^{-6}

Modulation
AM or FM (see Table A)

Internal signal
1kHz

Sound switch
Modulation 1kHz on/off (front panel)

CHROMA PM 5215

Systems (see Table A)
SECAM according to System L, K, K2

Signals
$D'_R = -1.9\ (E'_R - E'_Y)$
$D'_B = 1.5\ (E'_B - E'_Y)$

Sub-carrier frequency for TV system PAL is X-tal controlled

Frequencies
$D'_R = 4.40625\text{MHz} \pm 2\text{kHz}$
$f_o = \pm 0.3\text{kHz}$
$D'_B = 4.25000\text{MHz} \pm 2\text{kHz}$

Identification
According to TV system in line and frame (see fig. 1)

CHROMA PM 5217

Systems (see Table A)
SECAM according to System D, L, K, and K1
PAL according to System B-G-I-H

Sub-carrier frequency for TV system PAL is X-tal controlled

Frequency
4.443618MHz

Burst
According to PAL system

Burst amplitude
Continuously adjustable 0-150%

SYNCHRONIZATION

Line frequency
15625Hz

Frequency tolerance
±5Hz

Lines
625

Field frequency
50Hz

Frame sync. signal
According to TV standard, interlacing

POWER SUPPLY

Voltage
110-250V automatic adaptation to required main voltage by a double voltage stabilizer

Frequency
50Hz

Power consumption
30W

Dimensions and weight (w × h × d)
280 × 110 × 310mm
(11 × 4.3 × 12.2-in)

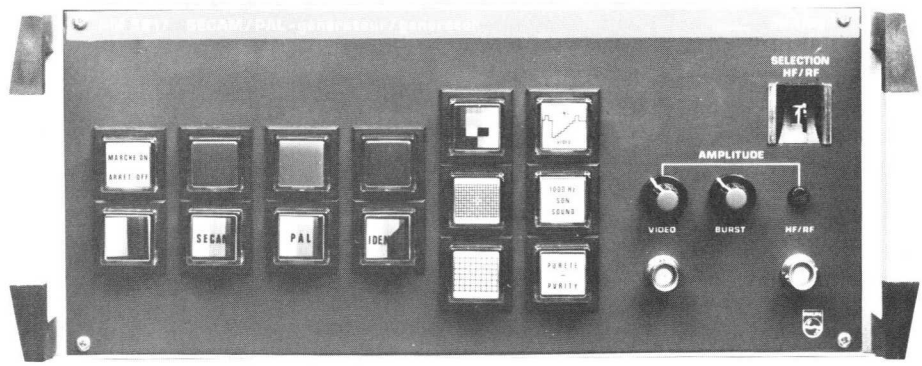
Weight
5kg (11lb)

ACCESSORIES SUPPLIED

– PM 9538 BNC output RF cable – TV 75Ω
– Instruction manual

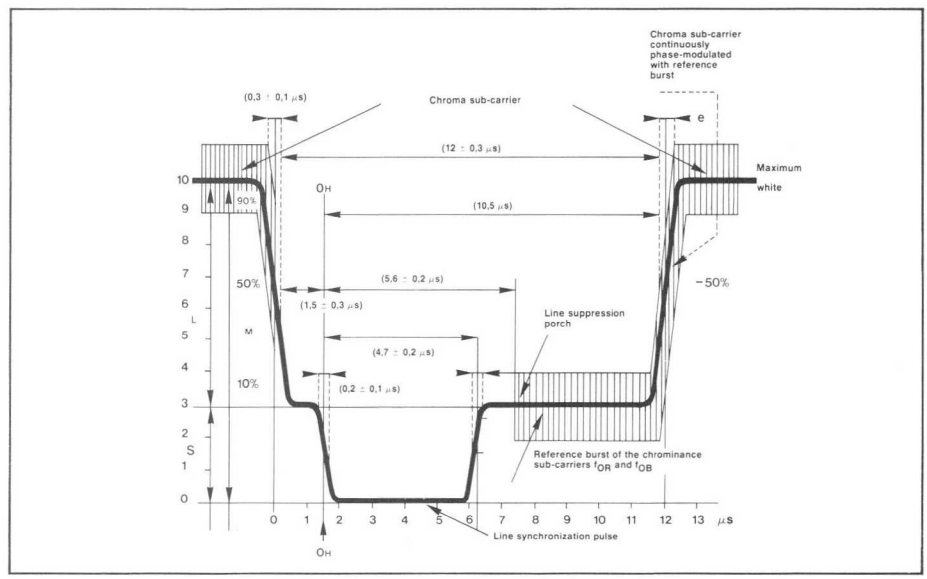
Table A

	PM 5217				
			PM 5215		
	PAL B, G, H	PAL I	SECAM B, G, H	SECAM D, K, K1	SECAM L
Chrominance subcarrier (Hz)	4 433 618.75	4 433 618.75	f_oB 4 250 000 f_oR 4 406 250		
Sound carrier relative to vision carrier (MHz)	5.500 000	5.999 600	5.500 000	6.500 000	6.500 000
Line frequency (lines/second)	15 625	15 625	15 625	15 625	15 625
Field frequency (fields/second)	50	50	50	50	50
Type and polarity of vision modulation	A5C neg.	A5C neg.	A5C neg.	A5C neg.	A5C pos.
Type of sound modulation	FM	FM	FM	FM	AM
Type of chrominance sub-carrier modulation	Suppressed carrier amplitude modulation of two sub-carries in quadrature		Frequency modulation		
Transmitted chrominance information	1. Line sequential E'_V and $-E'_V$ 2. E'_U		Line sequential D'_R and D'_B		



PM 5217

Fig. 1



8 frequency ranges, 3MHz . . . 860MHz

Sweep widt continuously adjustable over selected range

Sweep frequency adjustable 8 . . . 50Hz

One variable and three fixed markers

Accurate, stable, signal frequency

Stabilised output into 75Ω load

Built-in floating bias source

Optional fixed marker generator PM 5335

TV sweep/RF Generator PM 5334

PM 5334 is an extremely versatile TV sweep generator designed for quick alignment and servicing of B/W and colour TV. It is ideal for servicing, TV design and production areas and educational applications. Individual oscillators provide the eight frequency ranges which are clearly indicated on a large scale having small markers, which identify special frequencies used in TV receiver alignment. The sweep width is continuously adjustable over each range making the generator suitable for checking wideband amplifiers as well as giving full frequency coverage for TV bands, IF and FM ranges.

A sawtooth is used for the sweep signal having a variable frequency between 8 and 50Hz. The stabilized RF output voltage can be attenuated down from a max. of 200mV (into 75Ω). The variable marker can be accurately adjusted on the scale and there are also three fixed markers at 5.5MHz, 10.7MHz and 38.9MHz. The variable marker can be modulated with a 1kHz sine wave for the alignment of absorption circuits with a fixed marker (e.g. at 5.5MHz) to simplify alignment of IF stages and TV tuners. This can be further simplified, using the PM 5335 fixed marker generator as well. PM 5334 also supplies a floating bias voltage, adjustable between 0 and 30V, which can be used for bypassing AGC circuits in TV receivers or as a DC supply for small circuits.

TECHNICAL SPECIFICATION

SWEEP FREQUENCY GENERATOR

Frequency ranges
1. 3... 6MHz (TV sound and chroma IF)
2. 4... 7MHz (TV sound and chroma IF)
3. 7... 12MHz (FM, IF)
4. 30... 50MHz (TV picture IF)
5. 45... 85MHz (TV Band I)
6. 85...150MHz (FM Band II)
7. 150...270MHz (TV Band III)
8. 460...860MHz (TV Bands IV and V)

Principle
Individual oscillators, sweeping by means of varicap diodes

Sweep frequency
Sawtooth, adjustable from 8 to 50Hz

Blanking
Duty cycle 1 : 1
Blanking can be switched off

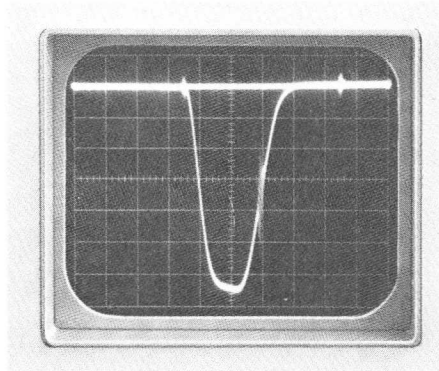
Sweep width
Continuously adjustable; Max. width covers the complete frequency range selected

Centre frequency
Continuously adjustable

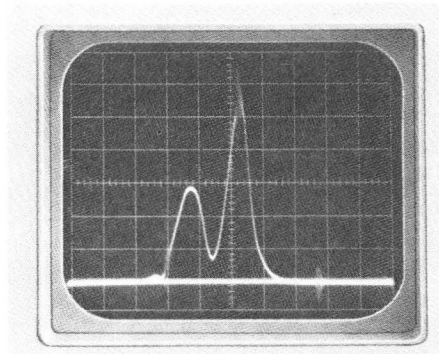
Output connector
BNC

RF output voltage
Electroncially stabilized
Ranges 1–6: 200mV ±1dB with 75Ω load
Ranges 7 and 8: 150mV ±1dB

Amplitude characteristics
For max. sweep width:
±1dB in ranges 1–6
±3dB in ranges 7–8
at 50MHz sweep width
±1dB in range 7
±2dB in range 8



Luminance IF bandpass curve



Chrominance IF bandpass curve

RF attenuator
Continuously adjustable from 0 to 80dB

Sawtooth
Max. $15V_{p-p}$ sawtooth, adjustable (X deflection for oscilloscope)

VARIABLE MARKER GENERATOR

Variable marker
Ranges 1–7: fundamental frequency
Range 8: 3rd harmonic

Frequency accuracy
Ranges 1–6: $\pm 1 \times 10^{-2}$
Ranges 7 and 8: approx. 1.5×10^{-2}

Temperature stability
$\pm 2.5 \times 10^{-4}$ per °C

Output voltage into 75Ω
Ranges 1–5: $100mV_{p-p}$
Range 6: $50mV_{p-p}$
Range 7: $10mV_{p-p}$
The marker generator can be superimposed on the RF sweep frequency output by means of the marker switch.

Modes of operation
Unmodulated
Amplitude modulated with 1kHz
Modulated with permanent markers at
5.5MHz
10.7MHz
38.9MHz
Scale: Drum scale, length 220mm
Marker knob: Coarse/fine ratio 1 : 3

FIXED MARKER GENERATOR

Fixed marker frequency
5.5MHz
10.7MHz
38.9MHz

Frequency stability
±0.1%

Temperature stability
$\pm 0.3 \times 10^{-4}$ per °C

Separated fixed marker output for subcarrier alignment
Output level: 250mV, continuous attenuation from 0 to > 25dB
Principle:
Marker mixing, AF beat frequency marker
Marker addition via loop through BNC connectors
Marker amplitude min $2V_{p-p}$
Attenuation adjustable with loop through connectors 1dB

Bias voltage source
Output voltage: Floating, 0–30V adjustable
Hum voltage: $1mV_{p-p}$
Internal resistance: less than 500Ω
Max. current: 50mV

TEMPERATURE

Ambient temperature: 0–40°C

POWER

Line voltages: 220 or 110V; ±10%
Frequency: 50 or 60Hz
Consumption: 32VA

DIMENSIONS AND WEIGHT

(w × h × d) 328 × 177 × 260mm
(12.9 × 6.9 × 10.2-in)
10kg (22lb)

ACCESSORIES SUPPLIED

Mains cable
Manual

OPTIONAL ACCESSORIES

PM 9336 Cable BNC – 10 : 1 probe
PM 9072 Cable BNC – 1 : 1 probe
PM 9075 Cable BNC – BNC
PM 9539 TV cable BNC – impedance transformer 75/300
PM 9538 TV cable BNC – TV connector
PM 9537 Radio cable BNC – impedance transformer 75/300
PM 5335 Fixed marker generator. (See next page.)

Counters and counter/timers

Introduction

The right choice!

Error free frequency counting on noisy signals, frequency measurements on narrow pulses or HF, VHF and UHF signals? Or is your application for time interval averaging capabilities? These and many other application requirements make other specification points as important as the maximum frequency, sensitivity and crystal oscillator characteristics.

Optional accessories

The conditions of use are important. Use in the field, on a laboratory bench or in an automatic test system require different options such as: battery supply, BCD output, analog output (for recording on a strip-chart recorder), BUS interface, rack-mount facilities etc.

These options enable a standard instrument to be used in your particular application without adaption problems.

In selecting a counter, the availability of a wide range of such options is of greatest importance when the type of application can change after some time of use.

Through the inclusion of another crystal oscillator time-base or other options, you can adapt your counter to future requirements.

Frequency counter or timer/counter?

More fundamental is the difference in counters, which are optimized for frequency counting (with maximum noise rejection for error free measurements) and counters focussed on accurate time interval measurements.

The requirements in input-signal conditioning for frequency and time measurements are quite contradictory. Any universal solution to make a combined counter/timer must compromise to either counting or timing.

In order to help you in making the right choice, the table overleaf gives a quick survey of the main specification points, the type of input circuit that is used and the optional accessories which make your counter best suited to your application conditions.

Features of the various types of inputs are examined in the following paragraphs to assist in identifying the right unit for a specific requirement.

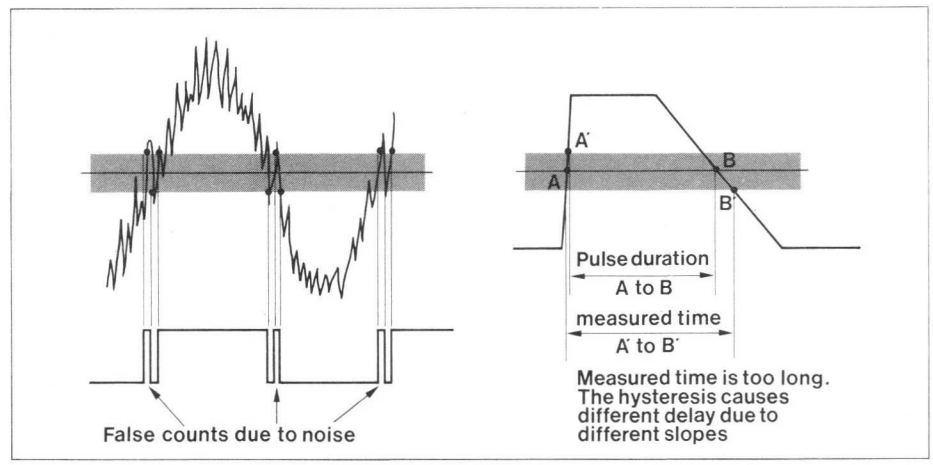


Fig. 1a. *Fig. 1b.*

Frequency counting

Figures 1a and 1b show a sinewave signal crossing the hysteresis band of the input circuit. Each period of the sinewave, that crosses the hysteresis band causes a clean pulse that can be counted by the digital circuitry.

Noise on the sinewave, however, causes the signal to pass through the hysteresis band more than once per sinewave-period giving faulse counts. Figure 2a shows how this type of error can be prevented.

Time interval measurement

Figure 1b shows a pulse, which duration

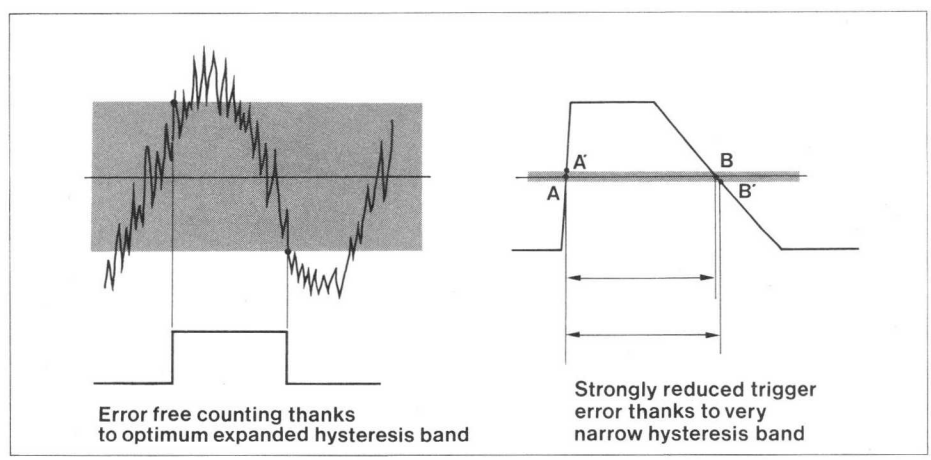


Fig. 2a. *Fig. 2b.*

is to be measured. Triggering at 50% of amplitude should open the main-gate at A and close it at B, to count during this interval the clock-pulses.
The hysteresis of the input circuit, however, causes triggering to occur at A' and B'. The different slopes of leading and training edges causes different delays, resulting in a faulty measurement. A very narrow hysteresis band as shown in fig. 2b will reduce these errors.

The solution

Figure 2a illustrates how error-free counting is obtained by a wider hysteresis band. The hysteresis band has been expanded so much that the noise no longer spans this band and cannot introduce false counts.
A wider hysteresis band means that the input of the frequency counter is made less sensitive by means of an input attenuator.
The lowered sensitivity makes the counter immune against noise over a wider band, usually referred to as the noise immunity band.
In practice, input signals can have *any* amplitude over a *wide* voltage range.
To adjust the counter's input sensitivity (hysteresis or noise immunity band) to any value of the input signal, a *continuous variable attenuator* is needed. To span a wide range of input voltages, also the input sensitivity of the counter must be adjustable over a wide range.
Good **frequency counters** feature a wide input voltage range with continuous adjustable attenuation.
Input circuits that can perform continuous variable input attenuation can use e.g.:
potentiometers for 0...100MHz
diodes for 0...100MHz
AGC for LF... > 1GHz
PIN-diodes for 1MHz... > 12GHz
Diode attenuators, AGC and PIN-diode attenuators feature automatic control.
In the case of the time interval measurement, we see in figure 2b, that a hysteresis band, as narrow as possible, reduces trigger errors. To reduce trigger errors, an input attenuator is *not* needed and even unwanted. The use of a fixed step attenuator: ×10 for instance, is to expand the basic trigger level off-set range. Such an attenuator allows trigger level settings from −30V... +30V with a basic off-set range of −3V... +3V. *Mind* that the use of ×10 attenuator also expands the hysteresis band thus increasing trigger errors.
In timer/counters, such a step attenuator is also used to expand the noise-immunity band, when measuring frequencies. A ×10 step attenuator, however, does not always allow maximum noise rejection.

A good basic range for trigger level off-set (without attenuation) and drift makes that a maximum narrow hysteresis band has its limits. The PM 6620-series timer/counters feature a typical width of the hysteresis band of 25mV$_{p-p}$. Another solution to reduce these trigger errors is automatic hysteresis compensation as used in the counter/timer PM 6650, see fig. 3.

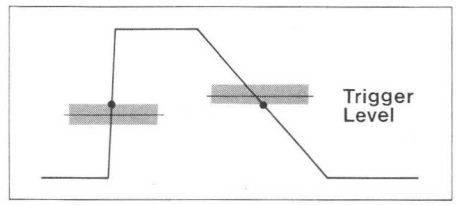


Fig. 3. Automatic hysteresis compensation shifts the hysteresis band on positive slopes downwards and on negative slopes upwards, with a value of half that hysteresis band.

Triggering occurs now at the set level, by virtual elimination of the hysteresis band.

AC-coupling

Frequency counting on sinewaves or on more or less symmetrical signals is best achieved with AC-coupled inputs. AC coupling has *no* temperature drift problems, while added DC signal components are eliminated. This assures *simple, stable* thus *reliable* triggering.
Universal frequency counters need to measure also on narrow pulses or other waveforms, even when they feature AC coupling, which has the above mentioned advantages.

Triggering on any waveform, having any duty factor can be assumed by means of a trigger level off-set in the final amplifier stage. The 10Hz...80MHz input channel on PM 6610-series instruments has 3 fixed trigger level positions to cover all duty factors.
This type of triggering can even be used for simple time interval measurements. With the triggering on leading edges it is possible to measure the time between a start and stop pulse. Also the delay between two sinewaves can accurately be measured to define the phase angle.

DC-coupling

Time interval measurements with accurately set trigger levels or signals with varying duty factor require DC-coupling. This might be e.g. a rise-time measurement on a pulse; requiring 10% to 90% level setting or a pulse duration measurement with accurate setting of trigger levels at 50% of the pulse amplitude.
Such measurements can only be made accurately, if a trigger level output is available to measure the set level. Such trigger level monitors are found on timer/counters in the PM 6620-series and on the PM 6650.
It should be noted that accurate time interval measurements needing precise trigger level settings also require time interval averaging. Timer/counters without this averaging feature are further unable to measure very short time intervals. DC-coupling is further a necessity when measurements of very low frequencies are made.

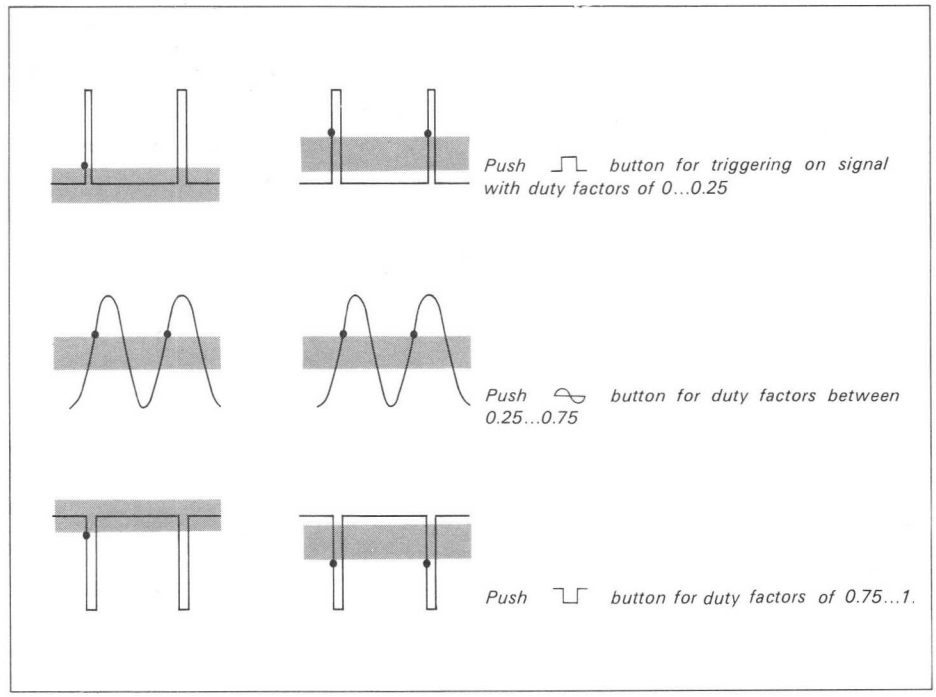


Fig. 4.

IEC-625

PM 6611 80MHz Universal counter
PM 6612 80MHz Counter timer
PM 6613 250MHz Universal counter
PM 6614 520MHz Universal counter
PM 6615 1GHz Universal counter
PM 6616 1.3GHz Universal counter

Wide frequency ranges from 10Hz up to 80MHz . . . 250MHz . . . 520MHz . . . 1GHz and 1.3GHz

Two different inputs, respectively LF and RF, specially designed for noise-free measurements

The automatic PIN-diode attenuator in the RF channel gives:
- Ease of operation
- Noise suppression
- Overload protection

High sensitivity of 10mV

High time-resolution of 100ns

9 digit planar display ensures the best resolution with overflow

Good portability through battery option and compact lightweight construction

Choice of 4 X-tal oscillators

IF display offset

IEC Bus-line interface

BCD output and digital-to-analog converter output options, for digital print-out or analog recording of measuring data

Ease of operation, thanks to excellent ergonomic lay-out and automated functions, while the very bright planar display ensures the best readability

Type Number	Frequency					Period + Period av.	Multiple Ratio	Totalizing of Counts	Time interval
	80MHz	250MHz	520MHz	1GHz	1.3GHz				
PM 6611	■					■	■	■	
PM 6612	■					■	■	■	■
PM 6613	■	■				■	■	■	
PM 6614	■	■	■			■	■	■	
PM 6615	■	■	■	■		■	■	■	
PM 6616	■	■	■	■	■	■	■	■	

Table 1. Performance survey of PM 6610-series of universal counters

WIDE VERSATILITY AND FLEXIBILITY TO MEET YOUR PARTICULAR REQUIREMENTS

The PM 6610-series forms a family of five universal frequency counters: 80MHz, 250MHz, 520MHz, 1GHz and 1.3GHz plus one 80MHz counter/timer.

All models measure a wide variety of frequency- and time- related parameters such as: FREQUENCY, PERIOD-AVERAGE, MULTIPLE-RATIO, TOTALIZING of counts, SELF-CHECK (and TIME-INTERVAL PM 6612 only). They further offer a facility as stopwatch.

The universal counter PM 6611 and the counter/time PM 6612, both ranging up to 80MHz, are designed for general purpose frequency and time measurements in research and development – production testing – maintenance and repair – and education. The universal counters PM 6613, PM 6614, PM 6615 and PM 6616 have specifically been designed for high frequency measurements, on telecommunication – broadcast- and TV equipment. The rechargeable battery unit plus the compact and lightweight construction make all these units very suitable for portable field use.

Choice of time-base oscillator

There is choice of 5 X-tal oscillators, see table 2. In this way the individual stability requirement can be met economically and also upgraded, if necessary at a later stage. By means of the external reference input, use can be made of a frequency standard.

Instantaneous high stability time base

The PM 6610-series, break new ground in the area of portable counters by extending the instantaneous high stability of laboratory instruments to field applications. This has been achieved by developing oven-contained crystal oscillators with extremely low power consumption.

The high-stability ovenized time-base options therefore can also be used with the internal battery pack. No warm-up times are thus needed when changing locations with a counter having a stability much higher than that of TCXO's (temperature compensated X-tal oscillator). The battery capacity is sufficient for 24 hours stand-by operation. This makes these counters the most suitable for portable field service use currently available.

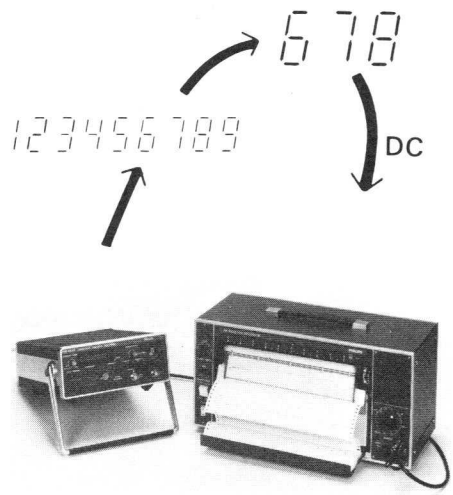


Fig. 1

Mains (line voltage) or battery supply

Each instrument is equipped for the following alternative supply voltages:

Table 2. Choice of time-base oscillators

PM 661./..version Including time-base:	01 version PM 9677	02 version PM 9678	03 version PM 9679	04 version PM 9690	05 version PM 9691
STABILITY against: Type:	standard	TCXO	proportionally oven controlled	proportionally oven controlled	proportionally oven controlled
Ageing:	$< 5\times10^{-7}$ per month	$< 1\times10^{-7}$ per month	$< 1\times10^{-7}$ per month	$< 1.5\times10^{-9}$ per 24h*	$< 5\times10^{-10}$ per 24h*
Temperature: 0°C...50°C, ref. to +25°C	$< 1\times10^{-5}$	$< 1\times10^{-6}$	$< 1\times10^{-7}$	$< 3\times10^{-8}$	$< 5\times10^{-9}$
Change in measuring – and supply mode; line/int. battery/ ext. DC 12V...28V	$< 3\times10^{-7}$	$< 5\times10^{-8}$	$< 1\times10^{-8}$	$< 3\times10^{-9}$	$< 3\times10^{-9}$
Line voltage; ±10%	$< 1\times10^{-8}$	$< 1\times10^{-9}$	$< 1\times10^{-9}$	$< 5\times10^{-10}$	$< 5\times10^{-10}$
Warm-up time to reach 1×10^{-7}	—	—	< 10min	< 15min	< 15min

* *after 72 hours of continuous operation*

- Line voltage: 110...240V_{RMS}; 45...440Hz
- External battery: 11.8...28V_{DC} (for mobile use)
- Internal rechargable battery unit (for portable use)

IF (Display) off-set unit PM 9668

The optional circuit board PM 9668 enables the addition or subtraction of a programmable value to the measured value. In this way it allows the 8 most significant digits to be off-set.
This unit offers the external selection between *two* pre-programmable off-set values.

BCD – output PM 9674

The optional circuit board PM 9674 gives BCD-data in a parallel format for connection to a standard printer such as the Philips PM 2466.

Analog output PM 9675

The digital-to-analog converter PM 9675 provides a high resolution analog output for recording frequency stabilities of oscillators, filters and crystals on a Y-t chart recorder. In frequency control systems having analog feed back the DAC serves as an extremely accurate frequency-voltage converter. The PM 9675 permits conversion of any three consecutive digits out of the total of 9, or the two least significant digits. As such it functions as a magnifying glass to focus on just that part of the read-out which is most important (see fig. 1).

The normal mode converts 000 into a zero analog output, and 999 into a full scale output.

The flexibility is boosted by choice of operating mode. In the offset mode, the conversion of 500 produces a zero analog output; whilst 000 gives a mid-scale deflection.

For a display changing between 9.9999999 and 10.0000000MHz it is possible to record the frequency on the center of the strip chart, rather than having the output shifting between zero and full scale.

Bus Interface PM 9676

The serial data output-unit PM 9676 enables data processing by connecting the instrument to a standard bus-line.

Carrying case PM 9676

To protect the whole instrument during transport or field use, an ever-ready case PM 9672 can be ordered as an optional extra.

Rackmount adapters PM 9669

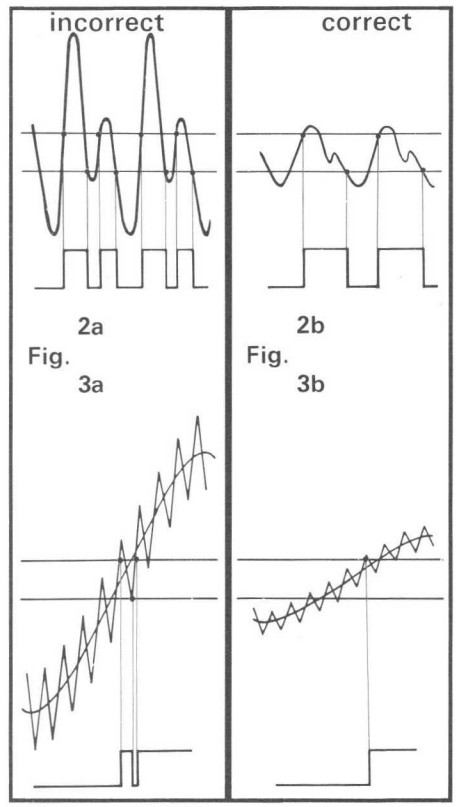
The counters can easily be fitted in a standard 19" rack by the use of the rack adapter PM 9669/01 or PM 9669/02 for one respectively two counters.

Standard accessories

Operation/service manual
Line cord
Front panel protection cover

MORE ACCURATE AND RELIABLE LF AND RF FREQUENCY MEASUREMENTS

Whilst the basic accuracy of any counter is ±1 digit ±the time base error, it is not always realized that noise or interference can cause false counting and can lead to significant errors



With the PM 6610-series, the superior accuracy for both LF- and RF- measurements is due to the improved triggering with noise- and interference rejection. This break-through in trigger performance has been obtained by two specially designed input- and trigger channels optimized respectively for LF- and RF-signal processing.
The fig. 1a in the introduction indicate how distortion or noise in a conventional counter can cause the signal to pass through the trigger window (hysteresis band) and hence give false counts.
The Philips PM 6610-series of counters feature **continuously** variable input attenuation, which reduces the input signal to an amplitude just above the value of the trigger window. At the same time, noise and interference are suppressed so much that they cannot span the trigger window. False counts from noise, interference, etc. are thus eliminated in these counters. This optimum input matching (which cannot be achieved with conventional counters having decade-step attenuators) ensures that the accuracy as measured is the maximum attainable accuracy of ±1 digit ±the time base error.

LF-input

For the low frequency input (A), the continuous attenuation is set manually by the sensitivity control for universal waveforms up to 80MHz. For accurate LF measurements, the built-in low-pass filter may be switched on. This filter rejects HF noise or interference, having amplitudes much higher than that of the input signal under test (see curve).

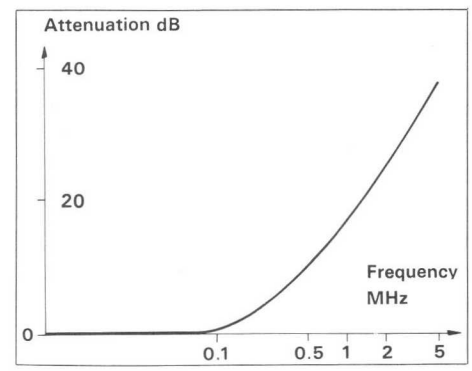


Fig. 4. This filter characteristic shows the attenuation of high frequency signals.

RF-input

The special RF input channel (B) on models PM 6613...PM 6616 features an automatic multistage PIN-Diode attenuator circuit. In addition to the noise suppression this gives the following user benefits:

1. wide dynamic input voltage range
2. ease of operation
3. high overload protection

Wide input voltage range

The use of PIN-diode attenuators and other state of the art components in the RF stages ensures perfect triggering at input levels between −27dBm and +35dBm (10mV_{RMS}...12V_{RMS}).

Automatic triggering

The operator need not concern himself with setting the amplitude for optimum triggering. The AUTOMATIC ATTENUATION of input signals ensures the best triggering without human intervention.

RF-input protection

Unlike conventional AGC-circuits (where the gain is controlled, but where the full input voltage is applied to the amplifier input), the multi-stage PIN-Diode circuit really ATTENUATES the input signal.
This ensures that powerful signals are strongly reduced before they appear at the input of the sensitive amplifier. The attenuator functions as very fast RF INPUT PROTECTION up to a high +35dBm (12V) signal level.
It is evident that an electronic overload protection reacts much faster than the older mechanical methods such as RF-fuses or relays. In addition the latter do not offer protection against modulated- or pulsed RF, since they respond to the average signal value.

Low level RF measurements

In conventional counters, too low an input signal often causes stable and reproduceable yet fully erroneous measurements. Such measurements are eliminated in these counters by a distinct switch-off point.
A built-in level detector permits counting only when the input signal is of sufficient amplitude ($\geqslant$10mV).

EASE OF OPERATION

Like other new instruments in the Philips range, these counters have received a lot of attention from ergonomic design specialists to get an uncluttered front panel layout, which is well human engineered. The controls are placed so that operation is easily understood, whilst the clear and very bright 9-digit planar display gives readouts with high last digit resolution. This offers quick and full control over your counter; a convenience not offered by instruments having autoranging and less digits.

Easy to handle in field use

Due to the high degree of integration, all models have the same compact and lightweight construction. For easy operation in the field, a built-in type of battery unit keeps overall dimensions unchanged.

Display blinking is a warming that the battery charge is low. To complete your measurement, 10–15 minutes are left before recharging is needed.

The sealed lead-acid batteries eliminate damage from complete discharge. Recharging is possible from the line or from an external DC souce (at least 18V).

The built-in recharging circuit is fully automatic. For the user, this means no worries about the recharging time. The charging current is automatically controlled to protect the batteries against overcharge.

For mobile field use, the 11.8...28V power receptacle enables supply from external batteries (for instance from the cigarette lighter socket in your car).

ORDERING PROCEDURE

PM 661./01: 80/250/520/1000/1300 MHz Counter, including time base oscillator PM 9677
PM 661./02: idem, but including PM 9678
PM 661./03: idem, but including PM 9679
PM 661./04: idem, but including PM 9690
PM 661./05: idem, but including PM 9691
PM 9668: If off-set unit
PM 9669/01: 19-in rack mount adapter to fit one unit
PM 9669/02: 19-in rack mount adapter to fit two units
PM 9672: Carrying case
PM 9673: Battery/recharging unit
PM 9674: BCD-output unit
PM 9675: Digital-to-Analog converter
PM 9676: Bus-line interface (IEC TC66)
The time base oscillators, PM 9678, PM 9679, PM 9690 and PM 9691 can be ordered also separately, to upgrade the counter afterwards.

It should be noted that the options PM 9673, PM 9674, PM 9675 and PM 9676 CANNOT be combined.

TECHNICAL SPECIFICATION

FREQUENCY

Range
10Hz...80MHz (PM 6611)
10Hz...80MHz (PM 6612)
10Hz...250MHz (PM 6613)
10Hz...520MHz (PM 6614)
10Hz...1GHz (PM 6615)
10Hz...1.3GHz (PM 6616)

Gate times
10ms...10s (PM 6611, PM 6613...PM 6616)
100ms...10s (PM 6612)

Gate times selectable in decade steps. If the RF-input on models PM 6613...PM 6616 is used, the gate time is automatically multiplied with the prescaling factor.

Accuracy
$\pm$1 count $\pm$time base error.

Inputs
LF channel (A) 10Hz...80MHz (all models)
RF channel (B) >80MHz (PM 6613...PM 6616)

SINGLE PERIOD (ALL MODELS)

Range
100ns...100s

Resolution
100ns

Accuracy
$\pm$1 count $\pm$time base error $\pm$trigger error*

Input
channel A

PERIOD AVERAGE (ALL MODELS)

Range
1Hz...10MHz
10Hz...10MHz (for sinewaves)

Periods averaged (N)
10^2 and 10^4

Resolution
100ns/N

Accuracy
$\pm$1 count $\pm$time base error.
$\pm \frac{\text{trigger error}^*}{N}$

Input
channel A

COUNT (ALL MODELS)

Range
1...10^9

Count accumulation
during manual start/stop interval

Pulse pair resolution
12ns

Input
channel A

Note
In the Count Mode the memory is automatically switched off

TIME INTERVAL (PM 6612 ONLY)

Range
1μs...10^5s

Resolution
100ns or 100μs

Accuracy
$\pm$1 count $\pm$time base error $\pm$trigger error**

Inputs
channels A and B

CHECK (ALL MODELS)

10MHz clock frequency interconnected to input A. Any measuring function may be selected.

By using this mode, the COUNT function provides a stop-watch facility.

---

* trigger error is $\leqslant \pm 3 \times 10^{-3}$ for sinewaves with signal to noise ratio of $\geqslant$40dB

** trigger error for any waveshape is
$\leqslant \pm \frac{2.5 \times 10^{-3}}{\text{signal slope (V/ns)}}$ ns

MULTIPLE RATIO

Ratio fA/fC:
$\frac{10Hz...80MHz}{1kHz...10MHz}$ (PM 6611)

Ratio fA/fB:
$\frac{10Hz...80MHz}{10Hz...10MHz}$ (PM 6612)

Ratio fA or B/fC:
$\frac{10Hz...250MHz}{1kHz...10MHz}$ (PM 6613)
$\frac{10Hz...520MHz}{1kHz...10MHz}$ (PM 6614)
$\frac{10Hz...1GHz}{1kHz...10MHz}$ (PM 6615)
$\frac{10Hz...1.3GHz}{1kHz...10MHz}$ (PM 6616)

Multiplier (N)
10^2 and 10^4 with correct decimal point positioning

Accuracy
± 1 count
$\pm \frac{\text{trigger error* of the lower frequency}}{N}$

Ratio measurements with a multiplier factor
$N=10^5, 10^6, 10^7$ and 10^8 (PM 6611, PM 6613...PM 6616) and $N=10^6$, 10^7 and 10^8 (PM 6612) are obtained in the FREQUENCY mode, using the external reference input as lower frequency input. This arrangement, however, does not give correct decimal point positioning.

INPUT CHARACTERISTICS

Input A (all models)
Frequency range: 10Hz...80MHz, limited to 100kHz if internal low-pass filter is switched in
Pulse resolution: 6ns minimum pulse width
Sensitivity: $10mV_{RMS}$ (20Hz...80MHz) $30mV_{RMS}$ (10Hz...20Hz)
Impedance: $1M\Omega//25pF$
Coupling: AC
Attenuation: continuously variable between $\times 1 ... \times 400$
Trigger mode: ~ for signals having a duty factor $>25\%... <75\%$
⎍ for signals having a duty factor $<25\%$
⎍ for signals having a duty factor $>75\%$

Overload voltage without damage: $250V_{DC}$
$220V_{RMS}$; up to 400Hz
$12V_{RMS}$; >1MHz

Input B
(Not available on PM 6611)
Input B serves in the PM 6612 as stop channel in time-interval measurements and as lower frequency input for ratio measurements.

In the PM 6613...PM 6616 input B is the RF input channel with automatic attenuation.

Time Interval STOP-channel B (PM 6612 only)
Frequency range: 10Hz...10MHz
Pulse resolution: 50ns minimum pulse width
Sensitivity: $20mV_{RMS}$
Impedance: $1M\Omega//25pF$
Coupling: AC
Attenuation: continuously variable between $\times 1 ... \times 20$
Trigger mode: ~ for signals having a duty factor $>25\%... <75\%$
⎍ for signals having a duty factor $<25\%$
⎍ for signals having a duty factor $>75\%$

Overload voltage without damage: $250V_{DC}$
$220V_{RMS}$; up to 400Hz
$12V_{RMS}$; >1MHz

RF Input (B)
Frequency range: 5MHz...250MHz (PM 6613; $4\times$ prescaled)
50MHz...520MHz (PM 6614; $8\times$ prescaled)
50MHz...1000MHz (PM 6615; $16\times$ prescaled)
80MHz...1300MHz (PM 6616; $16\times$ prescaled)
Dynamic input voltage range: $10mV^*_{RMS}...12V_{RMS}$ (−27dBm...+35dBm)
Impedance: 50Ω
Attenuation: Continuous by automatic PIN-diode attenuation circuit; max 62dB
Coupling: AC
VSWR: always <2
AM tolerance: 98% at ⩽5kHz modulation frequency
30% at ⩾1MHz modulation frequency
Overload voltage without damage: $12V_{RMS}$

* Above 960MHz, the sensitivity of the PM 6615 might drop to −24dBm ($14mV_{RMS}$) at 1GHz. For PM 6616 dynamic range is $10mV_{RMS}...12V_{RMS}$ for frequencies 150MHz...1GHz and $20mV_{RMS}...12V_{RMS}$ for frequencies 80MHz...1.3GHz.

Input C (Ext. ref. oscillator)
Frequency range: $1kHz...10MHz_{RMS}$
Sensitivity: $500mV_{RMS}$
Impedance: approx. 10kΩ
Counting: AC
Overload voltage without damage: $50V_{RMS}$

OUTPUT CHARACTERISTICS

Oscillator output (rear)
X-tal frequency: 10MHz
Amplitude: approx. $1V_{RMS}$; open circuit
Output impedance: approx. 200Ω
Coupling: AC
Overload protection: short-circuit proof

GENERAL

Display
Read out: Planar, 9 digits; 7 segments gas discharge display with automatic decimal point positioning
Display time: 0.2...5s and ∞
Reset: Pushing 'Reset' resets the counter. Releasing 'Reset' starts new measurement.
Gate lamp: Indicates that main-gate is opened and counting takes place
Memory: Switchable by push-button. In the Count Mode, the memory is switched off and the button is used for 'start/stop' operation

Power requirements
Line voltage: 110/220V ±15%; 45...440Hz
Consumption: depending on type no. crystal oscillator and options: approx. 15VA
Mains interference: below CISPR: 22/3, 29/2 and 40/1
or via Internal battery PM 9673
or via External DC source:
voltage: between +11.8V and +28V
consumption: approx 8W.
Approx. 100mA in STANDBY position if an oven-stabilized oscillator is mounted.
Connector: 4 mm banana

Environmental
Temperature: Storage: −40°C...+70°C
Operating: 0°C...+50°C
Altitude/barometer pressure:
Storage: 15000m (50000ft)/15.2kN/m²
Operating: 5000m (15000ft)/53.3kN/m²
Humidity: 10...90% RH (26°C dewpoint)
Vibration test: According to IEC 68 Fc
Bump test: According to IEC 68 Eb
Handling test: According to IEC 68 Ec
Transport test: According to NLN-L88

Dimensions and weight
(w × h × d) 210 × 89 × 325mm
(8.25 × 3.5 × 12.8-in)
2.8kg (6.2lb)

Optional accessories
A complete list of optional accessories for both the PM 6620-Series and the PM 6610-Series appears one page 198.

IEC-625

IEC/IEEE Bus compatible

Time interval averaging down to 1ns

100ns single shot resolution

100ps TI average resolution

20mV sensitivity

Four time bases

Trigger hold-off

Universal Timer/Counters

80MHz PM 6622
520MHz PM 6624
1000MHz PM 6625

Compact Timer/Counters at 80, 520 and 1000MHz

These three Timer/Counters are extremely powerful, yet compact. Each has specific measurement facilities. All have the following common features:

- 80MHz direct frequency counting
- high 20mV sensitivity
- versatile time interval (averaging) measurements down to 1ns
- period, ratio and conditioned pulse counting.

Depending on your individual needs, you then select the specific model with either:

- trigger hold-off to extend the timing capability (PM 6622)
- extended frequency counting to 520MHz (PM 6624)
- or to 1GHz (PM 6625)

In addition to this basic choice there are many application orientated options such as higher stability timebases, digital or analog data outputs, internal battery pack, etc., etc. All options are housed in the same compact, durable metal case. Add it all up and you'll find that the Philips PM 6620-series is extremely powerful, yet competitively priced.

PM 6622

TECHNICAL SPECIFICATION

3 MODELS

The PM 6620-series comprises three Timer/Counters, each having two identical 80MHz channels for the following functions:
TIME INTERVAL
TIME INTERVAL AVERAGING
FREQUENCY
PERIOD
PERIOD-AVERAGE
MULTIPLE RATIO
and TOTALIZING of counts
All instruments feature:

- 100ns single shot resolution
- 100ps time interval average resolution (max.)
- 20mV sensitivity
- choice of 3 timebases
- bright, sharp 9-digit planar display
- tri-state trigger indicators for convenient and fast trigger level setting
- gate open monitor giving measurement feedback to avoid errors
- external reset/start to prevent false starts from spurious signals
- lightweight, compact construction
- complete range of accessories

In addition, special timing and frequency counting facilities are provided in the individual models.

PM 6622: trigger hold-off

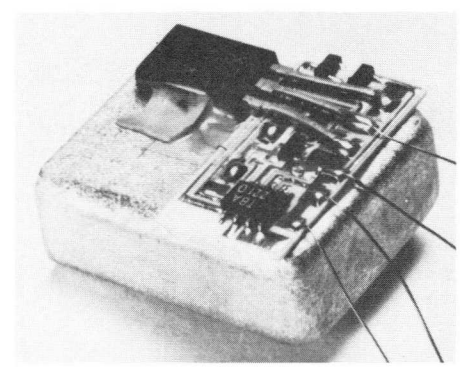
By ignoring false stop pulses, accurate time measurements on signals having contact bounce or ringing can be made. It further allows more complex period duration measurements to be made accurately e.g. double pulses, bursts or sinewaves having high noise levels.

PM 6624 or PM 6625: frequency extension to 520MHz or 1GHz

These models employ a special RF input channel featuring wide 10mV to 12V dynamic input voltage range and automatic and continuous variable attenuation using PIN-diodes. This gives easy operation, optimum input matching, maximum noise suppression, high amplitude modulation tolerance and blocking of signals that are too weak (below count threshold voltage, which would otherwise give erroneous measurements).

5 TIMEBASES

There is a choice of 5 X-tal timebase oscillators. This allows individual stability requirements to be met economically and if necessary, upgraded at a later date. By means of the external reference input, use can also be made of a house frequency standard.



Low consumption crystal oscillator oven plus integrated temperature control.

Instantaneous, high-stability timebases

The stand-by mode maintains the operating temperature inside the oven-enclosed oscillators. This ensures instantaneous high stability directly after switching on.

The PM 6620-series, however, is unique in that it extends this laboratory standard feature to field applications. This has been achieved by developing oven-contained crystal oscillators with extremely low power consumption (less than 100mA). The high-stability timebase options can therefore be used with the internal battery pack. No warm-up time is needed after changing location and the instrument has a stability much higher than that of TCXOs (temperature compensated X-tal oscillators). The battery capacity is sufficient for 24 hours of stand-by operation, making the PM 6620-series ideal for portable field use.

7 USEFUL OPTIONS

The PM 6620-series feature unequalled versatility in both *timing and counting*. There is no limitation on the numerous combinations of model, timebase and options. So whatever your application, the PM 6620-series flexibility offers the optimum in price and performance.

BCD-output

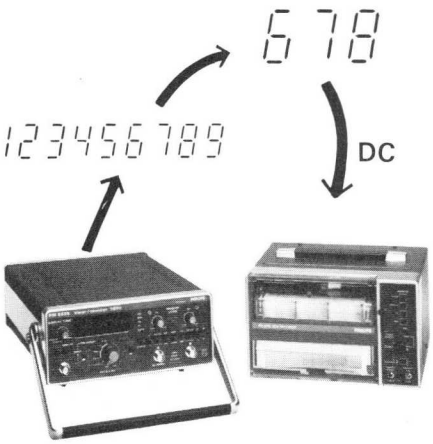
The PM 9674 PC board provides BCD-data in parallel format for automatic data processing or connection to a standard printer.

Analog-output

The digital-to-analog converter PM 9675 provides a high resolution analog output for recording frequency stabilities of oscillators, filters and crystals on a chart recorder. In frequency control systems requiring analog feedback, the DAC also serves as an extremely accurate frequency to voltage converter.

It allows conversion of any three consecutive digits out of the total of nine, or the two least significant digits. As such, it functions as a magnifying glass, to focus on just that part of the readout which is most important.

In the *normal* mode 000 is converted in a zero analog output and 999 into a full scale deflection. In the *offset* mode, however, 500 gives a zero output and 000 a mid-scale deflection. Thus, for a display changing between 99999999 and 100000000MHz, it is possible to record the frequency on the center of the strip chart, rather than shooting between zero and full scale.



DAC gives high resolution analog recording in this case on Philips mini recorder PM 8110.

General-purpose interface bus

The serial data output unit PM 9676 enables data processing by interfacing the instruments to an IEC-IEEE standard bus line.

Battery supply

Each instrument is equipped for the following power conditions:

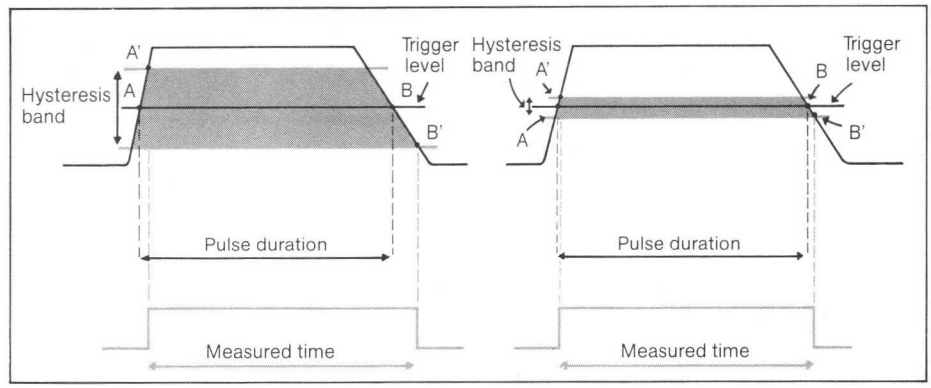


Fig.1. A wide hysteresis band (poor sensitivity) introduces measurement errors, as illustrated. In the PM 6620-series the low hysteresis voltage (typically 12mV$_p$) minimises the error.

- line voltage 110 to 240V$_{RMS}$ 45 to 440Hz
- external battery of 11.8 to 28V
- internal rechargeable battery option PM 9673

This latter feature gives truly portable operation, since the instrument's dimensions are unchanged and the total combined weight only 4.2kg (9.2lb). The PM 9673 features:

- 24 hours of stand-by operation capacity.

As detailed earlier, this gives instantaneous, high stabilities, even if oven oscillators are used, since warm-up times are not needed after changing locations.

- 2 to 4 hours of continuous operation (depending on model and X-tal oscillator).
- automatic recharging via a built-in circuit, which also protects the batteries against overcharging.
- low-charge indication. The display starts blinking 10 to 15 minutes before recharging is needed, allowing measurements to be completed.
- sealed, lead-acid batteries that are not damaged when completely discharged.
- recharging from the line supply or an external DC source of at least 18V.

Rack mounting

The instruments can be fitted into a standard 19-in rack using adapter PM 9669/01 or PM 9669/02 for one or two instruments respectively.

Carrying case

To protect the instrument and measuring leads during transportation an every-ready case PM 9672 can be ordered.

SPECIAL FACILITIES FOR HIGH MEASURING ACCURACY

High resolution

By using the time interval averaging technique, the PM 6620-series of Timer/Counters greatly improves both the measuring accuracy and resolution of signals that are asynchronous with respect to the timebase.

Compared to conventional methods, the basic 100ns resolution is improved by a factor of $\sqrt{N}$, where N is the number of time intervals being averaged. In the case of the PM 6620-series this becomes

$$\frac{100ns}{\sqrt{10^6}} = 100ps$$

High trigger accuracy

Meaningful use of the averaging technique is made through the high-speed synchronizers and equalized input channels. Amplifiers and Schmitt-trigger circuits for both start and stop channel are *all* on the one IC-chip, thereby avoiding differences in delay and rise-times, such as are found in con-

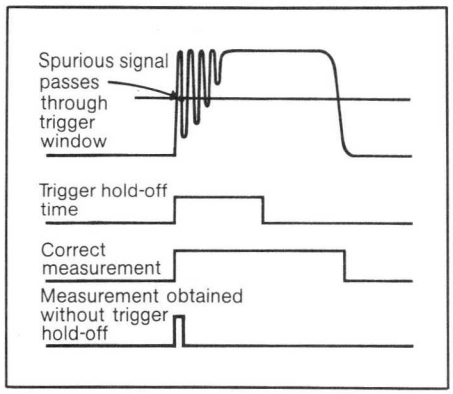


Fig. 2. The use of the PM 6622's variable trigger hold-off enables the influence of spurious signals such as ringing or relay bounce to be ignored and correct measurements obtained.

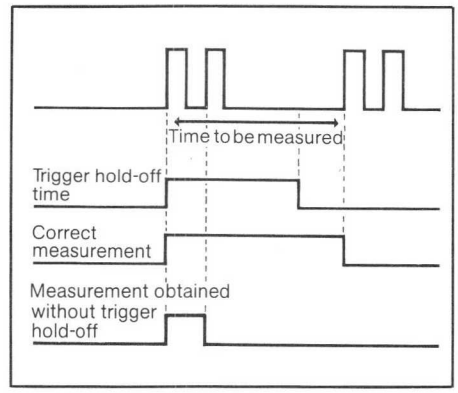


Fig. 3. Withough trigger hold-off this double-pulse period measurement would be impossible.

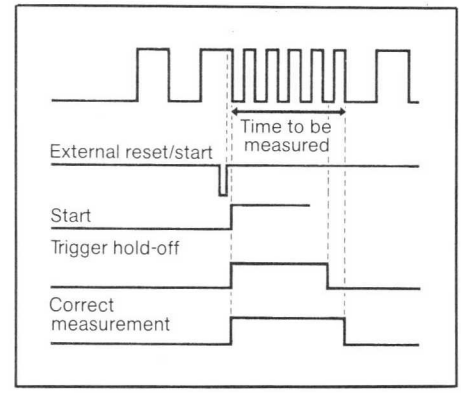


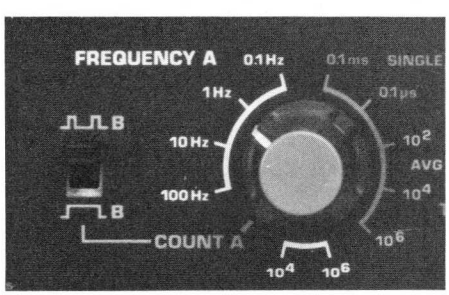
Fig. 4. The impressive combination of external reset/start and variable trigger hold-off enables this signal to be 'picked out' from the pulse train.

ventional counters. This reduces systematic trigger errors which cannot be eliminated by averaging. Systematic trigger errors are further reduced by the low hysteresis via the use of high sensitivity input amplifiers, as shown in fig. 1.

Quick and accurate trigger level setting
This important facility is provided by tristate LED trigger *indicators* on both channels as follows:
– BLINKING when the channel is triggering
– ON when the trigger level is too high
– OFF when the trigger level is too low
Additionally the *trigger level output* terminals on the front panel allow accurate measurements to be made of the set level with a DVM.
The trigger level can also be positioned with respect to the waveshape using an oscilloscope.

Real-time check
A real-time check of exactly what is being measured is provided by the *gate open monitor* – see fig. 4, opposite. This gives a simultaneous display on a scope of the measured signal and the gate-open signal. The actual measured time can therefore be directly related to the start/stop positions.
Note that the gate-open monitor on model PM 6622 described opposite is used simultaneously to monitor the trigger hold-off duration.

No false starts
The PM 6620-series of Timer/Counters gives you full control over the 'when' and 'ifs' of the start of the measurements. An external *reset/start* signal applied to the rear panel connector *resets* (on leading edges) the instrument and *conditions* (on trailing edges) in order to start a new measurement. This eliminates false-start triggering on unwanted signals. In this way measurements, which would otherwise be impossible, can be made. These include time interval measurements in a pulse stream (see fig. 4 opposite) and frequency sweep profile measurements.



Conditioned pulse counting gives totalizing of events on channel A. With the switch in the top position events are counted between a start and stop pulse. In the bottom position by a gate signal on channel B. Polarity and slope may be selected via the input controls.

PLUS EXTRA TIME MEASUREMENT FACILITIES IN MODEL PM 6622

In addition to the impressive features which are common to all three models, the PM 6622 offers special time measurement facilities. It employs *adjustable trigger hold-off*, that avoids false triggering on spurious signals. These unwanted signals, which would trigger the counter during the measurement interval, can therefore now be ignored. Typical examples of these spurious signals are ringing or relay contact bounce – see fig. 2. Trigger hold-off can also be employed to make accurate measurements on double pulses and to 'pick out' signals in complex pulse trains – see fig. 3.
Other measurements that the PM 6622 makes possible include period measurements on noisy signals up to 100kHz, while synchronous interference like oscillations and thyristor spikes can be entirely eliminated by setting the appropriate hold-off duration.
The *combination* of adjustable trigger hold-off and external reset/start as illustrated in fig. 2 is particularly useful. It gives conditioned start *and* stop triggering, thereby allowing many measurements to be made which would otherwise be completely impossible.

Accurate setting of the hold-off duration is extremely simple since when both *hold-off* and *check* are 'ON', the PM 6622 measures and displays is own hold-off time.

520MHz or 1GHz ERROR-FREE COUNTING

When your application calls for extended frequency counting rather than additional timing capability, then models PM 6624 and PM 6625 fit the bill. The former to 520MHz and the latter to 1GHz: both offer all the common features described in detail on page 161. The high frequency channel that these models employ features a multi-stage PIN-diode attenuation circuit that was developed and perfected in the Philips PM 6610-series of telecommunications counters and that gives high accuracy, reliable counting.
Features of the PIN-diode attenuation circuit, that led to the accurate and reliable frequency counting, are:
– Automatic noise suppression
– Automatic trigger adjustment
– Overload input protection
– High tolerance of amplitude modulation
– Automatic blocking of too weak signals
– Low reflection through perfect impedance matching
– Extremely low kickback
The 520MHz and 1GHz such as used in the Timer/Counters PM 6624 and PM 6625 are exactly identical to those in the PM 6614 and PM 6615 respectively.

For detailed explanation of all features, please look at page 157, where the PM 6610-series of unversal frequency counters are described.

Accessories included with the instrument
– Detailed operation and service manual
– Line cord
– Front panel protective cover

Measuring probes

PM 9326	1:1 0r 10:1 probe-set: 1MΩ or 10MΩ; for DC...15MHz signals
PM 9327	as for PM 9326 but with 2m cable
PM 8925	10:1 probe-set; 10MΩ; for DC...25MHz signals
PM 9339*	10:1 probe-set 500Ω/1.5pF; for DC...800MHz signals

* The PM 9339 has been designed for 50Ω inputs. For connection to the 1MΩ A and B inputs, the 50Ω feedthrough adapter PM 9585 is used.

Reliability and economy
The high performance and low coast of the PM 6620-series is basically due to the high degree of integration, such as: specially developed Philips LOCMOS LSIs and the integration of all input stages.

TECHNICAL SPECIFICATION

PM 6620-Series

FREQUENCY

Range
DC...80MHz (PM 6622)
DC...520MHz (PM 6624)
DC...1GHz (PM 6625)

Gate times
10ms...10s (in decade steps).

If the RF-input on models PM 6624 or PM 6625 is used, the gate time is automatically multiplied with the prescaling factor.

Resolution
0.1Hz...100Hz

Accuracy
±1 count±time base error

Inputs
LF channel A for:
DC...80MHz (all models)
RF channel C for:
50MHz...520MHz (PM 6624)
50MHz...1GHz (PM 6625)

SINGLE PERIOD

Range
100ns...10^5s (DC...10MHz)

Resolution
100ns and 100µs

Accuracy
±1 count ±time base error±trigger error*

Input
channel B

PERIOD AVERAGE

Range
1Hz...10MHz

Periods averaged (N):
10^2, 10^4 and 10^6

Resolution
$$\frac{100\text{ns}}{N}$$

Accuracy
±1 count±time base error
$$\pm\frac{\text{trigger error}^*}{N}$$

Input
channel B

TIME INTERVAL

Range
100ns...10^5s

Resolution
100ns or 100µs

Time interval repetition rate
max. 5MHz

Accuracy
±1 count±time base error ±trigger error**

Inputs
channels A and B; can be common or separate

TIME INTERVAL AVERAGE

Range
1ns...1s

Time intervals averaged (N)
10^2, 10^4 and 10^6

Statistical resolution
$$\frac{100\text{ns}}{\sqrt{N}}$$

Time interval repetition rate
max. 4MHz

Min. time from stop to start
250ns

Accuracy
±4ns±time base error
$$\pm\frac{100\text{ns}+\text{trigger error}^{**}}{\sqrt{N}}$$

Inputs
channel A and B; can be common or separate

COUNT (TOTALIZING)

Range
1...10^9

Mode
accumulates pulses between a start and stop pulse or during a gate signal, applied to input B

Pulse pair resolution
12ns

Input
channel A

MULTIPLE RATIO

Ratio fA/fB
$$\frac{\text{DC...80MHz}}{\text{DC...10MHz}}\ \text{(PM 6622)}$$

Ratio fA/fB or fC/fB
$$\frac{\text{DC...520MHz}}{\text{DC...10MHz}}\ \text{(PM 6624)}$$

Ratio fA/fB or fC/fB
$$\frac{\text{DC...1GHz}}{\text{DC...10MHz}}\ \text{(PM 6625)}$$

Multiplier (N)
10^4 and 10^6 with correct decimal point

Accuracy
$$\pm1\text{ count}\pm\frac{\text{trigger error}^*\text{ of B}}{N}$$

Ratio measurements with a multiplier factor
$N=10^5...10^9$ are obtained in the FREQUENCY mode, whereas in the PERIOD and PERIOD AVERAGE mode, multiplier factors of 1, 10^2, 10^4 and 10^6 can be obtained by using the external reference input. This arrangement, however, does not give correct decimal points.

TRIGGER HOLD-OFF
(only PM 6622)

Trigger hold-off (trigger delay) is activated by hold-off knob and functions in the single period and single time-interval modes.
Range: <10µs...500µs
and 500µs...100ms
The hold-off is monitored on the gate monitor output. The hold-off time can be digitally measured by the PM 6622 itself.

CHECK

Modes
– In the position 'Hold-off' OFF, a functional self test can be made. A 10MHz signal is internally applied to channels A and B. Any measuring function may be selected.
– In the position 'Hold-off' ON, the set hold-off duration will be displayed if a SINGLE period or time-interval mode has been selected.

* Trigger is $\leqslant\pm3\times10^{-3}$ for sinewaves with signal to noise ratio of ⩽40dB
** trigger error for any waveshape is
$$\leqslant\pm\frac{2.5\times10^{-3}}{\text{Signal slope (V/ns)}}\text{ns}$$

INPUT CHARACTERISTICS

Inputs A and B
(not prescaled)
Frequency range
DC coupled: DC...80MHz
AC coupled: 100Hz...80MHz
Rise time: approx. 4ns
Pulse resolution: 6ns minimum pulse duration
Sensitivity
Sine wave: $20mV_{RMS}$ and $200mV_{RMS}$
Pulse: 60_{p-p} and $600mV_{p-p}$
Trigger window
$25mV_{p-p}$ and $250mV_{p-p}$ (typical)
Impedance: 1MΩ//25pF

Trigger level: −2.5V...+2.5V and −25V...+25V; higher resolution aroung 0V and preset to 0V.
Trigger level monitor: set trigger voltages −2.5V...+2.5V available on 1mm jacks at the front.
Trigger slope: + and −
Coupling: DC and AC
Overload voltage without damage
20mV pos: $250V_{DC}$ or
$230V_{RMS}$; up to 440Hz
falling to $12V_{RMS}$ at ⩾1MHz
200mV pos: $250V_{DC}$ or $230V_{RMS}$
Switching mode: separate or common

PM 6625 timer/counter

Input C
Range
50MHz...520MHz
(PM 6624; 8 × prescaled)
50MHz...1GHz
(PM 6625; 16 × prescaled)
Dynamic input voltage range
10*mV$_{RMS}$...12V$_{RMS}$ (−27*dBm...+35dBm)
Impedance: 50Ω
Attenuation: Continuous by automatic PIN-diode attenuation circuit; max. 62dB
Coupling: AC
VSWR: always < 2
AM tolerance:
98% at ≤5kHz modulation frequency
30% at ≥1MHz modulation frequency
Overload voltage without damage:
12V$_{RMS}$

* above 960MHz, the sensitivity of the PM 6625's C input might drop to −24dBm (14mV$_{RMS}$) at 1GHz.

Reference frequency in/output D
The D Input/Output is switchable between external reference frequency input and internal reference oscillator output.

External reference (rear)
Frequency range: 1kHz...10MHz, correct decimal point only from 10MHz reference frequency
Sensitivity: 500mV$_{RMS}$
Impedance: approx. 10kΩ
Coupling: AC
Overload voltage without damage: 50V$_{RMS}$

Time base oscillator output (rear)
X-tal frequency: 10MHz
Amplitude: approx. 1V$_{RMS}$; open circuit
Output impedance: approx. 200Ω
Coupling: DC
Overload protection: short-circuit proof

External reset/start (rear)
Reset: Via 0V±0.4V signal, applied to the external reset input or contact closure to ground
Min. reset pulse duration: 100ns
Start of new measurement: When the input is returned to > +2.5V (max. 5.5V) or left open, the counter is released to carry out a new measurement. Minimum time between trailing edge and start of new measurement: 200ns.
Input current: at 0.4V$_{max.}$ 0.4mA
If the DISPLAY TIME is set to ∞, only one new measurement is made and stored. The counter is disabled from starting a new measurement until a new reset pulse has been applied.

Gate monitor output (rear)
The gate monitor output enables observation on an oscilloscope of the measured interval (and the hold-off time on the PM 6622).
Output level
main gate open: < 0.4V
hold-off time: approx. 1.5V
main gate closed: > 2.5V
Output impedance: approx. 400Ω
Delay: internal delay between the signal inputs and the trigger monitor output is approx. 65ns
Overload protection: short circuit proof

X-tal oscillator characteristics

PM 662./..version Including time-base:	01 version PM 9677	02 version PM 9678	03 version PM 9679	04 version PM 9690	05 version PM 9691
STABILITY against: Type:	standard	TCXO	proportionally oven controlled	proportionally oven controlled	proportionally oven controlled
Ageing:	$< 5\times10^{-7}$ per month	$< 1\times10^{-7}$ per month	$< 1\times10^{-7}$ per month	$< 1.5\times10^{-9}$ per 24h*	$< 5\times10^{-10}$ per 24h*
Temperature: 0°C...50°C, ref. to +25°C	$< 1\times10^{-5}$	$< 1\times10^{-6}$	$< 1\times10^{-7}$	$< 3\times10^{-8}$	$< 5\times10^{-9}$
Change in measuring – and supply mode; line/int. battery/ ext. DC 12V...28V	$< 3\times10^{-7}$	$< 5\times10^{-8}$	$< 1\times10^{-8}$	$< 3\times10^{-9}$	$< 3\times10^{-9}$
Line voltage; ±10%	$< 1\times10^{-8}$	$< 1\times10^{-9}$	$< 1\times10^{-9}$	$< 5\times10^{-10}$	$< 5\times10^{-10}$
Warm-up time to reach 1×10^{-7}	—	—	< 10min	< 15min	< 15min

* *after 72 hours of continuous operation*

GENERAL

Display
Read out: Planar, 9 digits; 7 segments gas discharge display with automatic decimal point.
Unit annunciators; kHz, MHz, ms and ns
Display time: 0.2...5s and ∞
Reset: Pushing 'Reset' resets the counter. Releasing 'Reset' starts new measurement.
Gate lamp: Indicates that main-gate is opened and counting takes place, in the stand-by position the gate lamp indicates that the line voltage or battery is connected for X-tal oscillator stabilization.
Memory: Display storage holds reading between samples, can be switched-off by front panel 'MEMORY' push-button.
Trigger indicators – Tri-state LED trigger lights with stretched operation (channels A and B)
Light ON: when trigger level is too high
Blinking: when triggering occurs
Light OFF: when trigger level is too low

Power requirements
Line voltage: 110/220V ±15%; 45...440Hz
Consumption: depending on type no., crystal oscillator and options: approx. 15VA
Mains interference: below CISPR: (22/3, 29/2 and 40/1)
or via INTERNAL BATTERY PM 9673
or via EXTERNAL DC SOURCE:
Voltage: between +11.8V and +28V
Consumption: approx. 8W
Approx. 100mA in STAND-BY position if an oven stabilized oscillator is mounted
Connector: 4mm banana connectors

Environmental
Temperature
Storage: −40°C...+70°C
Operating: 0°C...+50°C
Altitude/barometer pressure
Storage: 15000m (50000ft)/15.2kN/m²
Operating: 5000m (15000ft)/53.3kN/m²
Humidity: 10...90% RH (26°C dew point)
Vibration test: according IEC 68 Fc
Bump test: according IED 68 Eb
Handling test: according IEC 68 Ec
Transport test: according NLN-L 88

Dimensions and weight
(w × h × d) 210 × 89 × 325mm
(8.25 × 3.5 × 12.8-in)
2.8kg (6.2lb)

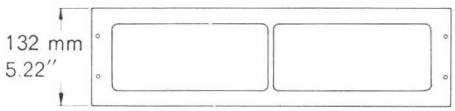
OPTIONS (see page 188)

Options for PM 6610 – and PM 6620 – series of counters

IF (display) off-set unit PM 9668 (PM 6610 series only)
Installation: Inside the instrument
Off-setable digits: 8 most significant digits
Off-set choice: External selection of two different pre-programmable values
Programming: Pre-programming of the off-set:
– magnitude, with diodes in BCD code
– polarity, with jumpers
Environmental conditions: Same as for the basic counters
Dimensions: 202 × 118 × 25mm (8 × 4.6 × 1-in)
Weight: approx. 150g (5.3oz)

Rack mount adapter dimensions PM 9669/01 and /02

PM 9669/01



PM 9669/02

Battery unit PM 9673
The PM 9673 is a rechargeable battery unit for mounting inside the counters.
The unit contains two standard 6V sealed batteries of solid gel lead acid type.
Battery capacity: 24Wh, 2...4 hours continuous operation, depending on type number and options. Minimum 2h operation for the 1GHz, PM 6615 including oven enclosed oscillator at 0°C ambient temperature
Battery voltage: $12V_{DC}$
Recharging time: 5h to approx. 75% and 10h to > 90% of full capacity
Battery low indication: by blinking display 10–15m before recharging is needed
Power requirements: charging power is supplied from the counter
< 12W nominal
Temperature
Storage: −40°C...+50°C
Operating: 0°C...+40°C
Other environmental conditions: as for the basic counters
Dimensions: 150 × 185 × 40mm
(5.9 × 7.3 × 1.6-in)
Weight: 1.4kg (3.1lb)

BCD-output unit PM 9674
Installation: The BCD-output circuit board is plugged-in through a slot in the rear panel of the counter
Output signals: 9 × 4 parallel data lines; 8–4–2–1 BCD; TTL positive true logic levels
READY. A negative pulse is given when the measurement and the parallel-to-serial conversion is finished; TTL level
Input command signals: EXT. TRIGGER; A low level signal (0V) resets counter and initiates a new measurement.
INHIBIT; The data transfer is inhibited as long as this input is kept low.
Connector: Amphenol Micro-ribbon 57–40500. Mating cable Amphenol 57–38500
Environmental conditions: Same as for the basic counters
Dimensions: 170 × 85 × 20mm
(6.7 × 3.3 × 0.8-in)
Weight: 80g (2.8oz)

Digital-to-analog converter PM 9675
Installation: The DAC circuit board is plugged-in through a slot in the rear panel of the counter
Decade conversion: Any 3 consecutive digits or the 2 least significant digits can be selected with an 8 position rotary switch
Normal mode: Analog output is directly proportional to digital input
000 produces 0V output
999 produces 1V output
Offset mode: This mode adds 500 to digital input to obtain half scale offset
500 produces 0V output
499 produces 1V output
Output: zero output: 0V
full scale output: +1V
connector: BNC
Accuracy: ±0.2% of fsd
Nonlinearity: ±0.05% of fsd
Output impedance: 100Ω ±1%
Environmental conditions: Same af for the basic counters
Dimensions: 170 × 85 × 25mm
(6.7 × 3.3 × 1-in)
Weight: 80g (2.8oz)

Bus interface PM 9676
The PM 9676 is a standard byte-serial/bit-parallel bus line interface, compatible to the IEC TC66 recommendation.
Installation: The interface unit is mounted inside the counter cabinet, thereby occupying the sapce reserved for the battery unit.
Data signal format: Data is coded in ASCII format
Sample rate: Controlled by display-time setting or the trigger command rate.
Programmability: Frontpanel control functions are not programmable
Environmental conditions: Same as for the basic counters
Dimensions: 202 × 150 × 25mm
(8 × 5.9 × 1-in)
Weight: approx. 250g (8.8oz)

Maximum ease of operation (only power On-OFF)

Automatic triggering

Automatic noise suppression

Automatic leading zero blanking

High 20mV$_{RMS}$ sensitivity

LED display, 8 digits

MHz. kHz. Hz – grouped read-out

Extremely compact and lightweight

Rugged metal case

Automatic frequency counter 80MHz PM 6661

The automatic frequency counter PM 6661 whilst sophisticated in design and technology is extremely simple to operate. The high degree of integration (LSI LOC-MOS) allows advanced circuitry that automates all control functions. The use of LOC-MOS also results in a very compact mechanical layout, which is contained within the small, rugged metal case.

This state-of-the-art frequency counter really represents the ultimate in ease of operation: NO CONTROLS at all, while accurate measurements are ensured by the use of an automatic and continuously variable input attenuator.

Considerable frequency counter design know-how has been embodied, resulting in a very compact, accurate and reliable counter of excellent quality at a most attractive price.

TECHNICAL SPECIFICATION

Frequency range
10Hz...80MHz

Gate time
1s*

Resolution
1Hz

Input sensitivity
20mV$_{RMS}$

Input attenuation
Automatically and continuously variable from ×1 to ×50

Input impedance
1MΩ//approx. 18pF

Accuracy
±1digit ±time base error

Max. input voltage without damage
300V$_{DC}$ or 260V$_{RMS}$ at < 440Hz, falling to 12V$_{RMS}$ at > 1MHz

* with 0.1s on request

Display
8 digits; 7.6mm LED with grouped presentation of MHz, kHz, Hz, leading zero blanking

Power requirements
115/230V +10%, −15%;
50...400Hz; 15VA

Mains interference
Below Class II CENELEC/CISPR

Temperature
Storage: −40°C...+70°C
Operating: 0°C...+45°C

Altitude/barometer pressure
Storage: 15,000m (50,000ft)/15.2kN/m²
Operating: 5,000m (15,000ft)/53.3kN/m²

Humidity
10...90% RH, (26°C dew point)

Vibration test
according IEC 68Fc

Bump test
according IEC 68Eb

Handling test
according IEC 68Ec

Transport test
according NLN – L88

Dimensions and weight
(w×h×d) 145×44.5×220mm
(5.75×1.75×8.7-in)
1.45kg (3.2lb) approx.

ORDERING PROCEDURE

PM 6661: 80MHz automatic counter
PM 9585: 50Ω/1W feed-through termination
PM 9665B 50kHz low pass filter
PM 9669/09 Panel mount adapter

Time base characteristics

X-tal frequency	2^{22}Hz
Ageing	$< 2\times10^{-6}$/year
Temperature stability 0...50°C, ref. to +25°C 20...30°C, ref. to +25°C	 $< 1.5\times10^{-5}$ $< 5\times10^{-6}$ (typical)

Microprocessor-control

High resolution computing counters

Built-in intelligence for easy operation

Auto triggering on all waveforms and duty cycles

Self-diagnosis routine

15mV$_{RMS}$ sensitivity

High-stability X-tal oscillators: 10^{-7}/mth

Line and battery operation

Clear high-contrast crystal display

new

High resolution counters

120MHz PM 6667

1GHz PM 6668

The microprocessor-controlled, high resolution counters PM 6667 and PM 6668 span a wide frequency range of 10Hz to 120MHz and 10Hz to 1GHz, respectively, with excellent economy. Operation is fast and the available computing power provides very high resolution capabilities normally associated with more expensive instruments.

The design incorporates an advanced technology microprocessor and dependable, large-scale C-MOS digital circuitry with fully integrated front ends which will handle a wide range of input signal voltages. Thus, the benefits of electronic performance are accompanied by a vastly reduced component count. As a result reliability and performance are increased, size and cost reduced.

Automatic triggering on all waveforms

No counter is better than its front-end circuitry, therefore special attention has been given to facilitate accurate and easy triggering. The multi-step attenuator allows attenuation of noisy input signals, giving a noise-immunity up to 10dB better than with normal ×10 attenuators.

Another state-of-the-art feature is automatic trigger level setting. Depending on the input signal waveform, the counter sets automatically the required (+, 0, −) trigger level. Correct triggering is ensured without tiresome manual adjustments, for sinewaves and low duty cycle pulses. In addition to these advanced features, the PM 6668 front-end has automatic PIN-diode attenuation, featuring automatic triggering and excellent excessive input signal tolerance.

High resolution computing counter

By making a multiple period measurement and computing the reciprocal value, these counters perform *high resolution frequency* measurements on low frequency signals. The microcomputer thus eliminates the traditional ±1 cycle error and avoids the need for long gate times or period measurements or the limitations of phase-locked frequency multipliers.

Choice of two measurement times optimizes the measurement rate to application. In the NORMAL mode, a seven digit resolution measurement is made every one second.

The FAST mode allows the user to follow changing frequency values (as for circuit trimming) and gives a full six digit resolution every 200ms.

Greater user convenience

In addition to automatic triggering, these counters bring excellent read-out convenience by eliminating manual range selection. Independent of the input frequency, maximum resolution is assured, without any risk of overflow.

This type of manipulation, including Hz, kHz, MHz and proper decimal point indication is accomplished by the microprocessor. Easy readout is ensured by the clear, high-contrast liquid crystal display with large 11.5mm digits.

Ideal for field use

Both counters are packed in a rugged, high temperature and impact resistant polyphenylenoxide case, containing a perfectly shielding metal inner construction.

The light weight yet compact construction together with an optional battery pack and carrying case make these counters ideal for portable field use. A full battery charge gives approx. 5 hours of uninterrupted operation.

Some 15 minutes before recharging is needed, a low battery indication 'LO BAT' is given on the LCD display.

Self diagnosis
After switch-on a self test routine is executed. Should an error be detected, it is shown on the display by a diagnostic code, explained in the manual.

Quality without compromise
These compact counters have been designed to the highest possible reliability standards. They employ a PHILIPS C-MOS LSI and a single chip microcomputer that contribute to the excellent MTBF of 40000 hours.

TECHNICAL SPECIFICATION

Frequency range
PM 6667: 10Hz...120MHz
PM 6668: 10Hz...1GHz

Input sensitivity
(in $15mV_{RMS}$ position)

LF-input: $15mV_{RMS}$ sinewave; 100Hz...75MHz
$25mV_{RMS}$ sinewave; 10Hz...120MHz
$45mV_{p-p}$ for pulses with a pulse duration of $\geqslant 7ns$

RF-input: (PM 6668 only)
$15mV_{RMS}$ sinewave; 70MHz...800MHz
$25mV_{RMS}$ sinewave; 800MHz...1GHz
(see input voltage characteristics)

Input attenuation
LF-input: ×1 to ×300 in 6 positions
RF-input: automatic attenuation

Trigger level
A fixed (+, 0 or −) voltage is automatically applied to ensure proper triggering on any waveform and duty cycle.

Coupling
AC

Input impedance
LF-input: 1MΩ// ≈ 25pF
RF-input: 50Ω nominal with VSWR < 2 (PM 6668 only)

Max. input voltage without damage
DC: 300V
AC: $260V_{RMS}$ at ≤ 440Hz, falling to $12V_{RMS}$ at 1MHz (see input voltage charcteristics above)

Measurement rate
Normal, (out): approx 1 measurement/s
Fast, (in): approx 5 measurements/s; at frequencies below 100Hz, the measurement rate gradually slows down to one measurement per second to reduce the trigger error influence.

Display
7 digits, 11.5mm, liquid crystal display with unit indication of Hz, kHz, MHz and LO BAT.

Inaccuracy (relative frequency error)

$$\pm \frac{LSD}{\text{input frequency}} \pm \text{rel. trigger error} \pm \text{time base error}$$

Rel. trigger error:

For any waveshape:

$$\frac{\text{Measurement rate}}{\text{Signal slope (V/s)}} \times \text{peak-to-peak noise voltage}$$

For sinewaves:

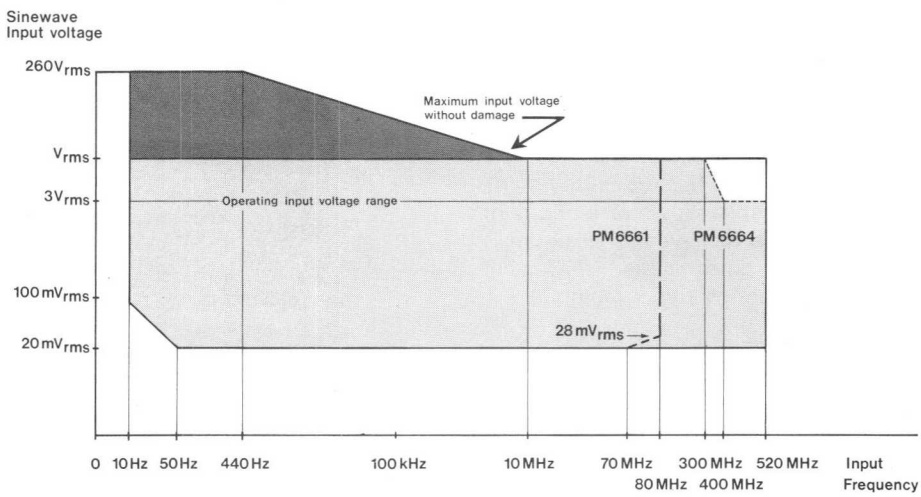
$$\frac{\text{Measurement rate}}{\text{Input frequency} \times \pi \times \text{S/N ratio}}$$

Example: for S/N ratio of 100 (40dB) and sample rate of 1 measurement/s, the trigger error is

$$\frac{3 \times 10^{-3}}{\text{input frequency}}$$

Resolution
For the least significant digit (LSD) and relative resolution see graph to the right.

Ext. reference input
Frequency: 10MHz
Input voltage range: $0.5V_{RMS}$...$12V_{RMS}$
Input impedance: approx. 2kΩ



Power requirements
115/230V, ±15%, 50...60Hz; 15VA or by built-in optional battery pack PM 9601 or by external 12V battery.

Safety
According to IEC 348 and CSA 556 B.

Line interference
Below class II CENELEC/CISPR

Dimensions and weight
(w × h × d) 160 × 77 × 180mm
(6.3 × 3 × 7.1-in)
1.2kg (2.6lb)
Weight: 0.75kg (1.65lb)

ENVIRONMENTAL CONDITIONS

Temperature
Storage: −40°C...+70°C
Operating: 0°C...+45°C

Altitude/barometer pressure
Storage: 15000m (50000ft)/15.2kN/m²
Operating: 5000m (15000ft)/53.3kN/m²

Humidity
10%...90% RH, (26°C dew point)
Vibration test: according IEC 68 Fc
Bump test: according IEC 68 Eb
Handling test: according IEC 68 Ec
Transport test: according NLN - L88

OPTIONAL ACCESSORIES

PM 9601 Battery unit
The PM 9601 is a rechargeable battery unit for mounting inside the counters. This unit contains a standard 6V, 3Ah sealed battery of solid gel lead-acid type and is provided with charging and over-charge-protection circuitry.

Capacity (typical at 20°C)
PM 6667: 6h of continuous operation
PM 6668: 4h of continuous operation

Recharging time (typical at 20°C)
10h to 90% of full capacity
5h to 70% of full capacity
Trickle charge during operation (Power on).

ORDERING INFORMATION

PM 6667/01	120MHz counter with standard osc.
PM 6667/02	120MHz counter with TCXO
PM 6668/01	1GHz counter with standard osc.
PM 6668/02	1GHz counter with TCXO
PM 9601	Battery pack
PM 9602	Carrying case
PM 9603	19-in rack/panel mount adapter
PM 9665B	50kHz low pass filter BNC-BNC
PM 9326	15MHz, 10MΩ attenuator probe set
PM 8935	250MHz, 10MΩ attenuator probe set

Time base characteristics

Time base version	/01 (standard)	/02 (TCXO)
X-tal frequency	10MHz	10MHz
Ageing	$\leqslant 5 \times 10^{-7}$/month	$\leqslant 1 \times 10^{-7}$/month
Temperature stability		
0...50°C, ref. to +25°C	$\leqslant 1 \times 10^{-5}$	$\leqslant 1 \times 10^{-6}$
20...30°C, ref. to +25°C	$\leqslant 3 \times 10^{-6}$ (typical)	$\leqslant 3 \times 10^{-7}$ (typical)

IEC-625

512MHz: 1ns Programmable Counter/Timer PM 6650

IEC/IEEE Bus compatible

Input for RF measurements up to 512MHz with an amplitude range of 10mV to 12V

Input channels with 1ns rise time for universal waveforms

Direct gating giving 1 Hz resolution in one second

Time interval averaging which gives resolutions up to 1ps

Comprehensive triggering facilities, including RF noise suppression and automatic hysteresis compensation

Triggered measurements of burst signals

Choice of time base oscillators

The PM 6650 is a powerful and versatile instrument that allows accurate time and frequency measurements to be made in a convenient manner. For example, the RF channel incorporates an automatic PIN-diode attenuation circuit that enables a wide 62dB dynamic range to be handled and at the same time reduces noise to a level below the 'trigger window'. (See Fig. 2 for more details). Similarly time measurements are facilitated and accuracy improved by a combination of features including LED indicators for quick setting of trigger levels, trigger level monitoring, automatic hysteresis compensation and the time interval averaging technique. Together with the 100MHz clock rate and very fast, equalised start/stop channels, this allows resolutions of up to 1ps to be achieved. This figure is some 10000 times better than that reached with conventional methods.

The basic 512MHz specification of the PM 6650 can be extended still further by sub-units, which increase the frequency range to 1GHz, while another unit increases the basic sensitivity by a factor of 50 over the range 10kHz to 200MHz.

Options are also available in the specification. There is a choice of three X-tal oscillators in order to meet individual stability requirements, see table.
Further are a number of interface options available such as:

- A GP-IP (general purpose interface bus compatible to IEC TC 66 and IEEE 488. Both TALK and LISTEN functions allow fully bidirectional bus communication. Since the PM 6650 is fully programmable, even such functions as input trigger settings are digitally programmable.
- Parallel BCD output and separate remote control input circuit boards for use in test set-ups not according to the GP-IB structure.
- An analog output for measuring-data recording on a chart recorder. This digital to analog converter option provides an economic and effective solution for long term stability measurements in oscillators, filters, etc.

The PM 6650 is thus one of the most powerful and versatile time and frequency measurement tools on the market today.

HIGH ACCURACY FREQUENCY MEASUREMENTS

Whilst the basic accuracy of any counter is ± 1 digit $\pm$ the time base error (a point that will be dealt with later in more detail), it is not always realised that noise can cause false counting and lead to significant errors. Noise, such as that shown in Fig. 2 is most often present on high frequency sine and carrier wave signals. The PM 6650 therefore incorporates a special input channel 'C' for RF frequency measurements. The input circuit of this channel attenuates noise to a level below the 'trigger window' and the kind of false counting shown.

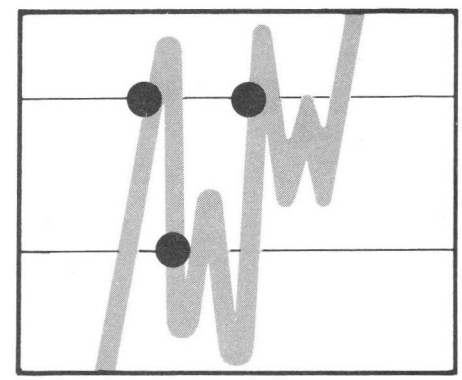


Fig. 1 is an enlarged detail of the RF waveform in fig. 2 and indicates how noise can cause the signal to pass through the trigger window and hence give a false count. This is eliminated in the PM 6650.

Two frequency inputs

Channel 'C', as mentioned earlier, is reserved for RF measurements from 5 to

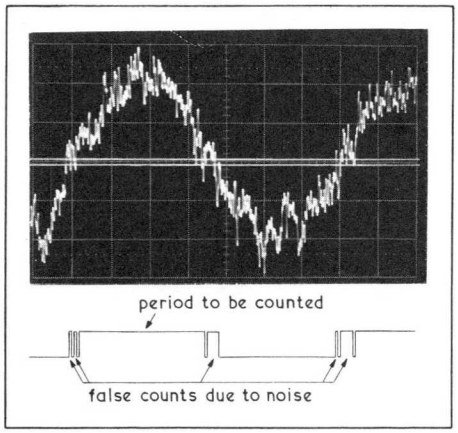


Fig. 2

512MHz. It also features a very wide 10mV to 12V (62dB) dynamic range due to the automatic PIN-diode attenuation circuit.
Channels 'A' and 'B' are reserved for universal sine and pulse measurements from DC to 160MHz.
It should be noted that all channels are direct gated (not prescaled). This means that in one second a resolution of ± 1Hz is obtained, an accuracy some 4–10 times better than that of a prescaled counter.

Comprehensive input facilities

Channels A and B have push-button selection of: input impedance (1MΩ or 50Ω); AC for DC coupling; trigger slope $\times 10$ attenuation plus continuous control of the trigger level.
LED indicators on all channels are illuminated when attenuation and trigger controls are correctly set. This eliminates the possibility of false counting. NB this feature also applies to RF channel C.

Burst frequencies

The PM 6650 also offers the facility of triggered frequency measurements for tone burst, pulses RF or pulse train frequency measurements. In this 'burst' frequency mode the counter waits until a signal appears. Then the main gate is synchronised and opened for the selected gate time.

High stability time base

As mentioned earlier, the basic accuracy of any counter is related to the accuracy of the time base. To ensure high measurement accuracies, the PM 6650B (standard version) uses a temperature compensated X-tal that provides a very high stability directly after switching on. No warm-up times are thus needed when changing locations.
For even higher stabilities, models PM 6650A and E are available, having oven-controlled X-tals. Specification details are given in table 1.

Table 1

Stability of internal time base oscillator

Version	Ageing Rate	Temperature	Line voltage (At 10% variation)
PM 6650B	$<1 \times 10^{-7}$/month	$<2\times10^{-8}$/°C av.	$<1\times10^{-9}$
PM 6650A	$<1.5\times10^{-9}$/24h*	$<5\times10^{-10}$/°C av.	$<1\times10^{-10}$
PM 6650E	$<5 \times 10^{-10}$/24h*	$<5\times10^{-10}$/°C av.	$<1\times10^{-10}$

* average, after 72 hours continuous operation.

TIME INTERVAL AVERAGING

Basically the time interval averaging technique improves both the accuracy and resolution of repetitive signals that are asynchronous with respect to the counter's time base.
Using this technique allows rise and fall times, pulse widths and propagation delays to be measured with considerably improved resolution.
Compared to conventional methods, time interval averaging gives an improvement in resolution by a factor of $\sqrt{N}$, viz. the

$$\text{Resolution} = \frac{1 \text{ count}}{\sqrt{N}}$$

where N is the selected number of time intervals averaged.
In the PM 6650 the resolution can be up to:

$$\frac{10 \text{ ns}}{\sqrt{10^8}} = 1\text{ps}$$

which is 10000 times better than with conventional methods.

What makes the difference

The PM 6650 achieves this remarkable performance by combining a 100MHz clock rate with very fast, equalised start/stop channels that have an overall rise time of approx. 1ns.
The equalisation of the channels is extremely important since any difference in propagation delay between the start and stop signal will cause systematic errors which cannot be eliminated by averaging.
Therefore the PM 6650 contains two perfectly equalised amplifiers and trigger circuits. One result is that an extremely high resolution of 1ps can be obtained for relative measurements of time delays from 100ps upwards. Moreover this high resolution (obtained by statistical averaging) is combined with other features such as automatic hysteresis compensation and trigger monitoring outputs for accurate setting of the trigger levels.

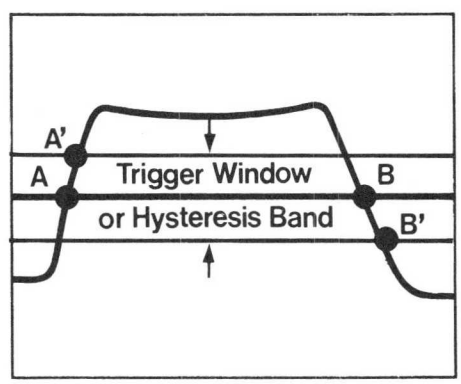


Fig. 3. Automatic hysteresis compensation ensures that triggering takes place at the level selected i.e. AB and not A'B'.

Automatic hysteresis compensation

Fig. 3 illustrates the trigger window or hysteresis band that is present in any counter/timer. Without compensation, triggering would occur at A' and B', when in fact the pulse width AB with a 50% trigger level was the parameter to be measured. Automatic compensation, however, ensures that triggering takes place at the trigger level selected. Also, since the hysteresis band has been virtually eliminated, it is not necessary to make any adjustment when switching from positive to negative slopes (or vice versa).

Trigger level monitoring

Accurate time interval measurements also require accurate settings of the trigger level. Therefore the PM 6650 is provided with analog outputs that allow the trigger level to be measured precisely on a digital voltmeter or to display on an oscilloscope.

10ns resolution for one-shot measurements

The time interval averaging technique does not apply to singleshot phenomenae. In this case the resolution basically depends on the clock generator, which is 100MHz. This is 10 times higher than that of most conventional counter/timers. The PM 6650 therefore accounts for the excellent resolution of 10ns.

See what you count

A quick setting of the trigger levels is facilitated by the LED indicators and the

Fig. 4 shows the compact cabinet PM 9714A.

Fig. 5 illustrates the PM 6650 being used as a systems instrument in combination with sub-unit PM 6634.

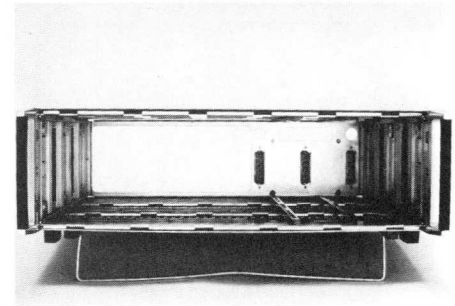


Fig. 6 demonstrates the convenience of the flush-fitting rear interconnection panel that powers and programs the sub-units.

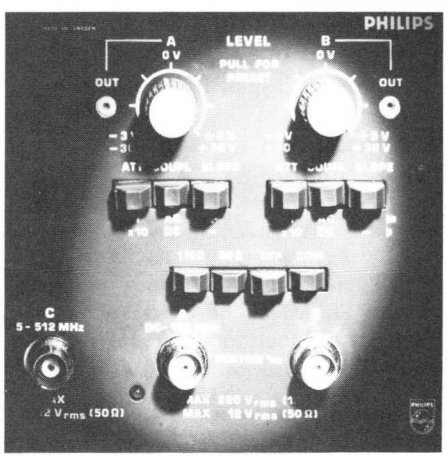
gate monitor signal (available at the rear), which can be used on an oscilloscope to indicate the waveform segment over which the measurement is being made.

Easy systems use

The GP-IB (General Purpose Interface Bus) as formulated in the IEC-TC 66 and IEEE 488-1975 documents is a widely adopted system of digitally interconnecting instruments.
Using the optional interface unit PM 9686, the counter/timer PM 6650 becomes fully compatible with the GP-IB.
Both TALK and LISTEN functions in the PM 6650 allow fully bidirectional bus communication. Data output is to the ISO 7-bit code (ASCII) and the measurement output rate up to 10kHz can be achieved. (See specification details on p 196.)

Analog output

The analog output board PM 9687 provides an extremely useful and unusual facility, particularly for recording frequency stabilities of oscillators, filters and crystals on an X-t chart recorder. Another application, for example, is the registration of power versus frequency of a microwave source on an X-Y recorder. The PM 9687 is basically a digital-to-analog converter. It allows any three consecutive digits out of the total of 9 (or the least two significant digits) to be converted into an analog voltage with a high 0.2% fsd accuracy. Linearity is 0.1% of fsd. Output levels are selectable on the board (1V, 100mV or 10mV).



LED indicators on all channels are illuminated when amplitude and trigger controls are correctly set, thus eliminating possibility of false counting.

Mechanical flexibility

The modular construction gives the PM 6650 the same flexibility as a plug-in counter/timer system. When used as a compact instrument the housing 4/6th 19-in cabinet PM 9714A shown in fig. 4 is used. A full 19-in cabinet PM 9716A provides space for the 4/6th main instrument and the sub-units, which are interconnected to the main unit for power and programming by the rear panel PM 9664 shown in fig. 5. When the preamplifier sub-unit PM 6633 is used, which only occupies a space of 1/6th, the blank panel PM 9721 is normally used.

SUB-UNITS

PM 6633 Preamplifier plug-in

The PM 6633 is a low noise plug-in preamplifier unit which increases the input sensitivity of the PM 6650 counter.

PM 6636 Automatic prescaler plug-in

The PM 6636 is used to extend the direct counting capability to over 1GHz. This is achieved by pre-scaling (dividing) the input frequency. No tuning or level adjustment is required. The automatic attenuation control which controls automatically the output levels acts at the same time as noise suppression circuit. The unit operates over the range 0.1GHz to 1GHz and at the same time adjusts the decimal point so that the reading on the counter is direct, when the function switch on the main counter is in the position SUB-UNIT.

TECHNICAL SPECIFICATION

Frequency
Range: DC...512MHz
Mode: normal frequency or burst frequency
Gate times: 100ns...100s (in decade steps)
Accuracy: ±1 count±1 time base accuracy
Inputs: channel A (DC...160MHz) channel C (5MHz...512MHz)
Display: kHz, MHz and GHz, decimal point automatically positioned.

Period
Range: DC...10MHz
Frequency Counted: 100MHz...1Hz (in decade steps)
Resolution: 10ns...1s
Accuracy: ±1 count±time base accuracy±trigger error*
Input: channel A
Display: µs, ms and s, decimal point automatically positioned

Period average
Range: DC...10MHz
Frequency Counted: 100MHz
Periods Averaged (N): 1...10^8 (in decade steps)
Resolution: 10ns/N
Accuracy: ±1 count+time base accuracy $\pm\frac{\text{trigger error*}}{N}$

Input: channel A
Display: ns and µs, decimal point automatically positioned

Time interval
Range: 40ns...10^9s (approx. 31 years)
Frequency Counted: 100MHz...1Hz (in decade steps)
Resolution: 10ns...1s
Time interval repetition rate: max. 10MHz
Accuracy: ±1 count±time base accuracy±trigger error**
Inputs: channels A and B; can be common or separate
Display: µs, ms and s, decimal point automatically positioned

Time interval Average
Range: 100ps...10s
Frequency Counted: 100MHz
Time Intervals Averaged (N): 1...10^8 (in decade steps)

Statistical resolution: $\frac{10\text{ns}}{\sqrt{N}}$
Time interval repetition rate: max. 10MHz
Min. time from stop to start: 50ns
Accuracy: ±1ns±time base accuracy $\pm\frac{10\text{ns}\pm\text{trigger error**}}{\sqrt{N}}$

Inputs: channels A and B; can be common or separate

Display: ns and µs, decimal point automatically positioned

Multiple Ratio (Ratio $\frac{f_A}{f_B} \times N$)

Frequency range:
Input A (high frequency); DC...160MHz
Input B (lower frequency); DC...10MHz
Multiplier (N): 1...10^7 (in decade steps)
Accuracy: ±1 count of f_A

$$\pm \frac{\text{trigger error* of } f_B}{N}$$

Display: dimensionless, decimal point automatically positioned

Count A (totalizing)
Range: 10^9
Pulse repetition rate: DC...160MHz
Pulse resolution: 2.5ns minimum pulse width
Count accumulation: during the first start/stop event or during repetitive start/stop events
Mode: start/stop by manual gate control or count A gated by channel B
Input: channel A
Display: dimensionless

Scaling $\left(\frac{f_A}{N}\right)$

Range: scaling factor selectable from 1...10^9 (in decade steps)
Frequency range: DC...10MHz
Input: channel A
Output: same as time base output
Display: dimensionless

Check
Functional test of logic circuits.

Display test
Functional test of all the decimal points, the measuring unit annunciation and the numerals' segments.

Sub-unit
In the position 'SUB-UNIT' the PM 6650 is programmed to accept sub-units such as the automatic microwave converter, prescaler etc.

INPUT CHARACTERISTICS

Channels A and B
(not prescaled)
Frequency range
DC coupled: DC...160MHz
AC coupled: 30Hz...160MHz
Pulse resolution: 2.5ns minimum pulse width
Sensitivity
sine wave: $50mV_{RMS}$ or $500mV_{RMS}$
pulse: $150mV_{p-p}$ or $1.5V_{p-p}$
Impedance: 1MΩ//25pF or 50Ω
Trigger window: approx. $80mV_{p-p}$ which is virtually eliminated in the TIME INTERVAL modes
Dynamic input-voltage range: ±3V added to set trigger level voltage × attenuator setting
Coupling: AC or DC
Attenuation: ×1 or ×10
Trigger slope: + or −
Trigger level: preset to center triggering 0V or variable between −3V...+3V × attenuation setting
Trigger level monitor: set trigger voltages available on miniature jacks (at front) and BNC (at rear)
Channel Inputs: channel A and B; can be common or separate
Overload protection: $230V_{RMS}$ (at ≤400Hz) or $300V_{DC}$ in 1MΩ position, $12V_{RMS}$ in the 50Ω position
Connector: BNC

* trigger error is $\leq \pm 3 \times 10^{-3}$ for sine wave signals with signal to noise ratio of ≥40dB

**trigger error is $\leq \frac{\pm 2.5 \times 10^{-3}}{\text{signal slope (V/ns)}}$

Input Channel C (not prescaled)
Frequency range: 5MHz...512MHz
Sensitivity: $10mV_{RMS}$
Impedance: 50Ω nominal
Attenuation: Automatic by PIN-diode circuit, max 62dB
AM modulation tolerance:
99% at modulation frequencies < 5kHz
50% at modulation frequencies 5kHz...10kHz
30% at modulation frequencies > 10kHz
Coupling: AC
Level indication: LED indicates sufficient signal level for correct triggering
Overload protection: $12V_{RMS}$
Connector: BNC

External Reference Input
Frequency range: 100kHz–10MHz
Impedance: 1kΩ//50pF
Sensitivity: $500mV_{RMS}$
Coupling: AC
Overload protection: $12V_{RMS}$
Connector: BNC

OUTPUT CHARACTERISTICS

Trigger level output
Range: −3V...+3V
Impedance: 4kΩ in 0V position
Overload protection: short circuit proof to earth
Connector: miniature jacks (at the front) BNC jacks (at the rear)

Gate Monitor (Gate Open)
Z-modulation output for observation of the measured interval.
Amplitude: approx. +0.4V when the gate is closed approx. +5V when the gate is open
Impedance: approx. 200Ω
Delay: internal delay between the signal inputs and the trigger monitor output is approx. 50ns
Overload protection: short circuit proof to earth
Connector: BNC

Time base out
Frequency: 100MHz...0.01Hz (in decade steps)
Amplitude: $500mV_{p-p}$ into 50Ω
Impedance: approx. 100Ω
Overload protection: short circuit proof to earth

A non-interrupted signal is available if the display time control is in the position 'Hold' and the function control in the position: 'Frequency, Period, Time Interval or Check'.

100MHz out
Amplitude: $1V_{RMS}$ into 1kΩ
Impedance: approx. 200Ω
Overload protection: short circuit proof to earth
Connector: BNC

GENERAL

Display
Read out: 9 digit planar display with leading zero blanking, 10mm high 7 segment numerals. Unit annunciator and decimal point indication.
Storage: switchable on-off on front panel.
Display time: 0.05s...5s or Hold, if triggered externally the minimum display time is 3ms
Unit annunciators: ns, µs, ms, kHz, MHz, GHz and NO-GO by read-only memory programming (ROM)

Gate lamp: LED indicates when the main gate is open and counting takes place
Oven/Osc.: LED indicates when power cord is connected and that oven/osc is on for initial stabilisation
Remote: LED indicates when the instrument is remotely controlled.
Remote control overrides manual control.

Supply
Voltage: 115/230V ±15%; 50...400Hz
Consumption:
40W without sub-units or options
75W incl. PM 6634 and all options
5W in standby (oven on)

Temperature range
Operating range: 0...+45°C
Storage range: −40...+70°C

Dimensions and weight

	Cabinet PM9714A	Cabinet PM9716A
Width:	305mm	445mm
Height:	132mm	132mm
Depth:	404mm	445mm (incl. handles)
Weight:	9.5kg	11.5kg

Ordering information
PM 6650A
512MHz: 1ns counter/timer with PM 9680A high stability oscillator

PM 6650B
512MHz: 1ns counter/timer with temperature compensated oscillator (TCXO)

PM 6650E
512MHz: 1ns counter/timer with ultra high stability oscillator PM 9681

PM 6633
Pre-amplifier

PM 6634
Automatic microwave converter

PM 6636
1GHz pre-scaler

PM 9664
Flush fitting interconnection rear panel

PM 9680A
Oven controlled crystal oscillator (for later upgrading the PM 6650B's reference oscillator specification)

PM 9681
Oven controlled crystal oscillator (for later upgrading the PM 6650A's and B's reference oscillator specification)

PM 9684
Data output board

PM 9685
Remote programming input board

PM 9686
IEC-Bus interface

PM 9687
Analog output board

PM 9714A
4/6th bench cabinet

PM 9716A
6/6th 19" bench/rackmount cabinet

PM 9721
1/6th blank panel

PM 9722
2/6th blank panel

AUTOMATIC SYSTEMS USE FOR PM 6650

Full programmability
The PM 6650 has been designed for easy systems use. All functions are fully bus-programmable. Not only the selection of measuring modes and time base setting are programmable, but ALL other front panel control settings (excluding the power on/off switch) are bus programmable. Even the setting of the trigger levels is directly programmable via the bus without using external digital-to-analog converters that would require separate addressing and control.

Programming functions
Sub-unit (1GHz or preamplifier)
Count A
Ratio A/B
Period A
Period average A
Time-interval A to B
Time-interval avarage A to B
Frequency A (160MHz max.)
Frequency C (512MHz max.)
Check, Display test
Time-base/multiplier selection in 11 steps
Trigger level (in 50mV steps)
AC/DC coupling
×1/×10 attenuation
+/− slope
Separate/common
50Ω/1MΩ input impedance
Memory on/off
Start/stop (for count A)
Gated by B (for count A)
Burst on/off
Display hold, minimum display time
Start new measurement and clear.

Bus commands
Source handshake function: SH 1
Acceptor handshake function: AH 1
Talker function: T 7
Listener function: L 4
Remote/Local function: RL 2
Reset functions: DC 1 or as program data
Trigger functions: DT 1 or as program data

Data output
Code ISO-7-bit code (ASCII)
Measurement output rate: depending on measuring time; down to minimum own cycle time of approx. 100μs, allowing up to 10KHz measurement rate.
Connector: IEC recommended type equivalent to MIL-C-24308.
Philips: F 161, Amphenol: series 17, Clinch and Cannon: type D.
A transition cable for interlinking IEC respectively IEEE recommended connectors is available under type number PM 9483.
Stackable IEC Bus cables can be ordered in lengths of 1, 2 and 4 m under type number PM 9480, PM 9481 and PM 9482.

Performance table of product range

IEC-625

Type no.	Frequency	Coupling	Input attenuation	Trigger level off-set	Period, period av. multiple ratio totalizing of counts	Time interval	Time interval average	Rack-mount, BCD - output analog output	IEC/ IEEE Bus	Battery and carrying case
PM 6611	10Hz...80MHz	AC	cont.	⎍∿⎍	yes	—	—	yes	yes	yes
PM 6612	10Hz...80MHz	AC	cont.	⎍∿⎍	yes	yes	—	yes	yes	yes
PM 6613	10Hz...80MHz	AC	cont.	⎍∿⎍	yes	—	—	yes	yes	yes
	+									
	50MHz...250MHz	AC	cont.	—						
PM 6614	10Hz...80MHz	AC	cont.	⎍∿⎍	yes	—	—	yes	yes	yes
	+									
	50MHz...520MHz	AC	cont.	—						
PM 6615	10Hz...80MHz	AC	cont.	⎍∿⎍	yes	—	—	yes	yes	yes
	+									
	50MHz...1GHz	AC	cont.	—						
PM 6616	10Hz...80MHz	AC	cont.		yes	—	—	yes	yes	yes
	+									
	80 MHz...1.3GHz									
PM 6622	0...80MHz	DC/AC	×10	−2.5V... +2.5V	yes	yes	yes	yes	yes	yes
PM 6624	0...80MHz	DC/AC	×10	−2.5V... +2.5V	yes	yes	yes	yes	yes	yes
	+									
	50...520MHz	AC	cont.	—						
PM 6625	0...80MHz	DC/AC	×10	−2.5V... +2.5V	yes	yes	yes	yes	yes	yes
	+									
	50MHz...1GHz	AC	cont.	—						
PM 6650*	0...160MHz	DC/AC	×10	−3V... +3V	yes	yes	yes	yes	yes	—
	+									
	5...520MHz	AC	cont.	−						
PM 6661	10Hz...80MHz	AC	cont.	—	—	—	—	—	—	—
PM 6667	10Hz...120MHz	AC	×1...×300 auto		—	—	—	r.m.	—	yes
PM 6668	10Hz...1GHz	AC	×1...×300 auto		—	—	—	r.m.	—	yes

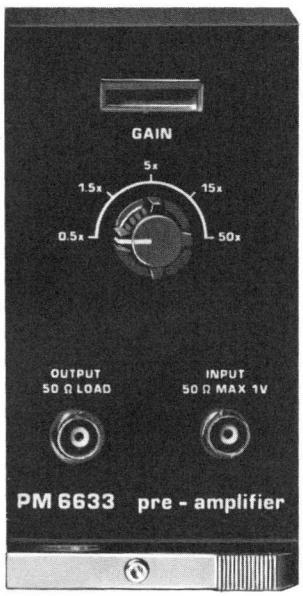
Summary:
PM 6611...16 feature powerful universal frequency measuring capabilities.
PM 6622...25 and PM 6650 have high performance time interval (+average) capabilities.
PM 6661 is an automatic frequency only counter.

* Remote control facilities.

PM 6633 Automatic pre-amplifier
This sub-unit is designed to be used in conjunction with the basic counters PM 6640, PM 6645 and PM 6650

PM 6636 Pre-scaler
This sub-unit is designed to be used in conjunction with the basic counters PM 6640, PM 6645 and PM 6650

sub-units PM 6633 and PM 6636



The PM 6633 is a low noise pre-amplifier that increases the input sensitivity of the main counter by a factor of 50. As illustrated, the sub-unit only occupies a space of 1/6th of the 19" rack and is therefore normally used in combination with the blank panel PM 9721N.

TECHNICAL SPECIFICATION

Frequency
10kHz...200MHz

Gain
×0.5...×50 (in 5 steps)

Input impedance
50Ω

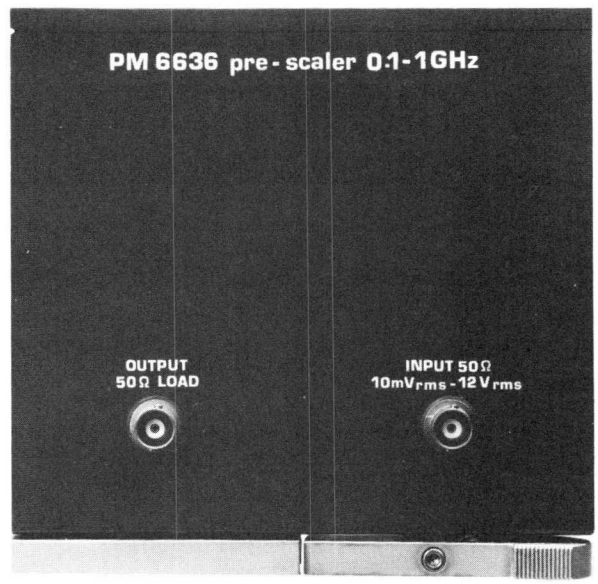
Overload
$1V_{RMS}$

Load impedance
50Ω nominal (open and short circuit proof)

Connectors
BNC (in and out)

Power
From the main counter via the flushfitting interconnection panel PM 9664.

Dimensions
1/6th of 19-in rack.



The PM 6636 extends the direct counting capability of the main counter to over 1GHz. This is achieved by pre-scaling (dividing) the input frequency.
No tuning or level adjustment is required, because the input signal is automatically adjusted by a PIN diode attenuation circuit, as described for the PM 6610 series (page 152). At the same time this circuit performs the automatic noise attenuation function previously described on page 165.
The sub-unit operates over the range 0.1 to 1GHz and at the same time adjusts the decimal point so that the reading on the counter is direct when the function switch is in the position 'sub-unit'.

TECHNICAL SPECIFICATION

Frequency
0.1...1GHz (prescaled by 10)

Sensitivity
$10mV^{*}_{RMS}$...$12V_{RMS}$

Input impedance
50Ω

Attenuation
Continuous by automatic PIN-diode circuit; max 62dB

Coupling
AC

VSWR:
< 2

AM tolerance
98% at ⩽5kHz mod. freq. 30% at ⩾1MHz mod. freq.

Overload protection
$12V_{RMS}$

Decimal point
Automatically shifted

Output impedance
50Ω

Connectors
BNC (in and out)

Power
From the main counter via the flush-fitting interconnection panel PM 9664

Dimensions
2/6 th of 19-in rack

* *above 960MHz the sensitivity might drop to −24dBm ($14V_{RMS}$ at 1GHz).*

Accessories for counters and counter/timers

PM 9601
Battery pack. This battery pack fits in the counters PM 6667 and PM 6668, thus providing portable and line-independent operation. The battery charging circuit is included.

PM 9602
Carrying case. This hard-shell high inpact ABS-carrying case fits the PM 6667 and PM 6668 and gives protection during transportation.

PM 9603
19" rack/panel mount adapter for the PM 6667 or PM 6668 to fit into a 19" rack system or for panel mounting.

PM 9664
Interconnection rear panel. This flush-fitting rear panel provides the interconnections that power and program the sub-units PM 6633 and PM 6636, if they are used together with the counter PM 6650.

PM 9665B
Low-pass filter. This 50kHz filter suppresses all high frequency signal components due to noise and interference if LF measurements are made. PH 9666 set of trigger level output cables for PM 6620-series or PM 6650.

PM 9668
IF off-set unit. This circuit board allows the 8 most significant digits to be off-set with a positive or negative value. This display off-set unit offers programming facilities for selection of two independent and different values. Both different in polarity magnitude.
It allows easy programming by soldering in diodes and can be mounted into all models of the PM 6610-series. The PM 9668 can be used in combination with any other option.

PM 9669/01/02
Rack mount adapter for one (/01) or two (/02) units of the PM 6610- or PM 6620-series of counters for mounting in a 19-in rack system.

PM 9669/09
Rack mounting kit for mounting PM 9661/64 in, e.g., a 19-in rack panel.

PM 9672
Carrying case. This ever-ready case fits all models in the PM 6610 and PM 6620 series to give protection during transportation.

PM 9673
Battery unit. The battery unit PM 9673 fits into all models of the PM 6610 and PM 6620 series of counters, thus providing portable and line-independent operation. The battery charging circuit is included in this battery unit.

PM 9674
BCD-output unit. This circuit board can be mounted into all models of the PM 6610 and PM 6620 series to provide a BCD data output.

PM 9675
Digital-to-Analog converter. This converter provides a high resolution analog output for recording frequency stabilities of oscillators, filters and X-tals on an X-t chart recorder. It allows the conversion of any three consecutive digits out of the total of 9 (or the least two significant digits). As such it functions as a magnifying glass to focus on just that part of the read-out, which is most important.
The PM 9675 fits into all models of the PM 6610 and PM 6620 series (N.B. it cannot be used simultaneously with the BCD output).

PM 9676
General-purpose interface bus. The PM 9676 is a standard byte-serial/bit-parallel bus line interface, compatible to the IEC and IEEE standards. It can be mounted into all models of the PM 6610-series and PM 6620-series.

PM 9677
X-tal time base oscillator. This is supplied as standard in the /01 models of the PM 6610 and PM 6620 series of counters.

PM 9678
X-tal time base oscillator. This temperature compensated X-tal oscillator is included as standard in the /02 models of the PM 6610 and PM 6620 series of counters, but can also be ordered separately to upgrade the /01 versions.

PM 9679
X-tal time base oscillator. This oven controlled X-tal oscillator is included as standard in the /03 models of the PM 6610 and 6620 series of counters, but can also be ordered separately to upgrade the /01 and /02 versions.

PM 9680P
Oven controlled X-tal oscillator. This high stability oscillator is mounted in the counter PM 6650A but can also be ordered separately to upgrade the B versions.

PM 9681P
Oven controlled X-tal oscillator. This ultra high stability oscillator is mounted in the counter PM 6650E but can also be ordered separately to upgrade the A and B versions.

PM 9682
BCD-output unit. This circuit board can be fitted into the PM 6645 to provide a BCD data output.

PM 9683
Remote control unit. This circuit is to provide the PM 6645 with programmable operation features.

PM 9684
BCD-output unit. This output circuit board provides the counter/timer PM 6650 not only measuring data in BCD format, but also data about the measuring unit and the decimal point.

PM 9685
Remote control unit. This control unit converts the PM 6650 into a completely programmable counter/time. All functions including the input controls are remotely programmable.

PM 9686
IEC-bus interface. The PM 9686 is a standard byte-serial/bit parallel input/output interface, according to the IEC and IEEE standards.

PM 9687
Digital-to-Analog converter. Functions in the same manner as the PM 9675 DAC, but is designed for use in the PM 6650.

PM 9688
Digital-to-Analog converter. Functions in the same manner as the PM 9675 DAC, but is designed for use in the PM 6645.

PM 9690
X-tal time base oscillator. This high stability oven controlled X-tal oscillator is included as standard in the /04 models of the PM 6610 and PM 6620 series of counters, but can also be ordered separately to upgrade the /01, /02 and /03 versions.

PM 9691
X-tal time base oscillator. This high stability oven controlled X-tal oscillator is included as standard in the /05 models of the PM 6610 and PM 6620 series of counters, but can also be ordered separately to upgrade the /01, /02, /03 and /04 versions.

PM 9714A
4/6th bench cabinet for use with PM 6650.

PM 9716A
6/6th 19" bench/rackmount cabinet for use with PM 6650.

PM 9721
1/6th blank panel to fill empty space in a PM 9716A when PM 6650 is used together with e.g. PM 6633.

PM 9722
2/6th blank panel to fill empty space in a PM 9716A when PM 6650 is used alone.

Pulse generators

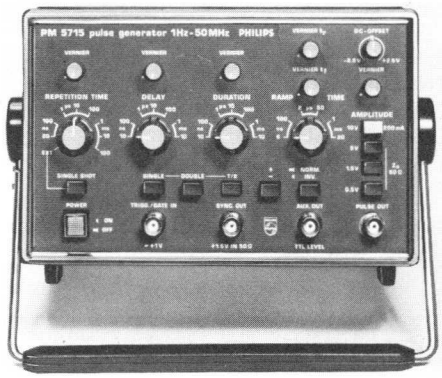
Unit	Description	Frequency range	Amplitude range	Rise/fall time	Page
Introduction					200
PM 5771	High frequency general purpose	1Hz...100MHz	80mV...10V + or −	2.4ns...100µs (variable)	201
PM 5716	High frequency MOS general purpose	1Hz...50MHz	2V...20V + or −	6ns...100ms (variable)	203
PM 5715	High frequency TTL general purpose	1Hz...50MHz	200mV...10V + or −	6ns...500ms (variable)	206
PM 5712	High frequency TTL general purpose	1Hz...50MHz	200mV...10V +	4ns	208
PM 5705	General purpose	0.1Hz...10MHz	1V...15V +	10ns	210
PM 5705E	PM 5705 plus educational package	0.1Hz...10MHz	1V...15V +	10ns	212

Introduction

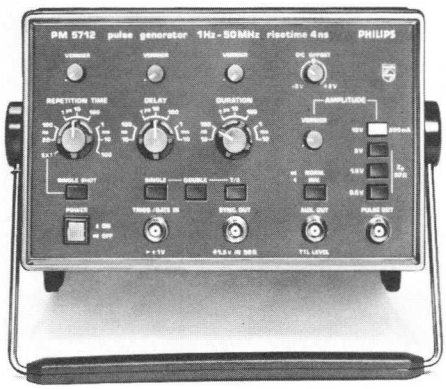
The Philips programme of pulse generators is one of the most comprehensive and advanced in Europe. All instruments feature advanced specifications, logical front panel layouts and attractive price-performance ratios. But perhaps more important is the fact that the wide choice enables close matching of specification to application requirement to be achieved. Instruments are available at frequency ranges of 10, 50 and 100MHz with a choice of fixed and variable transition times. At 100MHz there is for example a generator with variable rise and fall time from 2.4ns up to 100μs. With this facility, the generator can be used for testing of almost every logic family.

PM 5716 Universal MOS generator 1Hz-50MHz frequency range and 6ns to 100ms rise/fall time range.

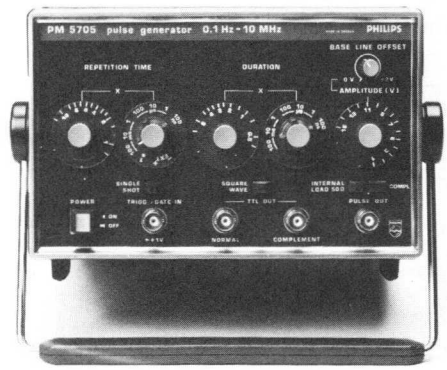
Specially for MOS logic, PM 5716 has been equipped with a very high + or −20V pulse amplitude paired with a built-in amplitude limiter giving increased ease of operation. In the 50MHz range there is also a choice between fixed and variable transition time generators, both offering auxiliary TTL level output and facility for fixed duty cycle over the whole frequency range.



PM 5712 and PM 5715 two Universal pulse generators for TTL logic. Frequency range 1Hz...50MHz, rise/fall time range: PM 5715 6ns...500ms, PM 5712 4ns.



Pulse generators with fixed transition times are of a less complicated electrical design meaning a considerable price reduction.
At 10MHz generators are used for more basic design work and are also required for educational purpose. The Philips programme contains one instrument in this frequency range concentrating on providing a basic specification at an attractive price combined with a simple front panel layout.



PM 5705 Universal pulse generator, frequency range 0.1Hz...10MHz features TTL line driver outputs and a 1...15V output with base line offset.

All in all six generators are available. At one end of the frequency spectrum they contain advanced circuits giving fast rise-times. At the other they contain cost-saving ideas like an educational package. In this way we ensure that the instrument more than matches your application requirement.

1Hz to 100MHz frequency range

Very fast variable transition times: 2.4ns to 100μs

Wide amplitude range: 80mV to 10V

Variable DC offset: $\pm$5V

$\pm$polarity, normal or inverted output

100MHz: 2.4ns pulse generator PM 5771

The PM 5771 is a versatile generator, providing fast, variable rise time pulses over the range 2.4ns to 100μs. It is therefore ideal for detailed measurements on TTL, Schottky TTL and ECL 10k circuits. The output amplitude is divided into subranges, to match the different parameters that these components require. The 1V range is for ECL logic and the 2V and 5V ranges are for TTL, while the 10V range is very useful for DTL, MOS and other circuits that work with high voltage levels. In the 5V and lower ranges the output termination is 50 Ω. The 10V range has a 200mA current generator output. On all ranges the instrument is well protected against external voltages and transients and can be short- and open-circuited without any effect.
A wide DC offset of $\pm$5V is also provided for making measurements on biased circuits, with a special snap-in lock of the zero position.

TTL pulse

A clock or syncpulse is also available. This pulse is a symmetrical square wave with fast transitions about 1.5 to 3ns. The amplitude is 5V open circuit with an internal resistance of 120Ω. This is the best output for fixed duty factor TTL-level pulses.

Delay and double pulse

The delay function in PM 5771 delays the output pulse from the syncpulse. It has a fixed 30ns delay plus the variable delay time of 5ns to 100ms.

The double pulse function is operated by a push button and gives twin pulses, the first appearing 30ns after the sync pulse, the second coming 5ns to 100ms later depending on the delay time setting. It is also possible to adjust the controls and produce a double frequency signal on the 'pulse out' connector, as shown in fig. 3.

Pulse shaping

When the generator is externally triggered by a pulse greater than 1.2V, then the pulses on the 'sync out' connector are as shown in fig. 2. Note this is not a square wave, but has the same pulse width as the trigger signal.

External, synchronous gating

The generator can be switched to external gating and then gated by a pulse greater than 1.2V. Pulses are then available on the pulse out connector, as shown in fig. 3. The first pulse is synchronous with or delayed from the positive leading edge of the gating pulse, while the last pulse will be complete i.e. it is not cut by the trailing edge of the gating pulse. The delay and duration of these pulses are determined by the setting of the 'delay' and 'duration' controls.

Fast rise time applications

PM 5771 is designed to meet the need for fast pulses with a clean, accurate and reproducible output. This means very low overshoot/rounding, good linearity of the rise and fall time, no preshot, low or no tilt also on very long durations.

Unsaturated logics as ECL are specified with rise times from 20 to 80% amplitude

due to the rounding effect. As illustrated in fig. 4, the PM 5771 has very small roundings and the rise time is specified as 2.4ns, from 10 to 90%. Measuring 20 to 80% on PM 5771 gives a rise time that is typically 1.7ns. All these rise times are measured at 5V amplitude.

For Schottky TTL logics where the full 10 to 90% rise time is important, it is possible to improve the rise time 20% by reducing the amplitude to 4V, as illustrated in fig. 5.

TECHNICAL SPECIFICATION

PULSE CHARACTERISTICS

Repetition rate
1Hz to 100MHz variable in 9 ranges
Jitter: Less than 0.1% or 50ps whichever is greater

Delay
5ns to 100ms variable in 8 ranges
Jitter: Less than 0.1% or 50ps whichever is greater.

Duration
5ns to 100ms variable in 8 ranges
Jitter: Less than 0.1% or 50ps whichever is greater.
Duty factor: greater than 50%

Transition times
(at 5V and lower positions)
2.4ns to 100μs variable in 4 ranges. The min. falltime of a positive pulse may be 2.6ns. 2.0ns typical rise time can be achieved on not inverted pulses by reducing amplitude with the vernier

Waveform aberration: ⩽ ±5% of set amplitude with rise and fall times > 2.4ns in 5V and lower positions; ⩽5% of set amplitude with rise and fall times > 4ns in 10V position

Amplitude
80mV to 10V into 50Ω variable in 6 ranges. The amplitude may decrease from 10V at 50MHz to 7V at 100MHz.
Source impedance: 50Ω in the 5V and lower ranges. Current source in the 10V range.

DC-offset
0 to ±2.5V in 5V and lower positions
0 to ±5V in 10V range
Pulse amplitude plus DC-offset max ±10V

Protection
The output stage is protected with diodes against transients.

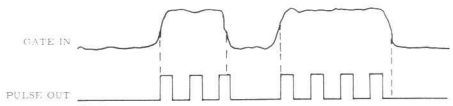


Fig. 1

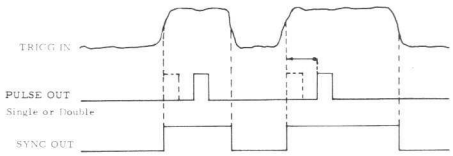


Fig. 2

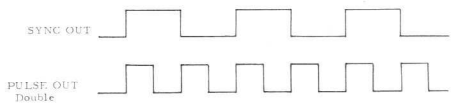


Fig. 3

SYNC PULSE CHARACTERISTICS

Amplitude
+1.5V into 50Ω (+4V open circuit)
Source impedance: 120Ω

Transition time
1.5ns...3ns fixed

Duration
Duty factor 50% (±20% at fastest rep. time positions)

Delay
Pulse occurs approx. 30ns ahead of the main pulse

MODES OF OPERATION

Internal triggering
1Hz to 100MHz variable in 9 ranges

External triggering
DC to 50MHz
Sensitivity: 1.2V
Delay: From 'TRIGG. IN' to 'SYNC. OUT' approx. 12ns
Input impedance: approx. 1kΩ
Polarity: positive pulses
Safe overload: max. ±20V

Single shot
Single shot facility by means of pushbutton

Gated
Synchronous gating. Positive pulse over +1.2V turns the generator on

Single/double pulse
'Twin' pulses at set delay with simultaneously controlled pulse duration

Normal/inverted pulse
Inverted pulse by means of push button

GENERAL

Operation temperature range
0–40°C

Power
Line voltages: 100–130V, 200–260V, (85–115V and 170–230V solderable), 50–400Hz.
Consumption: 90VA

Dimensions and weight
(w × h × d) 215 × 195 × 265mm
(8.4 × 7.7 × 10.4-in)
7kg (15.4lb)

ACCESSORIES SUPPLIED

1 mains cable
1 operating and service manual

OPTIONAL ACCESSORIES

PM 9581 50Ω-termination (3W)
PM 9585 50Ω-termination (1W)
PM 9583 Coaxial cable set
(5 × 1ns, 4 × 2ns, 3 × 3ns, 3 × 10ns)
PM 9584 50Ω T-piece

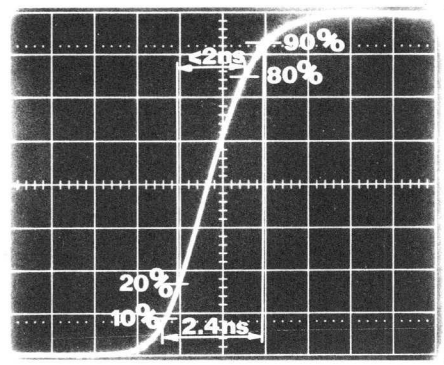


Fig. 4

Fig. 5. 4V, 2ns leading edge

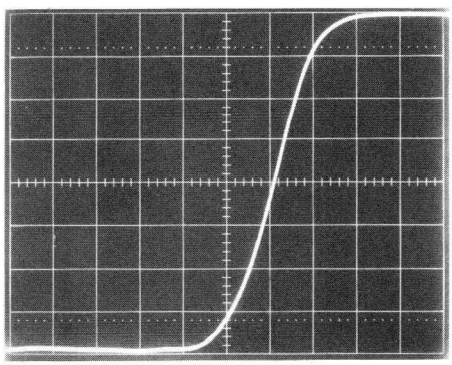


Fig. 6. Double pulses

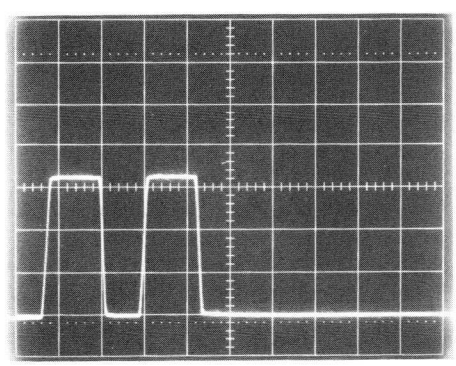
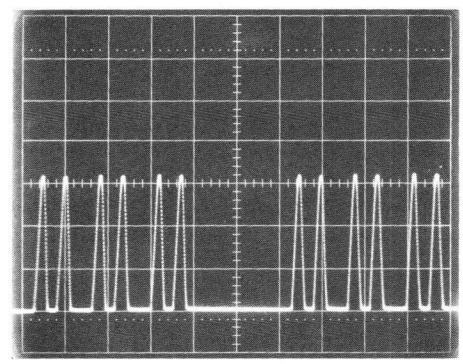


Fig. 7. Gated pulses



1Hz. . .50MHz repetition rate

6ns. . .100ms rise and fall times

2V. . .20V amplitude, within the range of −20V. . .+20V

Independent control for upper and lower pulse levels

Pulse amplitude limiter to protect device under test

Built-in 50Ω backmatch, no need for external termination

Versatile facilities for external triggering, gating and pulse amplifying

50MHz; ±20V Pulse generator PM 5716

This truly universal pulse generator has been purpose-designed to meet all MOS logic testing requirements as well as TTL and other HNIL circuits.
It meets the exacting performance criteria demanded by this wide range of devices without any sacrifices of, for instance, fast transition times or special outputs for TTL.
Moreover, the wide range of repetition rates, delay, duration and transition times makes PM 5716 an ideal pulse source also for analog applications.
This instrument therefore introduces a new dimension to the existing range of Philips pulse generators and new standards in pulse generator design and performance.

Pulse amplitudes to 20V

The main pulse amplitude from the PM 5716 is continuously adjustable between 2V and 20V.
The pulse level setting is done with two independent sliding potentiometers with ranges from −20V to +20V. The two sliders are mechanically interlocked in such a way that they cannot pass each other and the maximum separation corresponds to a 20V pulse amplitude. (Fig. 1)
The generator has a source impedance of 50Ω and the maximum output amplitude is 20V into ⩾5kΩ. Into 50Ω this value is 10V. The front panel scale is graduated for both cases. The very good output stage of the PM 5716 maintains the 20V pulse amplitude over the whole frequency range.
The PM 5716 is designed for ease of operation. The square wave pulse mode gives freedom from selecting delay and duration; the operator need only set the repetition time, amplitude and shortest transition time and the pulse is there.
As can be seen from the illustration it is easy to read pulse amplitude directly from the scales.
By systematically avoiding the use of double function controls the PM 5716 has become an instrument which is very convenient to operate.

Amplitude limiter

The PM 5716 has as standard an amplitude limiter to protect the device under test. (Fig. 2)
When the MOS supply voltage is connected to the limiter inputs your circuits are automatically safeguarded against excessive pulse levels.
The pulse levels can not exceed the upper/lower levels of the limiting voltages. This makes it possible also to remotely control the output levels within the range set by the sliders.

Backmatched 50Ω output

The built-in 50Ω termination in the PM 5716 is compensated for the reactive impedance components of the output stage.
Fig. 3 shows a 20V pulse with 6ns rise time fed into a 1 meter open ended cable, illustrates how the internal termination absorbs the reflection. The residual reflection from the PM 5716 is guaranteed to be less than ±3% with this set-up.
This backmatch makes it possible to work with unterminated cables and high ohmic loads without spending time on checking the waveform.
The benefits gained from this specially designed output are summarized, as follows:
- reflections from all kind of mismatches are absorbed in the generator
- gives a better waveform, less dependent on external load
- the fixed load means protection of the output stage
- ideal for high ohmic loads such as MOS circuits
- no need for external termination – easier to use

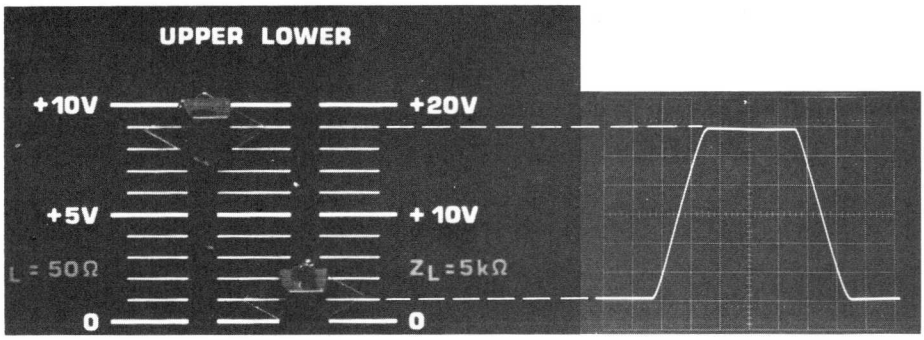


Fig. 1. Independent slide potentiometers for setting maximum and minimum pulse levels.

Transition times

In the PM 5716 the transition time is not dependent on the amplitude.
This gives freedom to vary the amplitude during a test sequence without having to check and readjust the rise and fall time.
The repetition and transition time ranges in the PM 5716 far exceed the requirements for the MOS logic of today. This makes the generator a suitable pulse source for new developments in MOS in the years to come. Fig. 4a shows how the rise time is varied from 6ns to 60ns. The very good characteristics of the rise time circuit are obvious. Linearity is excellent and the pulse has hardly any overshoot.
Both parameters contribute to the high measuring accuracy of the PM 5716.
As the transition time range starts at 6ns it enables not only MOS to be tested but also most other logic families such as TTL, RTL and DTL.
The very long transition time of 100ms enables threshold testing and drive of operational amplifiers.
Changing from normal to complementary pulse means, in the PM 5716, that besides the duty factor change rise and fall times are reversed. Figure 4b indicates the effect of the change. This is a convenient facility because of the conformity with IC terminology.
Thus:

- transition times are variable over a very wide range
- shortest transition time 6ns relates to TTL logic
- the linear ramp increases measurement accuracy
- transition times are independent of set amplitude

High ohmic trigger input

In logic testing it is often desirable to trigger a pulse generator from the circuit under test. The trigger take-off must then be of sufficiently high ohmic value to avoid overloading the circuit under test. The PM 5716 has for that reason got a trigger input impedance of 1MΩ//20pF which is suitable for MOS logic.

The trigger level in the PM 5716 is variable from −2V to +2V enabling triggering from all kinds of logic and most analog sources.
The high input impedance is compatible with most attenuator probes enabling a further decrease of the circuit loading to 10MΩ//11pF with the PM 9350 as shown in Fig. 5.

Clock and auxiliary outputs

The auxiliary output of the PM 5716 gives a +2.5V pulse into a 50Ω load. As the source is backmatched by 50Ω a +5V amplitude across high ohmic loads is available.

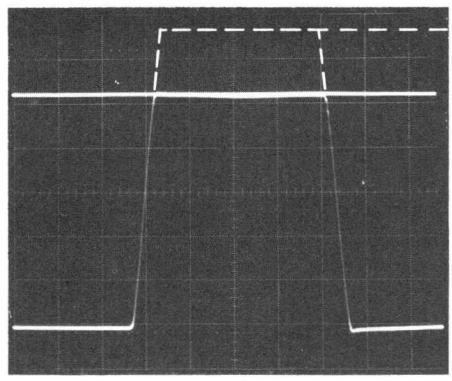


Fig. 2. Pulse limiter protects MOS circuit under test against excessive input pulse amplitudes.

The pulse always has set delay and duration and a 6ns transition time. Fig. 6 shows how it can be used together with a complementary pulse from the main output for differential drive of circuits under test.
The clock output always gives symmetrical pulses which are suitable for use as a time reference, because of the fixed duty factor. The resetting of delay and duration is therefore avoided when sweeping over a wide frequency range.

Output protection

The reliability of a signal source is most important. But pulse generator outputs exposed to all kind of reflections, external DC-levels and transients, have always been difficult to safeguard.

The PM 5716 includes an output protection system of diodes shorting any external transients applied to the internal supply voltage. In the case of external DC-levels, the whole internal voltage supply (which is floating) is shifted to avoid overload of the output transistors. The two 5V outputs are also protected with diodes against external transients.

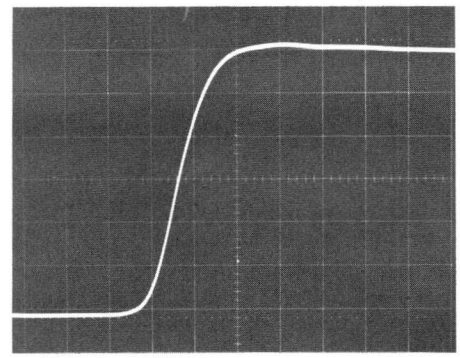


Fig. 3.

TECHNICAL SPECIFICATION

REPETITION RATE

Internal: 1Hz-50MHz variable in 8 ranges with continuous control within the ranges.
Jitter: ⩽ 0.1% or 50ps whichever is greater
External: DC–50MHz

PULSE DELAY

10ns–100ms. Variable in 7 ranges with continuous control within the ranges.
Jitter: ⩽ 0.1% or 50ps whichever is greater.

PULSE DURATION

10ns–100ms. Variable in 7 ranges with continuous control within the ranges.
Jitter: ⩽0.1% or 50ps whichever is greater.
Duty factor: more than 50%. Duty factor over 99% possible with complementary mode.

MAIN OUTPUT PULSE CHARACTERISTICS

Amplitude: 2V...20V between −20V and +20V with 5kΩ load
1V...10V between −10V and +10V with 50Ω load
Rise and fall times: ⩽ 6ns...100ms, (at amplitudes below 4V (2V) from 8ns).
Independent continuous controls within 8 selectable ranges. The transition time remains constant when the pulse amplitude is varied.
Source impedance: 50Ω compensated, ideal for driving MOS circuits without terminating load. A total reflexion of a 6ns rise time pulse gives less than ±3% distortion.
Waveform aberrations: ⩽ 5% for all transition times
Amplitude limiter: The upper (lower) pulse level may be limited by an external DC-source to any value between +20V and −18V (+18V and −20V).
With high ohmic load the max. output level is equal to the limiter levels. With 50 ohm load 50% of the levels.
The input resistance of the limiter measured between upper or lower terminals and earth is ⩾1kΩ.

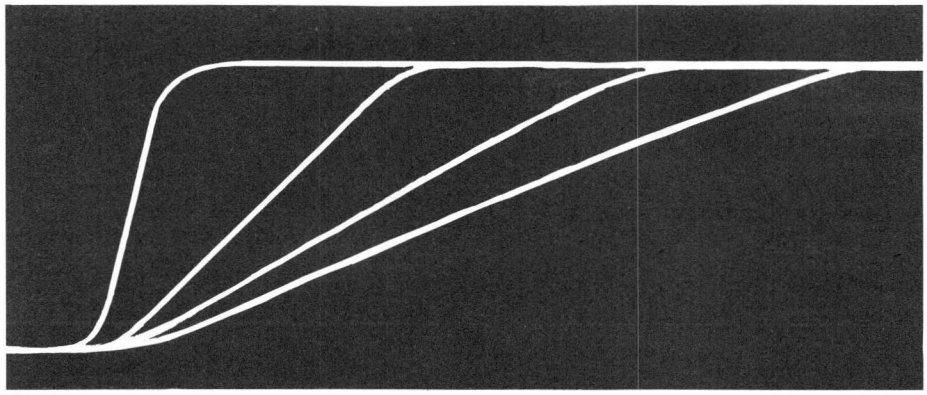
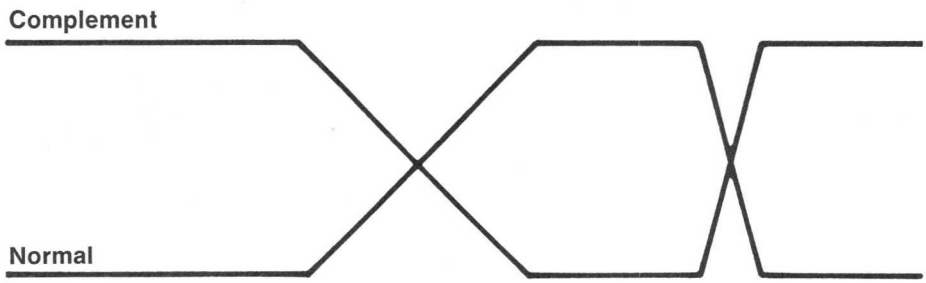


Fig. 4a.

Fig. 4b.



Protection: Short and open circuit safe
Protected against external DC-voltages between + and −20V. Special transient protection circuits have been built in.
Timing: The pulse is delayed 50ns plus set delay from an external trigger pulse.

CLOCK PULSE CHARACTERISTICS

Amplitude: +2.5V into 50Ω and +5V into 5kΩ
Source impedance: 50Ω
Rise and fall times: approx 6ns
Duty factor: 50% ±5% (in fastest range 25–45% duty factor)
Protection: Short and open circuit safe, diode protection against transients
Timing: Pulse occurs approx 35ns plus set delay ahead of main pulse and 15ns after external trigger pulse

AUXILIARY PULSE CHARACTERISTICS

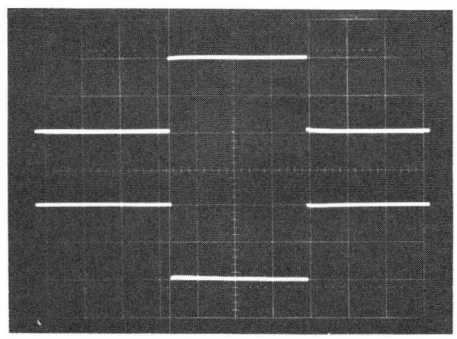
Amplitude: +2.5V into 50Ω and +5V into 5kΩ
Source impedance: 50Ω
Rise and fall times: approx 6ns
Duty factor: As set by 'DURATION'
Pulse mode: Single or double pulses
Protection: Short and open circuit safe, diode protection against transients
Timing: Pulse occurs approx 15ns plus set delay ahead of main pulse and 35ns after external trigger pulse

EXTERNAL TRIGGERING/GATING

Electrical: Frequency range: DC-50MHz
Sensitivity: 200mV
Trig level: variable −2V to +2V, with 10:1 probe −20 to +20V
Trig slope: selectable leading or trailing edge
Max. external voltage: ±20V
Input impedance: 1MΩ//20pF suitable for probes
PM 9327 DC to 15MHz
PM 8927 DC to 50MHz
Manual: Single shot by means of push button

Fig. 5.

Fig. 6. Additional outputs give complementary TTL compatible pulses.



MODES OF OPERATION

1	INT CLOCK	Internal clock gives repetition rates from 1Hz to 50MHz.
2	MAN TRIGG	Manual trigger gives one single/double pulse with set duration or one pulse with same duration as the manual trigger pulse.
3	EXT GATE	Gated pulses. First pulse coincides with leading/trailing edge of gate pulse.
4	EXT TRIGG	Triggering on leading/trailing edge of external pulse.
5	EXT DUR	Pulses with same duration and repetition rate as external pulses.

PULSE MODES

1		Gives a square wave on main output (50% ±5%; approx 25% duty factor in fastest range). And gives single pulses with set duration on aux. output.
2		Gives single pulses with set duration on both main and aux output
3		Gives double pulses with set duration on both main and aux output
4	NORM	'Normal' gives pulses as previously described
5	COMPL	'Complementary' gives the complement to the set pulse on main output only.

POWER

Line voltages: 200–265V, 85–115V, 100–130V } switchable
Mains frequency: 50Hz or 60Hz solderable
Power consumption: 90VA

Dimensions and weight
(w × h × d) 280 × 133 × 360mm
(11 × 5.2 × 14.2-in)
9kg

ACCESSORIES SUPPLIED

1 line cable
1 manual

OPTIONAL ACCESSORIES

PM 9581 50Ω feed through termination 3W
PM 9584 50Ω T-piece (power splitter)
PM 9585 50Ω feed through termination 1W
PM 9588 Coaxial cable set (5 × 1ns, 4 × 2ns, 3 × 3ns, 3 × 10ns)
PM 9327 10:1 attenuator probe DC −15MHz
PM 8927 10:1 attenuator probe DC −50MHz

50MHz: ⩽6ns Pulse generator PM 5715

1Hz to 50MHz frequency range

⩽6ns to 500ms transition times with independent fine adjustment of rise and fall times

Wide amplitude range 200mV. . .10V

10ns to 100ms pulse delay/duration

Variable DC offset ±2.5V

TTL compatible auxiliary output

Facilities for:
- **External triggering**
- **Synchronous gating**
- **Single shot operation**
- **Pulse shaping**
- **Double pulse operation**
- **Square wave operation**
- **Sync output**
- **±polarity, normal or inverted output**

Compact, lightweight construction

The PM 5715 is a universal generator that is ideal for a wide range of applications. The versatile control of transition times from less than or equal to 6ns to 500ms, for example, allows digital circuits and components to be examined for responses to either fast and/or slow rise and fall times. The generator can operate direct into circuits using high level logic components and the noise thresholds can be tested with an adjustable DC offset of ±2.5V. A second output is also available, providing the same signals as the main output but at fixed TTL levels.

Operation

Three pulse modes are available – single pulse, double pulse and T/2 mode. One of three mechanically interlocked push-button switches must be depressed to select the required mode. Normal or inverted pulses are obtained by appropriate positioning of the 'normal/inverted' switch. Similarly, the required polarity is selected using the 'positive/negative' pushbutton switch. When using inverted pulses, a duty cycle of almost 100% can be achieved. However, a duty cycle of better than 50% can be obtained when normal pulses are generated. Pulse amplitude is variable from 200mV to 10V in four ranges (500mV, 1.5V, 5V and 10V) each having continuous vernier control throughout. A vernier control provides continuous offset of the DC baseline from −2.5V to +2.5V.

A square wave 'synchronous output' is available, which remains unaffected by the settings of the delay and duration switches. This output is 3V open output and its frequency is determined by the setting of the 'repetition time' switch.

An 'auxiliary' output provides the same pulses as the normal output, but at levels suitable for direct feed into TTL circuitry. The pulses at this output are of positive polarity and have a fixed transition time. Operation of the 'normal/inverted' switch, setting of amplitude or DC off-set do not affect the auxiliary output. Coarse adjustment of the pulse rise and fall times (6ns to 500ms) is effected by means of a six-position switch. The rise and fall times have separate vernier controls for fine adjustment in each range.

The 'output' pulses can be synchronously gated by an external signal. The first pulse coincides with the trailing edge of the gating signal, the last pulse is completed even if the gating signal ends during the pulse.

Single pulse mode

Single pulses are continuously generated at a frequency, set by the 'repetition time' switch.

Pulse delay, transition time are other variable parameters in this mode.

Double pulse mode

Twin pulses are generated at a frequency determined by the setting of the 'repetition time' switch, with the time between pulses set by the 'delay' switch. Both pulses have the same duration which is controlled by the 'duration' switch.

Transition time control influences both pulses.

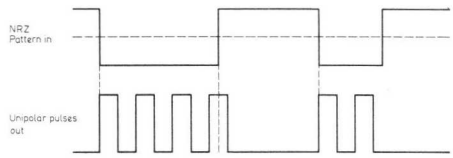
T/2 square wave mode

At the output a square wave signal whose frequency (1Hz to 50MHz) is determined by the setting of the 'repetition time' switch. Adjustments to the pulse delay, duration and transition time settings do not affect the output.

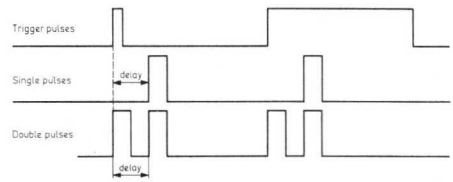
The auxiliary output provides single or double pulses with set delay and duration.

External triggering
The 'repetition time' switch must be set to the 'external' position. The repetition rate is then determined by the external trigger signal, but delay, duration and transition time by the PM 5715 controls.

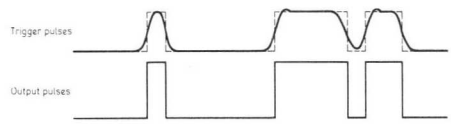
External gating
The output pulses can be synchronously gated by an external signal. The first pulse coincides with the trailing edge of the gating signal, the last pulse is completed even if the gating signal ends during the pulse.



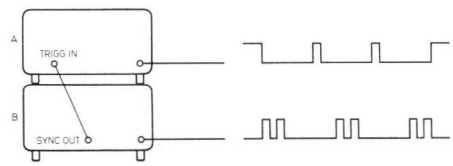
Single shot mode
A single or twin pulse is generated either on receipt of a pulse at the 'trigger/gate' input or on operation of the single shot pushbutton.



Pulse shaping
In the T/2 mode, and externally triggered, the repetition time, delay and duration switches have no effect. The pulses at the output of the generator, are of the same duration and repetition time as those received at the 'trigger/gate' input. The amplitude, DC offset and transition times are determined by the generator controls. (At the auxiliary output, however, the signal is available with delay and duration as set with the PM 5715 control).



Dual channel arrangement
Two PM 5715 can be interconnected to form a true dual channel pulse generator. Complex pulse patterns can be generated by mixing the outputs of two generators using the mixing piece PM 9584.



TECHNICAL SPECIFICATION

REPETITION RATE

Internal repetition rate
1Hz...50MHz. Variable in 8 ranges with continuous control within the ranges

PULSE DELAY

Range
10ns...100ms. Variable in 7 ranges with continuous control within the ranges

Jitter
$\leq$0.1% or 50ps whichever is greater

PULSE DURATION

Range
10ns...100ms. Variable in 7 ranges with continuous control within the ranges

Jitter
$\leq$0.1% or 50ps. whichever is greater

Duty cycle
More than 50%, normal and inverted mode using the inverted pulse mode, the duty cycle will approach 100%.

MAIN OUTPUT PULSE CHARACTERISTICS

Amplitude
0.2V...10V into 50Ω. Variable in 4 ranges, (500mV, 1.5V, 5V and 10V) with continuous control within the ranges.

Polarity
positive or negative (switchable).

Rise- and fall times (at 5V and lower positions)
$\leq$6ns...0.5s. Independent continuous control within 6 ranges. The time remains constant when pulse amplitude is varied.

Source impedance
Current source at 10V, terminated with internal 50Ω in the 5V, 1.5V and 500mV positions.

Waveform aberrations
$\leq$5% of set amplitude

DC-offset
Continuously variable from −2.5V to +2.5V into 50Ω. Pulse amplitude plus DC-offset max ±10V.

AUXILIARY OUTPUT PULSE CHARACTERISTICS

Amplitude
Fixed output level, TTL compatible, +4.5V open circuit

Source impedance
50Ω

Times
Pulse delay – and duration are set: with the controls DELAY and DURATION. Single – or double pulse (not T/2).
The pulse appears approx. 12ns ahead of the main pulse

SYNC OUTPUT

Pulse duration
Square wave appears approx 40ns ahead of the main pulse with the pulse delay set to 10ns.

Amplitude
+1.5V into 50Ω

Source impedance
50Ω

EXTERNAL TRIGGERING

Electrical triggering
Input voltage: > +1V to trigger the generator. Input current min 6mA.
Max. voltage: ±12V
Repetition rate: 0...50MHz
Input impedance: <1.5V approx 220Ω
>1.5V approx 800Ω
Delay from trigger input to the main-pulse output with pulse delay set to 10ns: approx. 50ns.

Manual triggering
Single shot facility by means of pushbutton.

EXTERNAL GATING

Input voltage
> +1V to gate the generator. The gating signal turns the generator off. The first pulse coincides with the trailing edge of the gating pulse. Input current min 6mA.

Input impedance
<1.5V: approx 220Ω
>1.5V: approx 800Ω

Delay from trigger input to the main pulse output with pulse delay set to 10ns:
approx. 50ns. Manual gating by means of single shot pushbutton.

MODES OF OPERATION

Pulse modes
Single pulse, double pulse or square wave (T/2). Double pulse mode provides 'twin' pulses at set delay with simultaneously controlled pulse duration.

Pulse shaping
In the external triggering position the generator can be used as a pulse conditioner. The pulses at the output of the generator are of the same duration and repetition time as those received at the 'trigger/gate' input. The amplitude and DC offset are determined by the generators controls.

GENERAL

Temperature range
0...+40°C

Supply
Line voltage: 100...130V and 200...260V (switchable)
85...115V and 170...230V solderable
Line frequency: 50...400Hz
Power consumption: 70VA

Dimensions and weight
(w×h×d) 210×130×275mm
(8.3×5×10.8-in)
4kg (8.8lb)

Accessories supplied
1 mains cable
1 manual

Optional accessories
PM 9581 50Ω-terminations (3W)
PM 9585 50Ω-termination (1W)
PM 9588 Coaxial cable set
(5×1ns, 4×2ns, 3×3ns, 3×10ns)
PM 9584 50Ω T-piece

50MHz: ⩽4ns Pulse generator PM 5712

1Hz to 50MHz frequency range
Fast rise and fall times (⩽4ns)
Wide amplitude range: 200mV. . .10V
10ns to 100ms pulse duration and delay
Variable DC offset: –5V. . .+2V
TTL compatible auxiliary output

The PM 5712 is a complementary instrument to the previously described PM 5715, having a faster fixed rise time of ⩽4ns. It is therefore ideal for carrying out the more standard type of test on high speed components and circuitry such as TTL and ECL integrated circuits, electronic counters, shift registers and delay lines. It can be used to examine the responses of circuits under test to changes in pulse duration and repetition rate. The instrument can also be used to measure the effect of double pulses, with a variable delay, on the circuits under test. Bursts of pulses can be derived using an external signal to gate the generator. An external signal can be used to initiate the output of pulses which are delayed and shaped according to the switch settings.

Two outputs are available. One is TTL compatible, and the other is variable up to 10V. The latter permits the unit to operate with high level, noise immune logic.
The PM 5712 is primarily intended to supply an output of positive polarity. However, negative polarity pulses (up to –5V) can be obtained by appropriate use of the normal/inverted switch and the DC offset control.

Operation

Three pulse modes are available – single pulse, double pulse and T/2 mode. When using inverted pulses, a duty cycle of almost 100% can be achieved. However, a duty cycle of better than 50% can be obtained when normal pulses are generated. Pulses have fixed transition times of ⩽4ns.
Pulse amplitude is variable from 200mV to 10V in four ranges (500mV, 1.5V, 5V and 10V) each having continuous vernier control throughout. By means of a vernier control, the DC baseline may be offset between –5V and +2V.
A square wave 'synchronous output' is available, which remains unaffected by the settings of the delay and duration switches. This output is 3V open output and its frequency is determined by the setting of the 'repetition time' switch.
An 'auxiliary' output generates the same pulses as the normal output, but at a level suitable for direct feed into TTL circuitry. It is unaffected by the position of the 'normal/inverted' switch, the amplitude setting and the DC offset control.
The generator can be synchronously gated by an external signal. The first pulse coincides with the trailing edge of the gating signal, the last pulse is completed even if the gating signal ends during the pulse.

Single pulse mode

In this mode, the generator has an output of single pulses, whose duration, delay and repetition rate are determined by the related switch settings.

Double pulse mode

Twin pulses are generated at a repetition rate variable from 1Hz to 25MHz. The interpulse delay is variable from 10ns to 100ms. The duration of each pulse is the same and it is possible to simultaneously vary the duration of the two pulses.

T/2 square wave mode

The output is a square wave signal with repetition rate variable from 1Hz to 50MHz. The operation is unaffected by the setting of the pulse delay and duration controls. The auxiliary output

still provides single or double pulses with variable delay and duration.
For more detailed information we refer to the description of the PM 5715 on page 180.

TECHNICAL SPECIFICATION

REPETITION RATE

Internal repetition rate
1Hz...50MHz. Variable in 8 ranges with continuous control within the ranges.

PULSE DELAY

Range
10ns...100ms. Variable in 7 ranges with continuous control within the ranges.

Jitter
$\leq$0.1% or 50ps, whichever is greater.

PULSE DURATION

Range
10ns...100ms. Variable in 7 ranges with continuous control within the ranges.

Jitter
$\leq$0.1% or 50ps, whichever is greater.

Duty cycle
More than 50%, normal and inverted mode. Using the inverted pulse mode, the duty cycle will approach 100% (limited only by the minimum duration).

MAIN OUTPUT PULSE CHARACTERISTICS

Amplitude
+200mV...+10V into 50Ω. Variable in 4 ranges, (500mV, 1.5V, 5V and 10V) with continuous control within the ranges.

Rise-and fall times (at 5V and lower positions)
$\leq$4ns with external 50Ω termination.

Source impedance
Current source at 10V, terminated with internal 50Ω in the 5V, 1.5V and 500mV positions.

Wave form aberrations
$\leq$5% of set amplitude

DC-offset
Continuously variable from −5V to +2V into 50Ω. Pulse amplitude plus DC-offset max +10V

AUXILIARY OUTPUT PULSE CHARACTERISTICS

Amplitude
Fixed output level, TTL compatible +4.5V open circuit

Source impedance
50Ω

Times
Pulse delay- and duration are set with the controls DELAY and DURATION Single – or double pulse (not T/2)
The pulse appears approx. 12ns ahead of the main pulse

SYNC OUTPUT

Pulse duration
Square wave appears approx 40ns ahead of the main pulse with the pulse delay set to 10ns

Amplitude
+1.5V into 50Ω

Source impedance
50Ω

EXTERNAL TRIGGERING

Electrical triggering
Input voltage: > +1V to trigger the generator with input current min 6mA.
Max. voltage: ±12V
Repetition rate: 0...50MHz
Input impedance: approx. 1kΩ
Delay from trigger input to the main-pulse output with pulse delay set to 10ns: approx. 50ns.

Manual triggering
Single shot facility by means of push-button.

EXTERNAL GATING

Input voltage
> +1V to gate the generator. The gating signal turns the generator off. The first pulse coincides with the trailing edge of the gating pulse. Input current min 6mA.

Input impedance
<1.5V: approx 220Ω
>1.5V: approx 800Ω

Delay from trigger input to the main pulse output with pulse delay set to 10ns:
approx. 50ns. Manual gating by means of single shot push button.

MODES OF OPERATION

Pulse modes
single pulse, double pulse or square wave (T/2). Double pulse mode provides 'twin' pulses at set delay with simultaneously controlled pulse duration.

Pulse shaping
In the external triggering position the generator can be used as a pulse conditioner. The pulses at the output of the generator are of the same duration and repetition time as those received at the 'trigger/gate' input. The amplitude and DC offset are determined by the generator controls.

GENERAL

Temperature range
0...+40°C

Supply
Line voltage: 100...130V and 200...260V (switchable)
85...115V and 170...230V solderable
Line: 50...400Hz
Power consumption: 70VA

Dimensions and weight
(w×h×d) 210×130×275mm
(8.3×5×10.8-in)
4kg (8.8lb)

Accessories supplied
1 mains cable
1 manual

Optional

PM 9581 50Ω-termination (3W)
PM 9585 50Ω-termination (1W)
PM 9588 Coaxial cable set
(5×1ns, 4×2ns, 3×3ns, 3×10ns).
PM 9584 T-piece 50Ω

10MHz: 15V output Pulse generator PM 5705

0.1Hz to 10MHz frequency range

TTL-compatible outputs, both normal and complementary

1.0V to 15V into 50Ω for TTL, HNIL and MOS applications

Baseline offset from 0 up to +2V

Resettable, engraved scales

External triggering on positive or negative slope; gating and single shot facilities

The PM 5705 is an ideal low-cost generator for a wide range of TTL MOS and HNIL applications. There are two TTL outputs, normal and complementary with sufficient power for up to 30 gates. For MOS and HNIL logic there is a 1 to 15V output. For current sink applications a 50Ω internal switchable load is included. This all-round performance is complemented by a logical front panel layout and the use of engraved, resettable scales.

These allow the pulse parameters to be set to a high degree of accuracy without employing an oscilloscope. This feature is particularly useful for educational applications. When the PM 5705 is used as a clock generator only the repetition time has to be set and the square wave push-button depressed.

The baseline offset of up to 2V is an additional useful feature, used to test biased circuits and components – for example the 'O' level in TTL.

Pulse bursts can be produced using an LF generator connected to the trig/gate input. The PM 5705 can also be triggered by an external pulse source, on either the positive or negative slopes.

TECHNICAL SPECIFICATION

15V PULSE OUTPUT

Repetition rate
0.1 Hz to 10MHz variable in 8 ranges with continuous control within the ranges. Jitter less than 0.1%.

Duration
50ns to 500ms variable in 7 ranges with continuous control within the ranges.
Jitter: less than 0.1%
Duty factor approaching 100% using complementary pulse. More than 50% in normal pulse mode

Delay
In square wave mode the positive edge of the TTL complementary is delayed from the complementary main pulse. The delay time is the set duration subtracted from half the repetition time.

Amplitude
Continuously variable from +1V to +15V into 50Ω. Max. current 300mA.

Source impedance
Voltage source with about 300Ω or 50Ω termination

Polarity
Positive

Modes of operation
Normal or complementary

Baseline offset
Continuously variable from 0 to +2V Max. offset current 80mA. Only the baseline is shiftting

Ramp time
⩽10ns at 5V and lower amplitudes with 50Ω internal or external termination. Typically 10ns at 10V and 15ns at 15V. (Typical rise time 6ns).

Waveform aberration
Less than ±5% between 3V and 15V into 50Ω and base line offset 0V.

Protection
Short and open circuit safe.

TTL PULSE OUTPUTS

Repetition rate
0.1Hz to 10MHz variable in 8 ranges with continuous control within the ranges.
Jitter: less than 0.1%

Duration
50ns to 500ms variable in 7 ranges with continuous control within the ranges

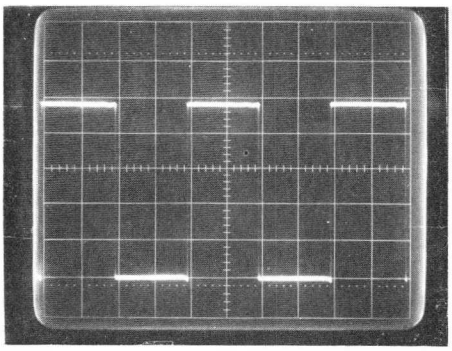


Fig. 1. Square wave at 5MHz

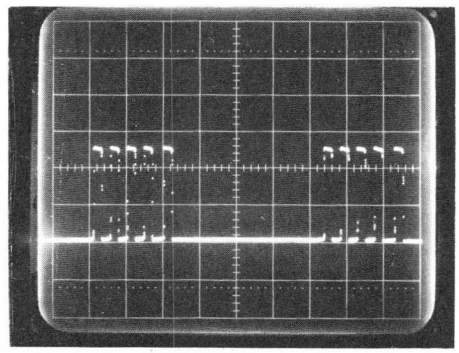


Fig. 2. Gated pulses

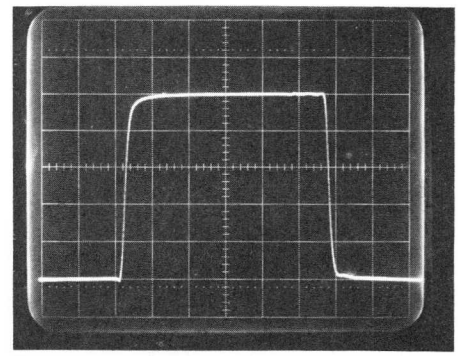


Fig. 3. TTL output

Jitter: less than 0.1%
Duty factor approaching 100% using complementary pulse. More than 50% in normal operation.

Delay
In square wave mode the positive edge of the TTL complementary is delayed from the main complementary pulse. The delay time is the set duration subtracted from half the repetition time.

Amplitude
TTL level. Fan out 30 gates.
About 4.5V open circuit

Polarity
Positive

Modes of operation
Normal and complementary

Ramp time
About 10ns

Waveform aberration
Less than 5% into 50Ω

Protection
Short and open circuit safe

Pulse output
50Ω TTL linedriver with filter for waveform correction, designed for 50Ω load.

GENERAL

External triggering and gating
Level: > +1V to trigger or gate the generator. Max. ±20V
Slope selection: positive or negative slope
Frequency: 0 to 10MHz
Input impedance: approx 1kΩ
Gating signal turns the generator 'off'. First pulse coincides with trailing edge of gating pulse

Pulse shaping
In square wave mode with repetition time set to external the frequency and duration of the output pulse are determined by the trigger pulses.

Single shot
Single shot facility by means of pushbutton. In square wave mode the TTL pulse duration is determined by the time the push-button single shot is depressed.

Manual gating
Depressing the single shot pushbutton inhibits pulses when the generator is internally triggered.

Temp. range
0...40°C

Supply
Line voltage: 90–110, 100–130, 180–210 and 200–260V solderable
Frequency: 50 to 400Hz
Consumption: 40VA

Dimensions and weight
(w × h × d) 210 × 130 × 275mm
(8.3 × 5 × 10.8-in)
3.5kg (7.7lb)

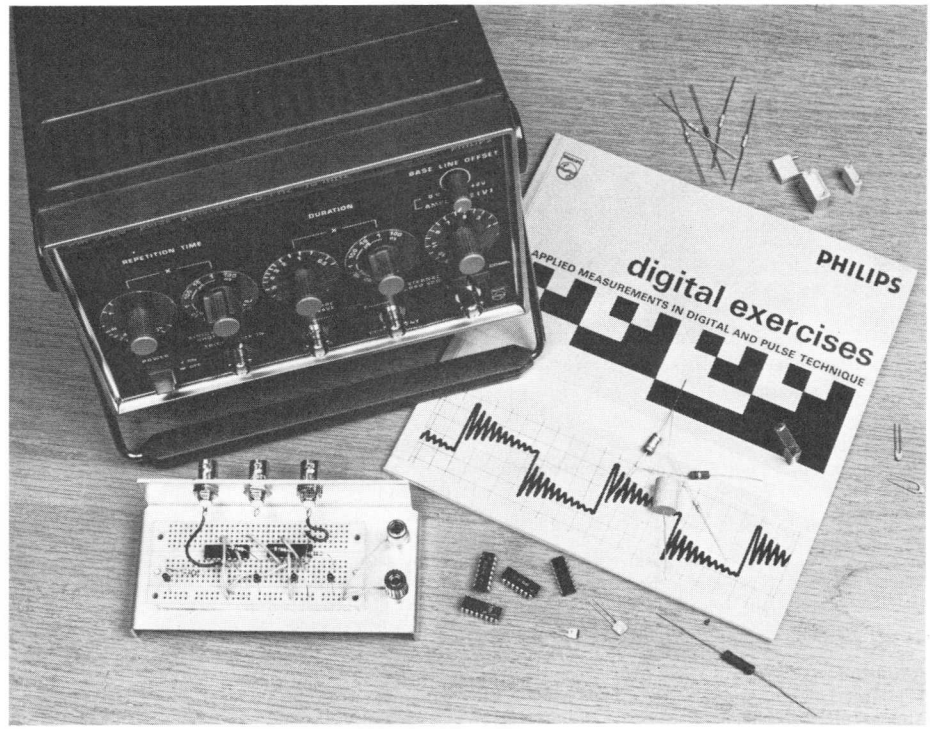
Accessories supplied
1 mains cable
1 manual

Optional

PM 9581 50Ω-termination (3W)
PM 9585 50Ω-termination (1W)
PM 9588 Coaxial cable set (5 × 1ns, 4 × 2ns, 3 × 3ns, 3 × 10ns).
PM 9584 50Ω mixing piece

Educational package PM 5705E

The Philips Educational package PM 5705E consists of:
– The booklet, 'Digital exercises'
– components
– a breadboard unit
which are described in detail on this page



'Digital Exercises' is a practical publication that supplements a theoretical education in digital techniques.
'Digital Exercises' contains 35 measuring exercises of varying degrees of complexity. Use is made of common integrated circuits from the two dominating logic families: TTL and C-MOS. It gives the student a good feeling for the components themselves. Comparison of measurements yields a clear understanding of the distinct difference between these important types of logic circuit.

EASY MOUNTING

The exercises make use of connecting strips in which the integrated circuits are simply plugged-in without the need for soldering. The advantage is that the same component can be used many times. They further reduce the time needed for changing from one exercise to another. Such an arrangement is very common for the breadboarding of circuits in industry and the student will therefore become familiar with this practice.

INSTRUCTIONS

The book, Digital Exercises, is based on the original work by civ.ing. Tommy Kjellander of the Royal Institute of Technology, Stockholm and it employs a step by step approach.
An introduction explains the principles of the pulse generator and the influence of the oscilloscope on pulse technique measurement accuracy. Next follows measurement of pulse parameters, time domain reflectometry and the influence of matched/mismatched cables. The measurements on integrated circuits start with TTL-logic in different applications then C-MOS logic is introduced and compared with TTL.
Finally there are some specific C-MOS exercises.

THE EQUIPMENT

To make the exercises self-instructional, all adjustment information has to be related to specific measuring instruments. We have chosen the 10MHz oscilloscope PM 3233 (alt. PM 3232) and the pulse generator PM 5705. Additionally one needs a $15V_{DC}$ power supply (e.g. PE 1535) and one electronic multimeter (e.g. PM 2503/PM 2513A).
The Philips educational package for digital techniques PM 5705E consists of:*

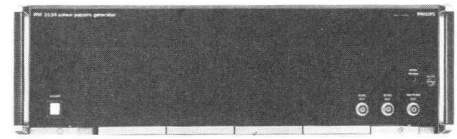
2 copies of the book 'Digital Exercises, Applied measurements in digital and pulse technique' containing 35 measuring exercises.

A set of components including 11 integrated circuits, 1 diode, 4 LED's, 1 reed relay in Dual-in-line package, 18 resistors, 1 potentiometer, 13 capacitors and 1 inductance. Datasheets for these components are also supplied. In addition, the set contains a plug-in board of connecting strips mounted on a chassis.

A pulse generator. The package PM 5705E includes a pulse generator PM 5705 which covers all exercises. It has two fixed TTL level pulse outputs and one 1–15V pulse output.

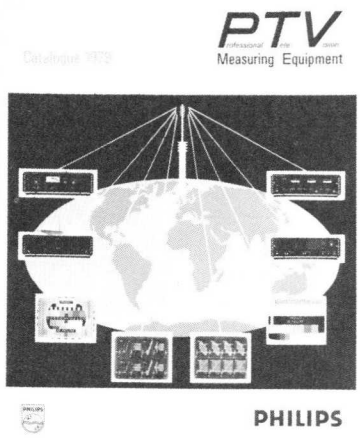
* The book 'Digital Exercises' and generator PM 5705 are also available separately.

Professional TV equipment



Introduction

This short section of the catalog is devoted to the extensive Philips range of professional instruments for television. Since this is a somewhat specialised activity, only a short summary has been given of each model. A comprehensive PTV catalogue is available on request.
Whilst the remainder of this catalog clearly demonstrates Philips' position as Europe's largest manufacturer of test and measuring equipment, it is worth emphasising that Philips are totally involved in the A to Z of television. From studio equipment through to transmitters and on the receivers in the home. In other words, we know the market requirement for test and measuring equipment in detail. Philips are also a major innovator in TV, with breakthroughs like the Plumbicon® camera tube and new recording techniques on cassettes and VLP's. We can therefore anticipate market requirements and move to meet them, as illustrated on the following pages.



TV signal generator PM 5533

Generates the most commonly used test signals

Can be genlocked to external TV signals

Contains a complete colour sync pulse generator

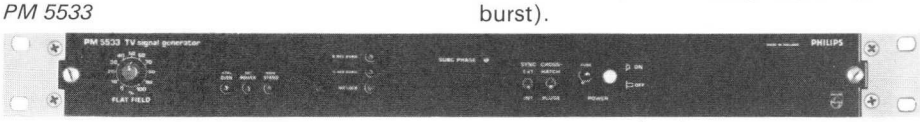
High stability through oven-controlled timebase oscillator

The PM 5533 TV signal generator is a video multi-signal generator producing the most commonly used video signals in the fields of broadcasting, cable-circuit TV and TV set manufacturing.

The supplied signals are: colour bar signal (several different versions are possible), cross-hatch, PLUGE with grey step, and flat-field signal. The colour bar signal and the flat-field signal are available simultaneously at two different sets of output connectors, while the cross-hatch or the PLUGE can be selected at a third set of output connectors by a front-panel switch.

The generator has its own built-in standard sync pulse generator (SPG), which can be genlocked to any video source. All synchronizing signals needed for driving a television system are provided on separate output connectors. These are: composite sync and blanking, horizontal and vertical drive, which are sufficient for monochrome systems and SECAM colour systems, – plus colour subcarrier, burst keying and PAL identification signals for PAL colour systems. Furthermore the flat-field signal can be used as a synchronizing signal (black burst).

PM 5533



Colour pattern generator PM 5534

Most recognized receiver test pattern in the world

Used intensively by broadcasting authorities and TV setmakers

Extended performance by optional text generator and/or clock

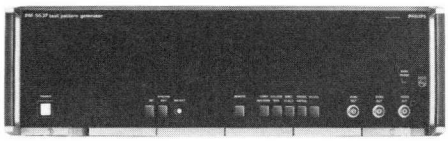
Built-in coder and sync pulse generator for all colour systems

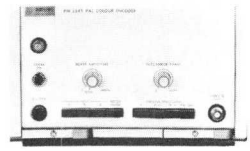
Colour pattern generator PM 5534 is successor to the well-known PM 5544. The pattern of the PM 5544, recognized all over the world, offers the unique feature that all important parameters of a TV set can be checked in one glance at the picture tube of the set itself.

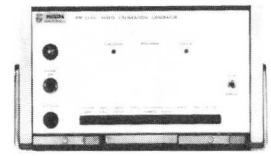
This test pattern has been adopted by the television authorities in more than 20 countries in all parts of the world as the test pattern to be transmitted outside the programme hours. Therefore the PM 5534 pattern has been made identical to that of the PM 5544, so that compatibility between the two instruments is ensured.

By using highly integrated components and customized integrated circuits it has been possible to incorporate both a colour sync pulse generator (SPG) and a colour encoder in the PM 5534. The instrument therefore only needs a mains connection to produce the complete, encoded colour pattern.

In addition there is room for optional print cards to extend the performance of the instrument.
These include a text generator, clock generator, an oven-controlled crystal oscillator and a 10MHz input card.







Test pattern generator PM 5537

Composite pattern based upon international insertion test signals

Used in eurovision network as a standby and link test pattern

Pattern composition allows both off-screen and waveform monitor evaluation of the transmission quality

Built-in encoder for most colour systems

The PM 5537 is the successor to extended performance through the PM 5547 test pattern generator, and it generates the same composite pattern, which is ideal for checking all sorts of internal and external transmission paths in broadcast TV system and networks.

The pattern is designed in such a way that it gives a fairly good impression of the transmission quality, when displayed on a colour monitor. Besides authority identification can be shown in alphanumeric display.

All the signal elements of the pattern except the colour bar, are the same as those composing the insertion test signals viz. white reference bar, multiburst, 2T sine-squared pulse, 20T pulse carrier-born and grey scale signal. This means that the pattern represents a full-field VIT signal, and by proper selection of the time base controls, the TV engineer can check the most important transmission characteristics on his waveform monitor. On top of that the colour bar signal gives valuable information that is not available from the VITS.

Colour encoder PM 5545

RGB and Y, R—Y and B—Y inputs

Separate encoded and luminance-only outputs

Available in European, Brazilian and Argentine PAL and NTSC versions

0 to 400° sub-carrier phasing control

0 to 200% burst amplitude control

The PM 5545 colour encoder is designed to encode R, G, B as well as Y, R-Y and B-Y signals into the various Colour TV formats. It is intended for use in conjunction with the PM 5532 colour sync. generator and finds application in colour TV transmitter centres and on CTV-set production lines. When mounted with the PM 5532 the two units, which form a complete encoder system, occupy only one 19-in cabinet rack. With PM 5545, R. G. B. signals are fed through matrixing and low-pass filter units to form the Y, R-Y and B-Y. When the signals are already in the latter form then the matrix is bypassed. The signals are then shaped, modulated on the subcarrier signal, and with burst-key information, are fed through an adder unit which provides the requisite encoded signals. Sync information is then added to the signals and, after amplification, they are available at four individual outputs.
It is also possible to modify the Y, R-Y and B-Y input in such a way that a second R, G, B input is provided e.g. for test operations.
The sub-carrier phase is adjustable from 0...400° and the burst amplitude can be varied between 0 and 200%.
The various controls can be remotely controlled.

Video calibration generator PM 5546

Most accurate video source available

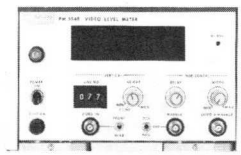
High stability by use of selected and aged components

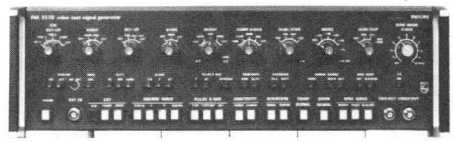
Compact instrument supplying:
— RGB colour bar signal
— white reference pulse
— grey scale signal
— PLUGE signal
— crosshatch/dot pattern
— colour difference signals

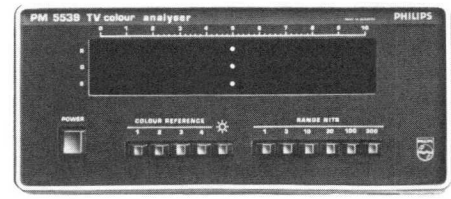
All signals available on fixed outputs as well as switchable on RGB outputs

Remote control facility

This new-concept generator is specifically designed for aligning and checking TV cameras and monitors, encoders and decoders, mixers and other items of video equipment. Its main application area is therefore in TV studios and continuity centres, as well as in switching and transmission centres.
The PM 5546 is controlled by the sync and blanking pulses supplied by a standard TV sync generator such as Philips models PM 5532 and PM 5533. A unique feedback circuit in the instrument completely eliminates the effect of temperature and longterm drift. This arrangement has produced what is almost certainly the most accurate video source on today's market.
Most of the test signals are available both at fixed outputs and at the switchable RGB outputs. This construction principle allows individual requirements to be met extremely economically together with great flexibility. The generator can also be remotely controlled by external +5V logic, which gives very convenient access to the generator when used as a central test or calibration source.







Video level meter PM 5548

Most accurate video level meter available

Foolproof readings

All levels in TV-field can be measured

Optional BCD output for digital printing or remote monitoring

This digital video level meter is specially designed for aligning and checking all kinds of video equipment, such as pattern generators, encoders, decoders, mixers, etc. It uses a sampling method that enables it to measure levels at any point of the television signal. It will perform level analyses on all kinds of video test signals even including insertion test signals. The meter can be equipped with an optional BCD output for digital printing or remote monitoring. Together with the Video Calibration Generator PM 5546, it forms the most accurate measuring system available. Level settings and adjustments can thus be performed in an easy and highly accurate way.

Video test signal generator PM 5570

Most versatile signal generator for testing transmission characteristics of video systems

Generates all necessary signals for aligning and checking TV studios, transmission links and transmitters

All levels are continuously variable with preset positions

Sweep signal from 100kHz up to 10MHz in one sweep with marker indication for each MHz

The PM 5570 is the most versatile video test signal generator available nowadays. It generates a wide variety of test signals necessary for measuring the system parameters of all kinds of video transmission equipment. Besides, it enables the user to vary all signal levels so that level dependent parameters can be detected as well.

The generator has its own standard SPG built-in, which can be genlocked to an external composite video – or black burst signal. A choice of the following test signals can be made: squarewave signals of different frequencies and with different rise times, pulse-and-bar signals, sawtooth- and staircase signals with and without superimposed sine wave/subcarrier, chrominance staircase, and various sine wave signals, viz. video sweep, multiburst and fixed frequencies. All signals can be superimposed with hum, and white noise can be added to check among others sync separators, clamp circuits, processing amplifiers, etc. A flat field signal (APL) can be added to the sawtooth and staircase signals forming the so-called duty signals (alternating 3 lines APL, 1 line sawtooth/staircase).

TV colour analyzer PM 5539

First practical solution to the problem of 'objective setting' of colour monitors

Optional battery makes operation possible where mains connection is impossible or inconvenient

The three LED bars mounted over each other ensure quick and accurate reading of the colour levels and balance

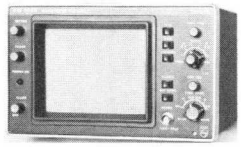
High sensitivity allows accurate setting of the 'colour white' at low luminance levels

The Philips TV colour analyser PM 5539 has been developed to meet the increasing demand for measurement and adjustment of the 'colour' white of colour TV-sets and colour monitors.

The light emitted by a colour picture tube consists of the three primary colours red, green and blue. White is obtained by additive mixing of these colours in the appropriate proportions. The PM 5539 has three independent LED displays so that the intensities of the three primary colours can be measured simultaneously.

To cope with different white standards or different brands of picture tubes, the PM 5539 has four matrix circuits which can be adjusted to give correct readings.

The white level is normally adjusted at both high and low brightness levels, but the ratio of the three primary colours should also stay the same at 'grey' levels. To permit this 'grey scale tracking', the PM 5539 has a wide sensitivity range (1 to 300 NIT full scale).



Waveform monitor PM 5565

Designed for use in broadcast studios and OB vans

Input at the front for a standard oscilloscope probe

Internal graticule for accurate level readings

Low power consumption

Compatible with other brands of waveform monitors

The PM 5565 waveform monitor was designed for use in television studios, VTR and telecine centres and OB vans. The main application of the instrument is to set-up and check the signals of b/w and colour cameras, videotape recorders, film and slide scanners etc.
As a unique feature for an instrument of its price class, the PM 5565 has a probe input at the front. This enables the PM 5565 to be used for fault finding in the equipment to which it is allocated, thus eliminating the need for an extra oscilloscope for servicing purposes.

The PM 5565 has two video inputs at the rear plus the facility for synchronization from a third video or composite sync input. The vertical sensitivity is $1V_{p-p}$ or $0.2V_{p-p}$ full screen size. Filters for display of luminance only or chrominance only are provided.

Horizontal deflections are one or two lines as well as one or two fields, full screen size. Also 20 times magnification is possible. For the convenience of adjusting colour camaras, the PM 5565 accepts the signals from a 'parade display' switcher.

Vectorscope PM 5567

Designed for use in broadcast studios and OB vans

Internal graticule for accurate vector readings

Low power consumption and high reliability

Very easy acces to servicing

Compatible with other brands of vectorscopes

Easy to operate because of logic ergonomy

The PM 5567 vectorscope was designed for use in television studios, VTR and telecine centres and OB vans. The main application is for setting-up and checking the colour content of signals from colour cameras, video taperecorders, film- and telecine scanners etc.

The colours of the selected signal are displayed as vectors.
Vector length represents the saturation of the colours; vector angle represents the hue of the colours (the latter with reference to the colour burst).

PM 5567 has two video inputs plus a further facility for synchronization from a third video colour subcarrier signal. In the PAL version the R-Y alternation can be switched off when checking the 180 degrees PAL switching of the displayed signal.
The internal graticule makes vector readings easier and more accurate, because parallax errors cannot occur. The graticule has special tolerance lines for reading both the amount of differential gain and phase distortion.

EBU insertion signal generator PM 5575A

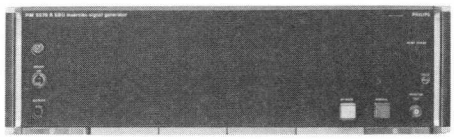
Authorized by the EBU for use in the Eurovision network

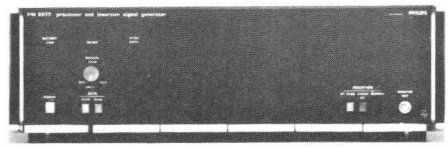
Easy programmability through front plate controls and matrix board

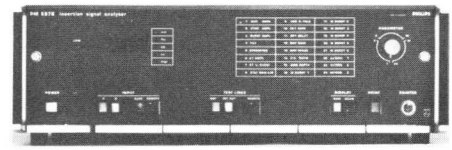
Keyed-in inputs for external insertion signals to be used for data signals, command codes or special insertion signals

This universal insertion signal generator and inserter has been specially developed to meet the growing need for 'in transmission' testing and automatic analysis. The PM 5575 is a precision instrument that generates, inserts and erases insertion signals in accordance with the EBU specifications for international transmissions, and it can also be used for data signals. It is easily and conveniently programmed on the front panel pinboard matrix.

The PM 5575 is particularly attractive for use in main terminals of broadcast and PTT switching centres as well as in advanced laboratories and maintenance workshops. This because it is easily programmed on the front panel, which has the advantage that the various settings can be seen directly at the frontplate. The instrument can be switched to full-field operation and this signal is available at all times. Moreover the full-field signal can be generated in various combinations, including a special 50Hz squarewave signal that is very useful for testing the low frequency response.







Insertion signal generator PM 5576A

In full conformity with the EBU performance specification for insertion signal equipment except that the PM 5576 has no full-field facility

Ideal for use in TV studios and OB vans, where simple and reliable operation is important

Easy programmability via internal matrix board

The PM 5576 insertion signal generator has been developed for those applications, where insertion signals are inserted into programme signals as routine operations that require no attention nor operation of the inserting equipment. The PM 5576 can be considered a simplified version of the fully EBU specified ITS generator PM 5575, since the ITS generating part and the inserter are identical in the two apparatus. Only the full-field signal part is omitted in the PM 5576, while the front plate controls of the PM 5575 have been placed inside the PM 5576.

The PM 5576 is particularly useful in OB vans, TV studios and switching centres because of its reliable and study construction and simple operation. Once the routine of using insertion signals within a broadcast authority has been established, the setting of the ITS generator is very rarely changed. The equipment should therefore only have a few controls to be operated by the operational staff.

Processor and ITS generator PM 5577

Compact unit provides processor plus ITS generation and insertion as a package for use in transmitter stations

Automatic gain control smoothes out variations in modulation depth caused by link drift and fading

White limiter prohibits intercarrier hum at sudden overmodulations without distorting the colour transmission

Insertion of 'fresh' sync pulses and insertion signals ensure best possible signals for the audience and reliable measurements of the transmitter distortion

The PM 5577 is a combined processor/ ITS generator and inserter designed for used in transmitter stations where it performs the functions of processing the incoming video signal, before it is fed into the transmitter, and of inserting 'fresh' ITS into the programme signal. This is done in order to allow measurement of the transmitter distortion without the influence of any distortion introduced earlier in the network.
The PM 5577 fulfils the German ARD specifications 5/23 section 5 and the EBU performance specification for ITS equipment (except for full-field signals).

Insertion signal analyser PM 5578

Up to 21 parameters can be measured

Outstanding accuracy of measuring results

Presentation by means of digital display

Adjustable limit selection with out-of-tolerance alarm facility

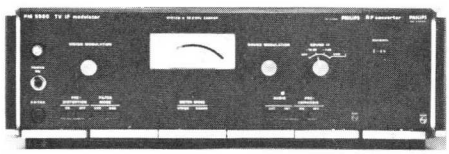
Data print-out possible (serial code ASCII)

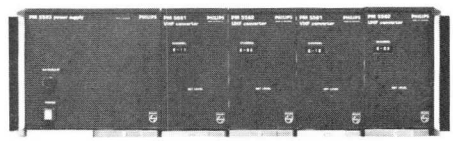
Output for data transmission to monitoring centre

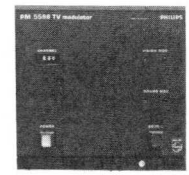
Additional inputs facilitate transmission of alarm functions

One 19-in rack cabinet, 3E high comprises all circuitry

This system is a precision instrument for carrying out continuous measurements of the distortion on television chains or other television equipment. It may be used wherever video equipment (from amplifiers and equalizers to transmission links and transmitters or the whole broadcast network from programme studio to transmitters) has to be checked, adjusted or constantly supervised in broadcast studios, switching centres and transmitter stations. Up to 21 different distortions can be measured with it, the results being extremely accurate. Presentation is by means of a digital display. The system includes adjustable limit selection with out-of-tolerance facility. Data print-out is possible (serial code ASCII). A special transmitter output is incorporated for transmitting the measuring results and alarm signals to a distant centre for remote monitoring. In combination with a minicomputer, several systems may be used for supervising a whole broadcast network.







IF modulator PM 5580

Narrow limits for bandpass and group delay profiles

Switchable DSB and VSB modes

Switchable linear and pre-corrected group delay characteristics

Synthesized carrier frequency generator

The PM 5580 is a compact combined vision and sound modulator that uses a highly stable 10MHz X-tal oscillator in order to derive that IF carrier. Synthesizing the signal in this way also allows other intermediate frequency to be provided. The modulator is used to supply either combined or separate IF vision and sound carrier to the VHF and UHF converters described on this page. In turn this combination can be used for signal distribution systems. The DSB mode facility of the modulator also allows it to be employed for testing, for example Nyquist receivers for pulse and frequency response.

VHF/UHF converters PM 5581 - PM 5583

Easy change of channel

Directional coupler in the IF output

Covers all VHF/UHF as well as S channels

High stability, very low distortion

The PM 5583 converts IF signals to signals in the VHF band whilst the PM 5582 converts to the UHF band. They are designed for use together with the IF modulator PM 5580. One converter can be plugged into the same 19-in cabinet as the PM 5580, from which it also is driven.
If more converters are used one has to use the PM 5583 base unit, which can contain up to four converters. The directional coupler unit enables the user to connect many converters in series, which is necessary in a IF distribution network.

TV modulators PM 5597 and PM 5598

Self-contained TV modulator for distribution and universal purposes

Double side-band modulation with special filter that reduces partly the lower side-band, and suppresses spurious and harmonic signals

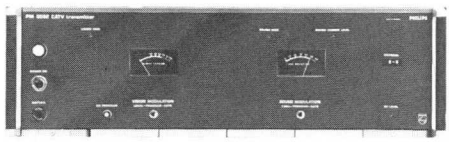
Built-in indicators for overmodulation of the video as well as the sound carriers

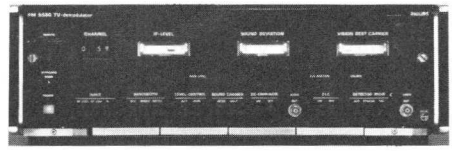
The output of several modulators can be combined by means of simple combiners

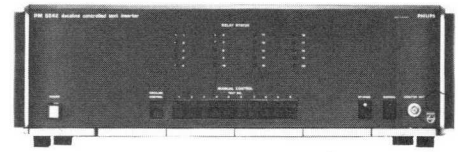
The PM 5597 and PM 5598 TV modulators are small one-channel, combined vision/sound 'transmitters' of professionel quality, well suited for colour and monochrome TV. The charrier frequency is crystal controlled, and all channels from 35MHz to 300MHz (PM 5597) and 470MHz to 960MHz (PM 5598) are available.

The output signal is in principle a double side-band modulated RF signal, but a band-pass filter in front of the output stage partly suppresses the lower side-band and the frequency content of the higher side-band above the sound carrier. Besides, this filter suppresses any spurious and harmonics outside the band-pass range. Thanks to wide-band output stage (75Ω output impedance over the complete frequency range) the outputs of several modulators can be connected to a single cable for distribution by means of simple combiners without any mutual disturbance of the signals. Only every other channel has to be kept free of signal.

Mechanically the modulators are plug-in units fitting into the PHILIPS 19-in rack/table cabinet. The PM 5597 is a 1/6 unit, while the PM 5598 is a 2/6 unit.







CATV transmitter PM 5592

Designed for CATV head-ends, where the most stringent quality is needed

Automatic substitution of video and sound signals in case 'missing' signal at main input

Special narrow limits CATV filters ensure minimum interference between adjacent channels

High stability due to the use of TCXO and synthesizer for carrier control

The requirements on equipment in the CATV head-end have increased enormously in the last few years. From using rather simple and semi-professional equipment in the past, CATV companies are now shifting over to equipment that is just as professional as that used by the official broadcasting authorities.
One of the key instruments in a CATV installation is the modulator. PHILIPS is known for its very professional line of television modulators, and the PM 5592 CATV modulator is no exception. As the design is based on professional broadcast equipment, the PM 5592 has features that are not found in any other CATV modulator on the market: synthesized carrier control, TCXO (temperature compensated crystal oscillator) controlled frequency accuracy and stability, plus possibility for synchronization of several modulators from the same frequency standard. Change from one channel frequency to another is performed by simple programming of the synthesizer in the RF converter part – without a need for changing crystals.
In order to meet the special CATV needs, the PM 5592 has a special vestigial sideband filter that heavily suppresses all signal content outside the channel band, as well as automatic/manual substitution of vision and sound signals.

TV demodulator PM 5560

Both synchronous and envelope detection modes give possibility of measuring more parameters than previously and with improved accuracy

Unique ROM and synthesizer circuits facilitate straight forward dialling of the wanted channel

Separate inputs for UHF and VHF channels at low and high levels plus IF input

Channel and input selection can be remotely controlled

The Philips PM 5560 TV demodulator is a compact precision Nyquist demodulator containing both the tuner and the IF demodulator.
The tuner is a combined VHF-UHF tuner using double conversion to obtain a good selectivity. The tuning is done by means of thumbwheels, indicating the selected channel number. Provisions have been made to cover also the S-channels, special VHF channels and to tune to transmitters using an off-set frequency.
The IF demodulator can be used in two modes:
a. synchronous detection
b. envelope detection
The modes can either be selected manually or automatically with a preference for the synchronous mode. Sound detection is also possible in two modes:
a. intercarrier sound
b. splitcarrier sound
Three meters are mounted at the front-plate enabling simultaneous checks of IF level, sound deviation and vision rest carrier.

Remote control unit PM 5542

Designed for installation at unattended transmitter stations

Generates and inserts up to 10 different messages into the programme signal

Each message may have up to two lines of 30 characters

Can be controlled remotely via a command code in the vertical interval

Outperforms the well-known optical slide scanner

By-pass relay minimizes the risk of unintentional interruption of the programme path

Optional: remote control of other equipment in the station - up to 20 functions

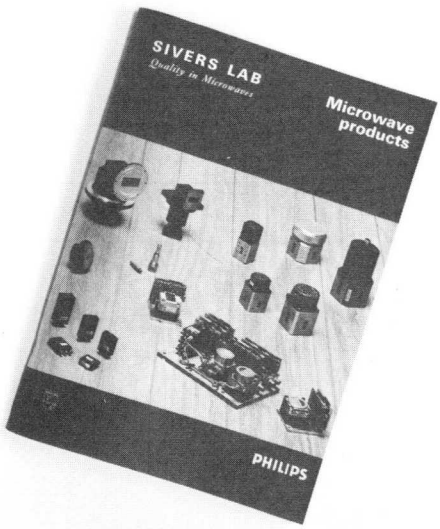
The Philips remote control system allows a person in a TV network centre to insert remotely certain messages or apologies and to control remotely the equipment at any site of the network.
The system comprises a command unit to be installed in the network centre and a number of units to be installed at the various sites in the network.
The PM 5542 dataline controlled text inserter is for remotely controlled insertion of messages and apologies. Optional: The PM 5542 may have relay functions as well.
The system makes use of one empty line in the TV signal to transmit the command codes from the centre to the sites in the network, in accordance with the supervisors operation of the command unit.

Microwave equipment

For complete information send for our microwave catalog

Catalog and product range

MAIN CATALOG



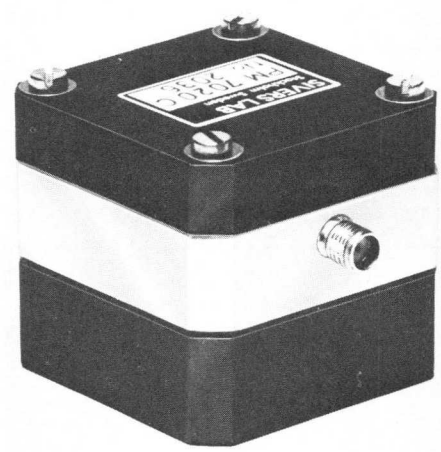
This microwave catalog is available on request.

ROTARY JOINTS

SL 6768L 5-channel L-band rotary joint.

Single and multichannel
waveguide and coaxial
covering most frequency bands
DC-18GHz
high-performance design

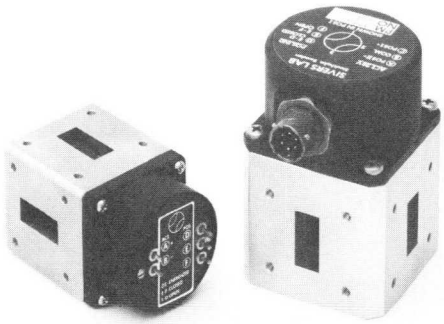
YIG-DEVICES



PM 7020C

Continuous frequency coverage
1-18GHz
Gunn and transistor sources
dual channel filters
fast tuned filters
tracking filter/oscillators for
superhet applications
integrated voltage-to-current converter

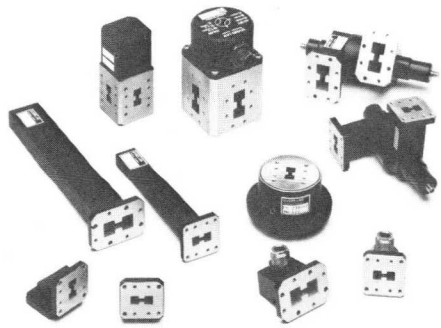
WAVEGUIDE SWITCHES



PM 7288 *PM 7286*

All frequency bands 1-18GHz
transfer and three-channel
latching and failsafe
automatic and manual
solenoid and motor driven actuators
position indication

DOUBLE RIDGE PRODUCTS



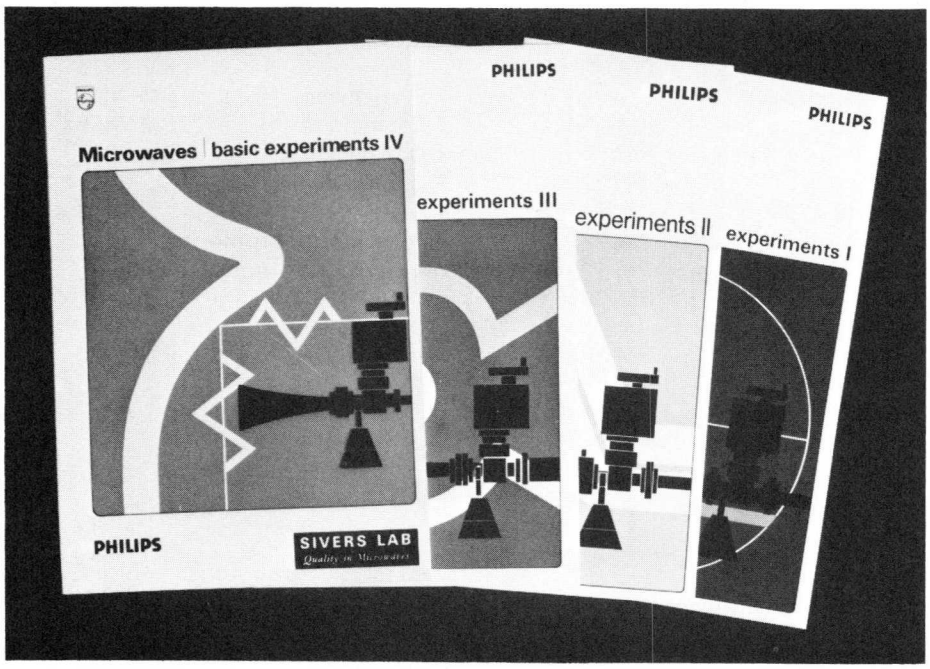
WRD 475, WRD 750
rotary and swivel joints switches
terminations, transitions, bends, couplers

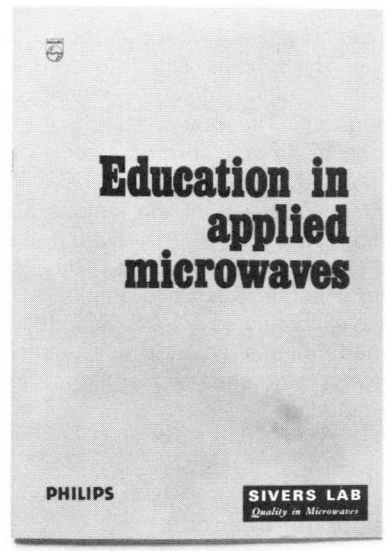
COAXIAL SWITCHES

PM 7555–7557.

DC-18GHz frequency coverage
transfer and SPDT
SMA and N-type connectors
latching and failsafe

Microwave education





A series of experimental booklets is available in five languages – English, French, German, Spanish and Swedish. Detailed descriptions of how to perform the various experiments given in such a way that even an inexperienced student will understand without difficulty ('step by step-procedure'). The theoretical background is treated briefly almost without any mathematics. References to move theoretical books are given.

Our complete range of microwave education containing, the booklets, the educational benches, all the instruments and components are described in the comprehensive brochure 'Education in applied microwaves'.

Basic Experiments I
1. Study of a reflex klystron
2. Frequency, wavelength and attenuation measurements
3. SWR measurements
4. Impedance measurements. The Smith Chart
5. Antenna measurements

Basic Experiments II
1. Study of a Gunn-oscillator
2. Power measurements
3. The directional coupler
4. Matching with the sliding screw tuner
5. Crystal detectors

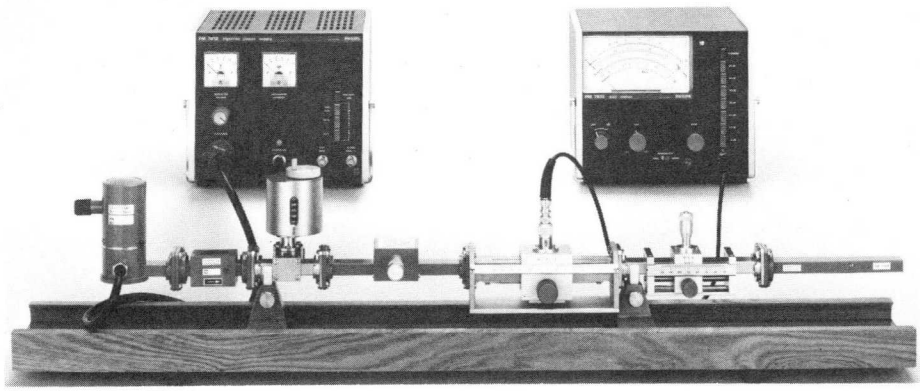
Basic Experiments III
1. Swept frequency measurements
2. Nonreciprocal ferrites
3. The YIG-filter
4. The Doppler effect

Basic Experiments IV
1. Study of a waveguide hybrid-T
2. Frequency conversion
3. A simple frequency-modulated microwave link
4. Injection phase locking of a microwave oscillator

Equipment
The instruments and components needed to perform the experiments have been grouped as follows:

Basic Experiments I: Bench PM 7000X
Basic Experiments II : Bench PM 7001X
Basic Experiments III: Bench PM 7002X
Basic Experiments IV: Bench PM 7003X

The benches are composed of standard items widely used by research, developments and service people all over the world. This means that the students are trained on modern equipment and achieve a good feeling for the practical aspects of microwaves.



Basic Experiments I
Microwave bench PM 7000X

This is the first bench in our series of comprehensive set-ups for microwave education.

The bench, called PM 7000X, uses a low power klystron as signal source and standard high quality components throughout. The power supply for the klyston has a built-in modulator section with either sine- or square-wave. The frequency meter is of the famous direct reading type PM 7070X with a direct reading accuracy of ±0.1%. The SWR-meter used, is a sensitive amplifier/voltmeter calibrated in VSWR and dB. For the performing of antenna measurements, a rotary joint and two antenna horns are included.

Components list PM 7000X

1 Klystron oscillator	PM 7011X
1 Ferrite isolator	PM 7045X
1 Frequency meter	PM 7070X/bg
1 Variable attenuator	PM 7110X
1 Standing wave detector	PM 7142X
1 Slide screw tuner	PM 7151X
1 Detector	PM 7195X
1 Movable short	PM 7216X
1 Termination	PM 7220X
2 Horn antenna	PM 7320X/01
2 Waveguide bend	PM 7345X
1 Straight waveguide section	PM 7366X
2 Waveguide carrier	PM 7700
2 Waveguide clamp	PM 7701X
1 Klystron power supply	PM 7815
1 SWR-meter	PM 7832
1 Rotary joint	PM 7888X
1 Oak bench	SL 80300
1 Laboratory stand	SL 80364

Additional equipment required (not included in PM 7000X)

1 Oscilloscope single-trace e.g.	PM 3225

Basic Experiments II
Microwave bench PM 7001X

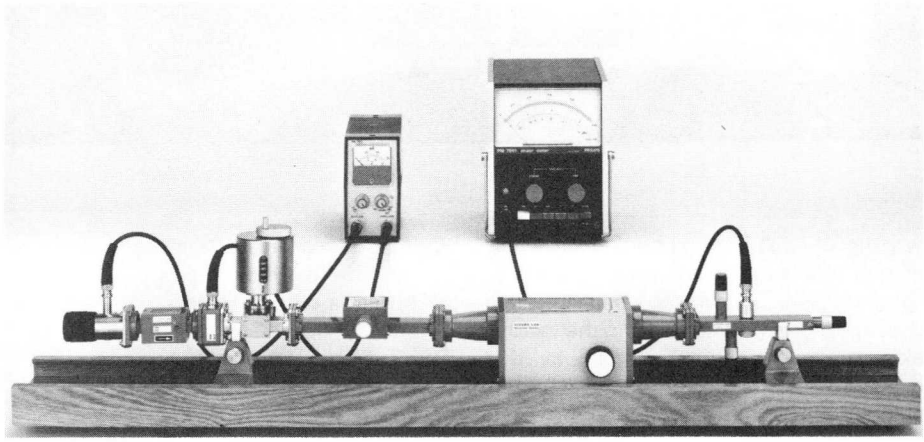
This second bench, PM 7001X, uses a Gunn-oscillator, a solid state replacement of the klystron. The Gunn-oscillator, PM 7015X consists of a semiconductor diode in a high Q waveguide cavity, which is mechanically tunable over a wide frequency range. To achieve the best modulated signal from the Gunn-oscillator, it is used together with a separate diode modulator. Both are, however, supplied from the same power supply/modulator PM 7813.

The photo also shows the direct reading frequency meter and the directional coupler together with the rotary vane attenuator PM 7101X. This high precision attenuator has an easy readable scale 0–60dB.

For accurate power measurements a thermistor mount and a power bridge are included.

Experiments

1. Study of a Gunn-oscillator
2. Power measurements
3. The directional coupler
4. Matching with the slide screw tuner
5. Crystal detectors

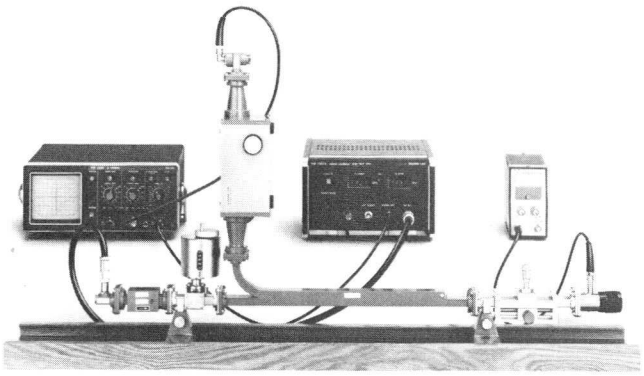


Components list PM 7001X

1 Gunn oscillator	PM 7015X
1 Modulator	PM 7026X/01
1 Ferrite isolator	PM 7045X
1 Frequency meter	PM 7070X/bg
1 Rotary vane attenuator	PM 7101X
1 Variable attenuator	PM 7110X
1 Slide screw tuner	PM 7151X
1 Detector	PM 7195X
1 Thermistor mount	PM 7201X
1 Movable short	PM 7216X
1 Termination	PM 7220X
1 Directional coupler 10dB	PM 7241X
2 Waveguide carrier	PM 7700
2 Waveguide clamp	PM 7701X
1 Gunn oscillator power supply	PM 7813
1 SWR-meter	PM 7832
1 Power meter	PM 7841
2 Adapter BNC-Banana	PM 9051
1 T-piece BNC	PM 9067
1 Oak bench	SL 80300

Additional equipment required (not included in PM 7001X)

1 DC-voltmeter e.g.	PM 2412
1 DC-mA meter e.g.	PM 2412
1 Oscilloscope single-trace e.g.	PM 3225



Basic Experiments III

This is slightly different from the two previous experiments. Swept frequency measurements using a sweep generator PM 7022X from the subject of the first chapter, which concerns measurement of insertion loss and return loss on both active and passive devices.
Nonreciprocal ferrite devices (isolator, circulator) are presented in the second chapter, and the third investigates the YIG-tuned filter. This device is being swept in the frequency domain by sweeping the tuning current. Most typical features are covered.
Finally, a simple Doppler radar set-up is discussed.

Experiments

1. Swept frequency measurements.
2. Non reciprocal ferrite devices.
3. The YIG-filter
4. A study of the doppler effect.

Basic Experiments III is based on the same instruments as Basic Exp. I and II, with the following additions:

Sweep oscillator PM 7022X

A YIG-tuned Gunn-oscillator which can be swept between any two frequencies within the range 8–12.4GHz. The output power is > 10mW.

YIG-filter unit PM 7440/01

This is a X-band bandpass YIG-filter combined with the necessary driving and tuning circuits. The frequency can be tuned manually and the frequency read on a scale.

Circulator PM 7050X

The three-port circulator transmits a wave only in one direction. A wave incident of port 1 is only coupled to port 2 and so on.

Components list 7002X

1 Gunn oscillator	PM 7015X
1 Sweep oscillator	PM 7022X
1 Modulator	PM 7026X/01
1 Ferrite isolator	PM 7045X
1 Ferrite circulator	PM 7050X
1 Frequency meter	PM 7070X/bg
1 Rotary vane attenuator	PM 7101X
1 Variable attenuator	PM 7110X
1 Slide screw tuner	PM 7151X
1 Detector	PM 7195X
1 Movable short	PM 7216X
1 Termination	PM 7220X
1 Directional coupler 10dB	PM 7241X
1 Horn antenna	PM 7320X/01
1 Transition wg/coax.	PM 7325X
2 Transition wg/coax.	PM 7328X
2 Waveguide carrier	PM 7700
2 Waveguide clamp	PM 7701X
1 Waveguide clamp	PM 7702X
1 YIG-filter unit	PM 7440/01
1 Gunn oscillator power supply	PM 7815
1 SWR-meter	PM 7832
1 Oak bench	SL 80300

Additional equipment required (not included in PM 7002X)

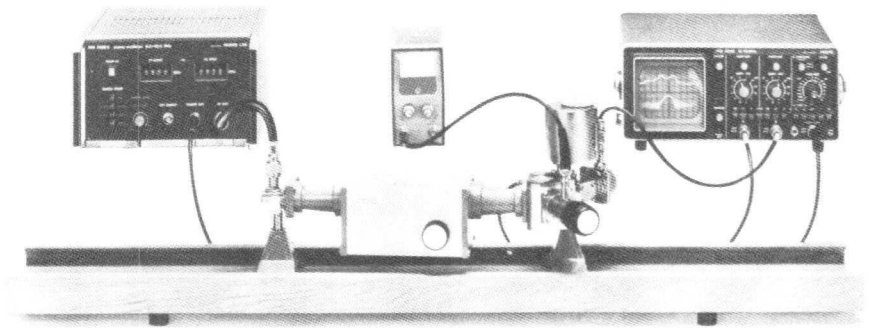
1 Oscilloscope e.g.	PM 3225
1 DC power supply e.g.	PE 1536

Basic Experiments IV

This set-up is directed towards applied microwave measurements. The first chapter covers the operation and characteristics of a hybrid-T, the microwave analogy of the low frequency balanced bridge. Frequency mixing in a microwave diode is the next subject. Here, the frequency from the sweep oscillator PM 7022X is mixed with the Gunn oscillator PM 7015X frequency in the detector PM 7197X.
A simple experiment of frequency modulation/demodulation is presented using PM 7022X as a source and the frequency meter PM 7070X/ag as a detector. The last experiment reveals the fundamentals around frequency injection locking. A Gunn oscillator PM 7015X is locked and locking bandwidth verses injected power is determined.
Basic Experiments IV is based on the equipment used in Basic Exp. 1-3 with a few additions.

Experiments

1. Study of a waveguide hybrid-T.
2. Frequency conversion.
3. A simple frequency-modulated microwave link.
4. Injection locking a microwave oscillator.



Components list PM 7003X

1 Gunn oscillator	PM 7015X
1 Varactor tuned oscillator	PM 7017X
1 Sweet oscillator	PM 7022X
1 Modulator	PM 7026X/01
1 Ferrite isolator	PM 7045X
1 Ferrite circulator	PM 7050X
1 Frequency meter	PM 7070X/bg
1 Rotary vane attenuator	PM 7101X
1 Variable attenuator	PM 7110X
1 Detector	PM 7197X
1 Movable short	PM 7216X
2 Termination	PM 7220X
1 Directional coupler 10dB	PM 7241X
1 Hybrid-T	PM 7260X
2 Horn antenna	PM 7320X/01
1 Transition wg/coax.	PM 7325X
2 Waveguide carrier	PM 7700
2 Waveguide clamp	PM 7701X
2 Waveguide clamp	PM 7702X
1 Gunn oscillator power supply	PM 7815
1 SWR-meter	PM 7832
1 T-piece BNC	PM 9067
1 Cable termination	PM 9585
1 Function generator	PM 9710
1 Oak bench	SL 80300

Additional equipment needed (not included in the PM 7003X)

1 Oscilloscope dual trace e.g.	PM 3226

Sweep oscillator 8.0–12.4GHz PM 7022X

Compact design

Compatible with network analysing equipment

Slow single sweep for recording purposes

Easy to operate

Light weight (7 kg)

Swept frequency measurements at low cost but still with highest accuracy is what the new sweep oscillator PM 7022X is designed for. Only necessary functions have been included in order to keep the cost down. The result is a compact, reliable instrument, easy to operate giving a min. output power of 10mW over the whole frequency range. It has variable sweep speeds for use with both oscilloscopes and pen recorders.

TECHNICAL SPECIFICATION

FREQUENCY

Frequency range
8.0–12.4GHz

Frequency accuracy (25°C)
CW-mode F_1: ±40MHz
Sweep linearity: ±1% of sweep width

Frequency stability
−10°C to +45°C total: 100MHz
10% mains voltage variation: 1MHz
Residual FM (CW-mode): 15kHz peak at 10kHz BW
With load VSWR 3 :1, all phases: 1MHz

GENERAL

CW
Sweep from F_1 to F_2 as set in 10MHz increments with the two thumbwheel settings. These are calibrated and independent. The sweep can be either up or down in frequency.

CW manual scan
Single frequency output
The frequency can be set anywhere between F_1 and F_2 by MANUAL SCAN knob.

Fast auto
Recurrent sweep
Continuously variable sweep speed from 20ms to 200ms

Slow single
Single sweep triggered by TRIGG button. Continuously variable from 5 seconds to 50 seconds.

External sweep
When the CW-button is pressed (MANUAL SCAN set to F_1) the frequency can be swept externally with a sweep voltage applied to EXT SWEEP connector. Zero volts for F_1 and +10 volts for F_2. Input impedance 1 kohm.

Sweep out
Zero volts corresponds to F_1 and +10 volts corresponds to F_2. The output voltage is proportional to the instant output frequency (Also operating in the CW-mode.)

Display blanking
One positive and one negative output each giving a pulse of 5 volts coincident in time with sweep retrace.

Pen lift
NO: Contact normally open
NC: Contact normally closed

RF blanking
ON: The RF turns off automatically during sweep retrace and remains off until next sweep starts.
OFF: The RF is on also during retrace. The sweep and retrace times are equal.

Reference sweep out
Direct coupled voltage proportional to instantaneous frequency
Zero volts at 8.0GHz and +5 volts at 12.4GHz
Compatible with Hewlett Packard Network Analyzer HP 84105

CW filter
To give low incidental PM
(CW operation only)

Dimensions and weight
Dimensions: 235 × 130 × 265mm excl. handles
(9.3 × 5.1 × 10.5-in)
Weight: 7kg (15.4lb)

Power
Line voltages: 110-127-220-240V ±10%, 50–60Hz
Consumption: 50VA
Min. output: 10mW
Power variation, max.: 6dB
Spurious signals:
Harmonics: −30dB
Nonharmonics: −50dB

DC power supplies and AC voltage stabilizers

Introduction

The question is often posed – to purchase power supplies or to manufacture in-house? The decision to manufacture involves many, major problems. Capital investment, a specialist design and development facility, a comprehensive testing capability, factory space, personnel recruitment. Thereafter, duplication of time, effort, finance, in meeting the inevitable problems that have already been overcome by true specialists. Specialists who have painstakingly evolved wide product range, readily available and at an economic price, from which the would-be manufacturer's requirements can easily be met. Philips, by investing considerable capital, involving suitably skilled personnel and by producing very large product volumes can offer power supplies and voltage stabilizers at attractive prices, from a few to thousands per order.

All products embody the latest design concepts, utilize state-of-the-art technologies and exhibit extremely high levels of reliability, each design having been subjected to exhaustive life testing throughout all stages of development.

It certainly pays to purchase, rather than make; it *really* pays to buy *Philips*.

Plenty of choice

The total range, which offers outputs from 10 to 1250 Watts, utilizes various techniques, like series regulation, ferroresonant, thyristor control and high frequency switched-mode designs. These are available in different standard physical packages, including bench types, modular, OEM versions, special economy models and Eurocard plug-ins.

Extended ranges plus DC/DC converters

This year sees the further extension of new designs introduced last year to give a comprehensive selection of power outputs. In addition, a new range of DC/DC converters is added to the already very large selection. The state-of-the-art techniques employed to further improve conversion efficiency ensure that these models give better than ever outputs related to size and represent excellent price/performance ratios.

Modular units are available in Philips standard dimensions 19-in rackmounts and in DIN 41494 systems (series-regulated *and* switched-mode types). In situations where very specialized power requirements cannot be met from the standard range of products (e.g. OEM applications) Philips will undertake the design and manufacture of 'tailor-made' power supplies.

The total standard range power supply programme is tabulated on the opposite page for quick reference. Detailed specifications will be found on the following pages along with information on DC/DC converters and 'tailor-made' units.

Bench types

Power supplies for bench use comprise a series of stand-alone units, giving outputs from 20 to 120W at varying voltage and current levels. Single-, dual- and triple-output models are available.

Lab/Systems types

The modern lab/systems power supply is far more than a mere provider of volts and amps, being a precision instrument, the outputs of which can be easily set and read. It is also an instrument that can function in either constant voltage or constant current modes. When higher outputs are needed, the units can operate in series or parallel. Most models can also be provided with optional, adjustable overvoltage protection to protect both the power supply and the powered circuitry. Again, this section of the power supply programme includes units grouped into 500W or 1000W output levels.

Modular Power supplies

Here too Philips offer a very comprehensive and sophisticated program of some 50 basic units. In addition there are many options in both the mechanical and electrical specifications, thereby meeting individual needs in the most economic manner possible.

Units are available using the conventional series-regulated technique as well as the high-efficiency switched mode method. Both types of units are ideal for a very wide range of applications. For example, their mechanical flexibility enables the units to be mounted direct into equipment, into Philips standard 19-in rack mounted systems, DIN 41494 racks or into special one-off systems, such as those often developed for production test applications. Of particular interest for this area is the facility of remote programming, using either external resistive or analog/digital voltage sources, or a digital signal.

Eurocard power supplies

This series of plug-in 100 × 160mm power supplies mounted on standard pcb's offers four different versions giving outputs of 5V, 12V, 24V and ±15V.

The cards can be easily adapted for use with most frontplates and can be purchased with either 32- or 31-pole connectors, as required.

AC stabilizers

Again Philips offers a choice of techniques to match the individual requirement, electronic/magnetic and magnetic-only. The choice depends on the degree of stability required and the type of load involved. Magnetic stabilizers offer a 1% line stability and excellent transient suppression. Their compact dimensions also allow them to be mounted direct into many types of equipment.

Electronic/magnetic stabilizers are obviously more sophisticated, offering a high 0.1% stability combined with good transient suppression. The combination of stability and suppression can also be tailored to the individual application. Unlike the magnetic approach, this technique is not frequency dependent and can also handle inductive loads. So, whatever the problem, and whatever the degree of stability needed, Philips can provide a total solution.

		MODULAR POWER SUPPLIES					
Bench Models	**Lab/system types**	**Series-regulated types (Philips 19-in rackmount)**	**Economy series**	**Switched-mode types (Philips 19-in rackmount)**	**Eurocards**	**AC Stabilizers (electronic/magnetic)**	**AC Stabilizers (magnetic)**
20V/2A PE 1536 20V/6A PE 1539 40V/0.5A PE 1535 40V/1A PE 1537 40V/3A PE 1540 75V/0.5A PE 1538 75V/2A PE 1541 20V/1A } PE 1542 20V/1A } 7V/3A }	20V/20A PE 1642 20V/45A PE 1643 40V/10A PE 1644 40V/25A PE 1645 75V/ 6A PE 1646 75V/14A PE 1647 125V/10A } PE 1213 250V/ 5A } 150V/ 3A PE 1648 150V/ 7A PE 1649 3.500V/10mA PE 1534	5V/0.85A PE 1216 5V/ 4A PE 1220 5V/ 7.5A PE 1221 5V/ 16A PE 1222 5V/ 30A PE 1223 12V/ 0.3A PE 1216 12V/0.45A PE 1217 12V/ 2.5A PE 1224 12V/ 5.5A PE 1225 12V/ 11A PE 1226 12V/ 20A PE 1227 24V/ 0.3A PE 1217 24V/ 1.8A PE 1228 24V/ 3.3A PE 1229 24V/ 6.5A PE 1230 24V/12.5A PE 1231 30V/ 2.4A PE 1233 30V/ 5.2A PE 1234 30V/ 11A PE 1235 48V/ 1.2A PE 1236 48V/ 1.8A PE 1237 48V/ 4A PE 1238 48V/ 7.6A PE 1239 Dual ±15V/ 2A PE 1232 Current at 55°C	5V/2.7A PE 1250 5V/4.5A PE 1253 12V/2A PE 1251 12V/2.6A PE 1254 24V/1.4A PE 1252 24V/ 2A PE 1255 Current at 55°C	5V/ 20A PE 1240 5V/ 65A PE 1241 5V/130A PE 1242 12V/ 9A PE 1243 12V/ 26A PE 1244 12V/ 55A PE 1245 24V/ 4.5A PE 1246 24V/ 16A PE 1247 24V/ 30A PE 1248 Current at 50°C	5V/2A PE 1271 12V/2A PE 1272 24V/1.1A PE 1273 ±15V/1.1A PE 1274 Current at 55°C	1kVA PE 1610 2kVA PE 1611 4kVA PE 1612 10kVA PE 1604/50	100VA PE 1400 200VA PE 1401 400VA PE 1402 850VA PE 1403 1500VA PE 1404
					Page 245		
		Series-regulated types (DIN 41494 dimensions)		**Switched-mode types (DIN 41494 dimensions)**	**DC/DC converters**		
		5V/4.2A PE 1257 12V/2.4A PE 1260 24V/1.4A PE 1263 ±12V/1.2A PE 1266 Current at 55°C		5V/ 6A PE 1267 5V/ 18A PE 1258 5V/ 40A PE 1259 12V/ 3A PE 1268 12V/ 8A PE 1261 12V/ 18A PE 1262 24V/1.6A PE 1269 24V/ 5A PE 1264 24V/ 11A PE 1265 Current at 55°C	5V/6A PE 1100 12V/3A PE 1101		
Page 230	**Page 232 and 234**	**Page 239**	**Page 246**	**Page 242**	**Page 255**	**Page 250**	**Page 253**

Power supplies for bench use

Excellent stability
Adjustable constant voltage/current
Series/parallel operation
MTBF 75000 operating hours
Advanced styling

This range of power supplies for bench use comprises a series of stand-alone units giving outputs from 20 to 120W at varying voltage and current levels. They will be of interest to laboratory personnel, educational establishments and service organisations. The design incorporates the most modern concepts of universal power supply equipment to achieve high conversion efficiency and exceptional price/performance ratios.

Reliability
Long-term reliability is assured by careful selection of components and materials and units are subjected to full mechanical, climatic and safety tests to IEC 68 and IEC 348. AC line interference conforms to VDE 0875, N-12 curve. The predicted MTBF is 75000 operating hours for max. load, stationary use, environmental temperatures between 0 and 40°C.

Output power ratings vary from 20W to 120W, depending on the model. A performance table for the range appears on the opposite page. The current programme has been extended, to further improve the performance spectrum of this present range of bench power supplies.

PERFORMANCE TABLE FOR BENCH UNITS

	PE 1535	PE 1536	PE 1537	PE 1538	PE 1539	PE 1540	PE 1541	PE 1542 I	PE 1542 II	PE 1542 III
CONSTANT VOLTAGE OPERATION										
Output voltage ranges Continuously adjustable (V)	**0...40**	**0...20**	**0...40**	**0...75**	**0...20**	**0...40**	**0...75**	**0...7**	**0...20**	**0...20**
Stability against line variations With ±10% line variations max. change of output voltage incl. short term drift	⩽ 0.05% or 4mV*	⩽ 0.01% or 1mV*	⩽ 0.01% or 2mV*	⩽ 0.01% or 4mV*	⩽ 0.01% or 1mV*	⩽ 0.01% or 2mV*	⩽ 0.01% or 4mV*	⩽ 0.05% or 1mV*	⩽ 0.05% or 2mV*	⩽ 0.05% or 2mV*
Recovery time For a sudden increase from 80% load to max. load or for a corresponding decrement (µs)	⩽ 10	⩽ 25	⩽ 25	⩽ 25	⩽ 50	⩽ 50	⩽ 50	⩽ 50	⩽ 50	⩽ 50
Ripple voltage (mV_{RMS})	⩽ 1.5	⩽ 1	⩽ 1	⩽ 1	⩽ 1	⩽ 1	⩽ 1	⩽ 0.5	⩽ 1	⩽ 1
Temperature coefficient (0...40°C) (%/°C)	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02
CONSTANT CURRENT OPERATION										
Output current ranges Continuously adjustable (A)	**0...05**	**0...2**	**0...1**	**0...0.5**	**0...6**	**0...3**	**0...1.6**	**0...3**	**0...1**	**0...1**
Stability against line variations With ±10% line voltage variations max. change of output current incl. short term drift	⩽ 0.05% or 0.5mA*	⩽ 0.05% or 0.4mA*	⩽ 0.05% or 0.2mA*	⩽ 0.05% or 0.1mA*	⩽ 0.05% or 1mA*	⩽ 0.05% or 0.5mA*	⩽ 0.05% or 0.3mA*	⩽ 0.5% or 3mA*	⩽ 0.5% or 1mA*	⩽ 0.5% or 1mA*
Stability against load variations With load variations of 0...100% max. change of output current (MA)	⩽ 4	⩽ 3	⩽ 3	⩽ 3	⩽ 3	⩽ 4	⩽ 4	⩽ 4	⩽ 4	⩽ 4
Ripple current (mA_{RMS})	⩽ 1	⩽ 2	⩽ 1	⩽ 1	⩽ 2	⩽ 1	⩽ 1	⩽ 1.5	⩽ 0.5	⩽ 0.5
Temperature coefficient (0...40°C) (mA/°C)	⩽ 0.05	⩽ 0.2	⩽ 0.1	⩽ 0.05	⩽ 0.6	⩽ 0.3	⩽ 0.15	⩽ 3	⩽ 0.1	⩽ 0.1
GENERAL										
Parallel and series connection	●	●	●	●	●	●	●		●	
Remote programming/sensing	—	—	—	—	●	●	●		●	
Master/slave operation	—	—	—	—	●	●	●		●	
Ambient temperature (max)	40°C	40°C	40°C	40°C	40°C	40°C	40°C		40°C	
Line supply	110; 127; 220; 240V 50/60Hz	110; 127; 220; 240V 50/60Hz	110; 127; 220; 240V 50/60Hz	110; 127; 220; 240V 50/60Hz	110; 127; 220; 240V 50/60Hz	110; 127; 220; 240V 50/60Hz	110; 127; 220; 240V 50/60Hz		110; 127; 220; 240V 50/60Hz	
Dimensions (w × h × d) (mm)	88 × 133 × 210	210 × 153 × 265	210 × 153 × 265	210 × 153 × 271	210 × 153 × 271	210 × 153 × 271	210 × 153 × 271		210 × 153 × 271	
(-in)	3.5 × 5.2 × 8.3	8.3 × 6 × 10.4	8.3 × 6 × 10.4	8.3 × 6 × 10.7	8.3 × 6 × 10.7	8.3 × 6 × 10.7	8.3 × 6 × 10.7		8.3 × 6 × 10.7	
Weight (kg)	2	5.1	5.1	7.8	7.8	7.8	7.8		6.5	
(lb)	4.4	11.2	11.2	17.2	17.2	17.2	17.2		14.3	

* whichever is the greater

Adjustable constant voltage/current operation with automatic crossover and visual LED indication

Systems facilities: remote control, sensing, master/slave, etc.

Separate volt- and ammeters

Built-in over-voltage protection

19-in rack or cabinet mounting

MTBF of 50 000 operating hours

500 watt lab/system series

These 500W power supplies use the thyristor, pre-regulation technique plus a novel and unique design feature that increases efficiency and reliability and at the same time reduces cost. They are ideal for both laboratory and OEM applications, having comprehensive systems facilities.
Separate volt- and ammeters, coarse and fine potentiometers, bright LED displays for mode indication and automatic indication of crossover also make the units simple and convenient to use.
The comprehensive over-voltage and overload protection is standard.
When operated, a 'DC failure' LED display is illuminated.

Systems facilities
Simple jumper connections are made at the rear of the units to provide the required systems facilities.
These cover remote sensing, operation in series or parallel, master/slave operation plus remote programming of both voltage and current outputs.

High efficiency
The units employ the standard antisurge choke on the **primary** side of the mains transformer and not in the conventional secondary position. This way the mains supply makes up the losses directly, instead of having them compounded via the transformer. The overall result is a lighter, more compact design with greater reliability and a lower price.

Ultra reliable
The high MTBF figure of 50000 operating hours is the result of many factors: *experience*, Philips being the leading European power supply manufacturer; *research*, into components and connection techniques, which in turn is backed by extensive quality control facilities and finally, *conservative, worst-case designs*, which ensure that under normal operating conditions there is considerable reserve in a Philips specification, as shown in Fig. 1.

Stable outputs
All units feature very stable outputs with high resolution and low ripple. They can work on a variety of line supplies and can cope with mains variations of up to 10%.

GENERAL SPECIFICATION

Input voltage
Suitable for mains voltages 110–127–220–240V/ 50...60Hz. The units are delivered pre-connected for 220V.

Ambient temperature
The ambient temperature is allowed to have any value between 0...40°C.

Polarity
The output terminals are insulated from the chassis; either the positive or the negative terminal may be earthed. The electrical data are valid with earthed output.

Protection
The units are protected against overvoltage by an adjustable o.v.p. which interrupts the drive of the power transistors. The units are also protected against overload and short circuits.

Indication
LEDs indicate whether the units are used as a constant voltage or as a constant current source and also if the output voltage exceeds the preset overvoltage level.

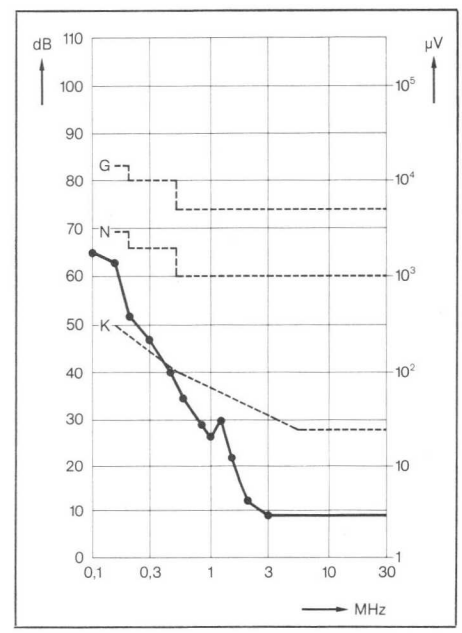


Fig. 1. Graph illustrates how for the great majority of the frequency spectrum the unit meets VDE 0875, curve K for mains interference, even through it is conservatively specified as meeting curve N.

Efficiency
62% PE 1642
73% PE 1644
81% PE 1646
81% PE 1648
} at nominal mains voltage and max. output power

Remote voltage/current control
The output voltage/current can be programmed (remotely adjusted) with a resistance or by a voltage source

Remote sensing
Separate sensing terminals at the rear enable specified voltage regulation to be maintained directly at the load by compensating for voltage drops across the load

Quality
The units are mechanical, climatic and safety tested referred to IEC 68 and IEC 348 (Class I). The predicted MTBF is 50000 operating hours for maximum load and stationary use

Inrush current
40A at 220V mains voltage
Duration 10ms valid for all units.

Parallel connection
Two or more power supply units can be connected in parallel.

Series connection
Two or more units can be connected in series.

Master/slave operation
One unit (master) can control the connected units (slaves) when more units are used in series or parallel connection. The terminal block at the rear of the unit eliminates the need to rewire internally for this function.

Design
The units have been designed for use as table model as well as for 19-in rack mounting.

Meters
The units are equipped with *separate* volt- and amp. meter.

Mains interference
Conforming VDE 0875 N-level

Dimensions and weight
For all units
(w × h × d) 482 × 132 × 315mm
(19 × 5.1 × 12.4-in)
21kg (46lb)

TECHNICAL SPECIFICATIONS

The specifications for stability against mains and load variations include thermal setting drift effects.

	PE 1642	PE 1644	PE 1646	PE 1648
AS A CONSTANT VOLTAGE SOURCE				
Output voltage Continuously adjusted with coarse and fine potentiometer	**0–20V**	**0–40V**	**0–75V**	**0–150V**
Resolution	0.5mV	1mV	2	4
Stability against mains variations With mains voltage variations of + or −10% the max. change of the output voltage is:	⩽0.02%* or 1mV	⩽0.02%* or 1mV	⩽0.013%* or 2mV	⩽0.013%* or 2mV
Stability against load variations With load variations of 0...100% the max. change of the output voltage is:	⩽20mV	⩽20mV	⩽25mV	⩽30mV
Internal resistance dynamic For sinusoidal load variations from 80% to 100% of full load at frequencies up to 250kHz the unit will have the following internal resistance values				
1kHz	0.01Ω	0.02Ω	0.02Ω	0.02Ω
10kHz	0.04Ω	0.06Ω	0.1 Ω	0.1 Ω
100kHz	0.1 Ω	0.1 Ω	0.1 Ω	0.1 Ω
250kHz	0.2 Ω	0.2 Ω	0.2 Ω	0.2 Ω
Ripple voltage The ripple voltage will be This is valid for any input voltage between 90% and 110% of nominal and for any load between no load and full load	⩽1mV$_{RMS}$	⩽1mV$_{RMS}$	⩽1mV$_{RMS}$	⩽1mV$_{RMS}$
Temperature coefficient The temperature coefficient for any ambient temperature variation in a range of 0–40°C will be	⩽0.01%/°C* or 0.2mV/°C	⩽0.005%/°C* or 0.2mV/°C	⩽0.005%/°C* or 0.5mV/°C	⩽0.005%/°C* or 1.5mV/°C
Recovery time For a sudden increase from 50% load to maximum load or for a corresponding decrement, the recovery time is:	⩽25μs	⩽50μs	⩽50μs	⩽50μs
AS A CONSTANT CURRENT SOURCE				
Output current The output current is continuously adjustable in one range by means of a coarse and a fine potentiometer between	**0–20A**	**0–10A**	**0–6A**	**0–3A**
Resolution	10mA	5mA	3mA	1.5mA
Stability against mains variations With mains voltage variations of + or −10% the max. change of the output current is:	⩽0.03%* or 6mA	⩽0.03%* or 3mA	⩽0.04%* or 2.5mA	⩽0.03%* or 1mA
Stability against load variations With load variations of 0...100% the max. change of the output current is	⩽5mA	⩽3mA	⩽4mA	⩽3mA
Ripple current In all circumstances the ripple current will be	⩽10mA$_{RMS}$	⩽5mA$_{RMS}$	⩽5mA$_{RMS}$	⩽3mA$_{RMS}$
Temperature coefficient With temperature variations in the range of 0...40°C the temperature coefficient of the output current is:	⩽2mA/°C	⩽1mA/°C	⩽0.5mA/°C	⩽0.3mA/°C

* which ever is the greater

Adjustable constant voltage/current operation with automatic crossover and visual LED indication

Systems facilities: remote control, sensing, master/slave, etc.

Separate volt- and ammeters

Built-in over-voltage protection

19-in rack or cabinet mounting

MTBF of 50 000 operating hours

1000 watt lab/systems series

These 1000W power supplies are a higher output power version of the 500W series. They use the same thyristor, pre-regulation technique plus a novel and unique design feature that intereases efficiency and reliability and at the same time reduces cost. They are ideal for both laboratory and OEM applications, having comprehensive systems facilities.
Separate volt- and ammeters, coarse and fine potentiometers, bright LED displays for mode indication and automatic indication of crossover also make the units simple and convenient to use.
The comprehensive over-voltage and overload protection is standard.
When operated, a 'DC failure' LED display is illuminated.

Systems facilities

Simple jumper connections are made at the rear of the units to provide the required systems facilities.
These cover remote sensing, operation in series or parallel, master/slave operation plus remote programming of both voltage and current outputs.

High efficiency

All units employ the standard antisurge choke on the **primary** side of the mains transformer and not in the conventional secondary position. This way the mains supply makes up the losses directly, instead of having them compounded via the transformer. The overall result is a lighter, more compact design with greater reliability and a lower price.

Ultra reliable

The high MTBF figure of 50000 operating hours is the result of many factors: *experience*, Philips being the leading European power supply manufacturer; *research*, into components and connection techniques, which in turn is backed by extensive quality control facilities and finally, *conservative, worst-case designs*, which ensure that under normal operating conditions there is considerable reserve in a Philips specification.

Stable outputs

All units feature very stable outputs with high resolution and low ripple. They can work on a variety of line supplies and can cope with mains variations of up to 10%.

GENERAL SPECIFICATION

Input voltage

Suitable for mains voltages 110–220–240V/ 50...60Hz. The units are delivered pre-connected for 220V.

Ambient temperature

The ambient temperature is allowed to have any value between 0...40°C.

Polarity

The output terminals are insulated from the chassis; either the positive or the negative terminal may be earthed. The electrical data are valid with earthed output.

Protection

The units are protected against overvoltage by an adjustable o.v.p. which interrupts the drive of the power transistors. The units are also protected against overload and short circuits.

Indication

LEDs indicate whether the units are used as a constant voltage or as a constant current source and also if the output voltage exceeds the preset overvoltage level.

Remote voltage/current control

The output voltage/current can be programmed (remotely adjusted) with a resistance or by a voltage source

Remote sensing

Separate sensing terminals at the rear enable specified voltage regulation to be maintained directly at the load by compensating for voltage drops across the load

Quality

The units are mechanical, climatic and safety tested referred to IEC 68 and IEC 348 (Class I). The predicted MTBF is 50000 operating hours for maximum load and stationary use

Parallel connection
Two or more power supply units can be connected in parallel.

Series connection
Two or more units can be connected in series.

Master/slave operation
One unit (master) can control the connected units (slaves) when more units are used in series or parallel connection. The terminal block at the rear of the unit eliminates the need to rewire internally for this function.

Design
The units have been designed for use as table model as well as for 19-in rack mounting.

Meters
The units are equipped with separate volt- and amp. meter.

Mains interference
Conforming VDE 0875 N-level

Dimensions and weight
For all units
(w × h × d) 482 × 132 × 477mm
(19 × 5.1 × 12.4-in)
37kg (81.4lb)

TECHNICAL SPECIFICATIONS

The specifications for stability against mains and load variations do include thermal setting drift effects.

	PE 1643	PE 1645	PE 1647	PE 1649
AS A CONSTANT VOLTAGE SOURCE				
Output voltage Continuously adjusted with coarse and fine potentiometer	**0-20V**	**0-40V**	**0-75V**	**0-150V**
Resolution	0.5mV	1mV	2mV	4mV
Stability against mains variations With mains voltage variations of + or −10% the max. change of the output voltage is:	⩽ 0.03%* or 2mV	⩽ 0.03%* or 3mV	⩽ 0.03%* or 4mV	⩽ 0.03%* or 5mV
Stability against load variations With load variations of 0...100% the max. change of the output voltage is:	⩽ 50mV	⩽ 60mV	⩽ 70mV	⩽ 80mV
Ripple voltage The ripple voltage will be... This is valid for any input voltage between 90% and 110% of nominal and for any load between no load and full load	⩽ $1mV_{RMS}$	⩽ $1mV_{RMS}$	⩽ $1mV_{RMS}$	⩽ $1mV_{RMS}$
Temperature coefficient The temperature coefficient for any ambient temperature variation in a range of 0-40°C will be	⩽ 0.01%/°C	⩽ 0.01%/°C	⩽ 0.01%/°C	⩽ 0.01%/°C
Recovery time For a sudden increase from 50% load to maximum load or for a corresponding decrement, the recovery time is:	⩽ 100µs	⩽ 100µs	⩽ 75µs	⩽ 75µs
AS A CONSTANT CURRENT SOURCE				
Output current The output current is continuously adjustable in one range by means of a coarse and a fine potentiometer between	**0-45A**	**0-25A**	**0-14A**	**0-7A**
Resolution	50mA	25mA	14mA	7mA
Stability against mains variations With mains voltage variations of + or −10% the max. change of the output current is:	⩽ 0.03%* or 30mA	⩽ 0.03%* or 10mA	⩽ 0.04%* or 7mA	⩽ 0.03%* or 4mA
Stability against load variations With load variations of 0...100% the max. change of the output current is:	⩽ 30mA	⩽ 15mA	⩽ 15mA	⩽ 10mA
Ripple current In all circumstances the ripple current will be	⩽ $100mA_{RMS}$	⩽ $50mA_{RMS}$	⩽ $50mA_{RMS}$	⩽ $25mA_{RMS}$
Temperature coefficient With temperature variations in the range of 0...40°C the temperature coefficient of the output current is:	⩽ 15mA/°C	⩽ 6mA/°C	⩽ 3mA/°C	⩽ 2mA/°C

* which ever is the greater

High voltage DC supply PE 1534

Output voltage continuously adjustable from 350 to 3500V

Output current limit continuously adjustable from 1 to 10mA

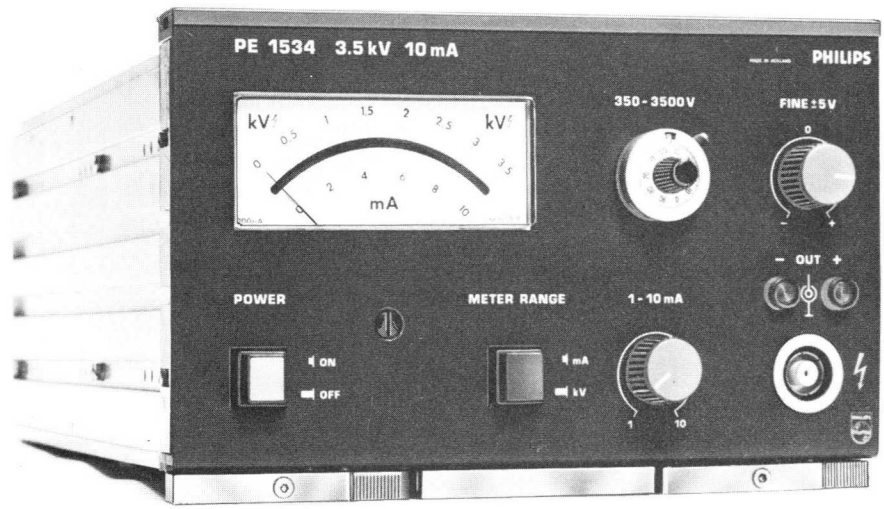
Very stable output with low ripple

Very safe operation

Can be used as a bench supply or for 19-in rack mounting

The PE 1534 low power, high-voltage DC stabilized power supply has been developed for powering photomultipliers, etc., also for high voltage testing requirements. Output is selected by coarse/fine controls (between 350V and 3500V) which achieve a resolution of ±100mV. Output current is limited to protect external circuitry from overload; adjustment between 1mA and 10mA is by a potentiometer. A common volt/ammeter indicates voltage and current settings. Output is fully stabilized and virtually ripple-free.

Safety features include a double back panel with a line-activated mechanical lock and the line and case are fully isolated. The unit is available in bench- or 19-in rackmount styling; in the 19-in version the output socket, normally front-panel mounted, is located at the rear.



TECHNICAL SPECIFICATION

INPUT DATA

Input voltage
110; 128; 220; 238 V_{RMS} ±10%

Input frequency
50Hz

Power consumption
max 150VA

OUTPUT DATA

Output voltage
350–3500V continuously adjustable with a resolution of ±5V.

Output current
Limit continuously adjustable, from 1...10mA.

Polarity
Plus or minus polarity, selectable. Selection indicated by lamps

Line regulation
For mains voltage variations of + or −10%, the output voltage variations are less than 175mV at 3500V (50ppm) and less than 50mV at 350V (143ppm), including short term drift (30s).

Load regulation
For load variations from no load to full load and vice versa the output voltage variations are less than 1000mV at 3500V (0.03%) and less than 1000mV at 350V (0.3%), including short term drift.

Recovery time
Zero, no overshoot

Ripple
Less than $10mV_{RMS}$

Resolution
Better than 100mV

Temperature coefficient
Less than 50ppm/°C throughout the range.

Internal resistance
Static: less than 200Ω at 0–1mA; less than 100Ω at 0–10mA.
Dynamic: less than 100Ω at 1kHz, 10kHz and 2MHz; less than 10Ω at 500kHz. Values apply for load variations from 8 to 10mA.

Short-circuit protection
Current limiting circuit. Max. current at short circuit from 2.5 to 12mA.

Meters
Combined volt/ammeter with switch-selection

Connection
HV coaxial connector on front panel. Can be mounted on back panel.

Multiple operation
Two instruments can be operated in parallel

GENERAL

Temperature range
0–45°C

Safety
Conforming to IEC 348. The instrument can only be opened when the mains supply is disconnected.

Earthing
By mains connector and cable

Mains interference
Conforming to VDE 0875 (N-level)

Quality
Conforming to IEC 68

Dimensions and weight
(w × h × d) 209 × 132 × 401mm
(8.2 × 5.2 × 15.8-in)
8kg (17.6lb)

1250W power

Thyristor phase shifting technique

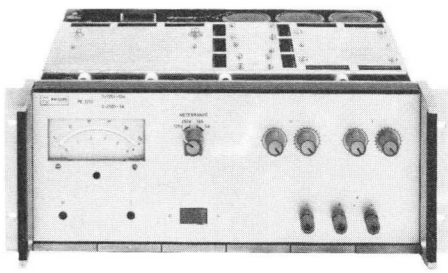
Up to 83% efficiency

Constant voltage or current operation with automatic cross-over

Convection cooling

PE 1213/00: built-in model
PE 1213/10: 19-in model

High power DC supply unit PE 1213



TECHNICAL SPECIFICATION

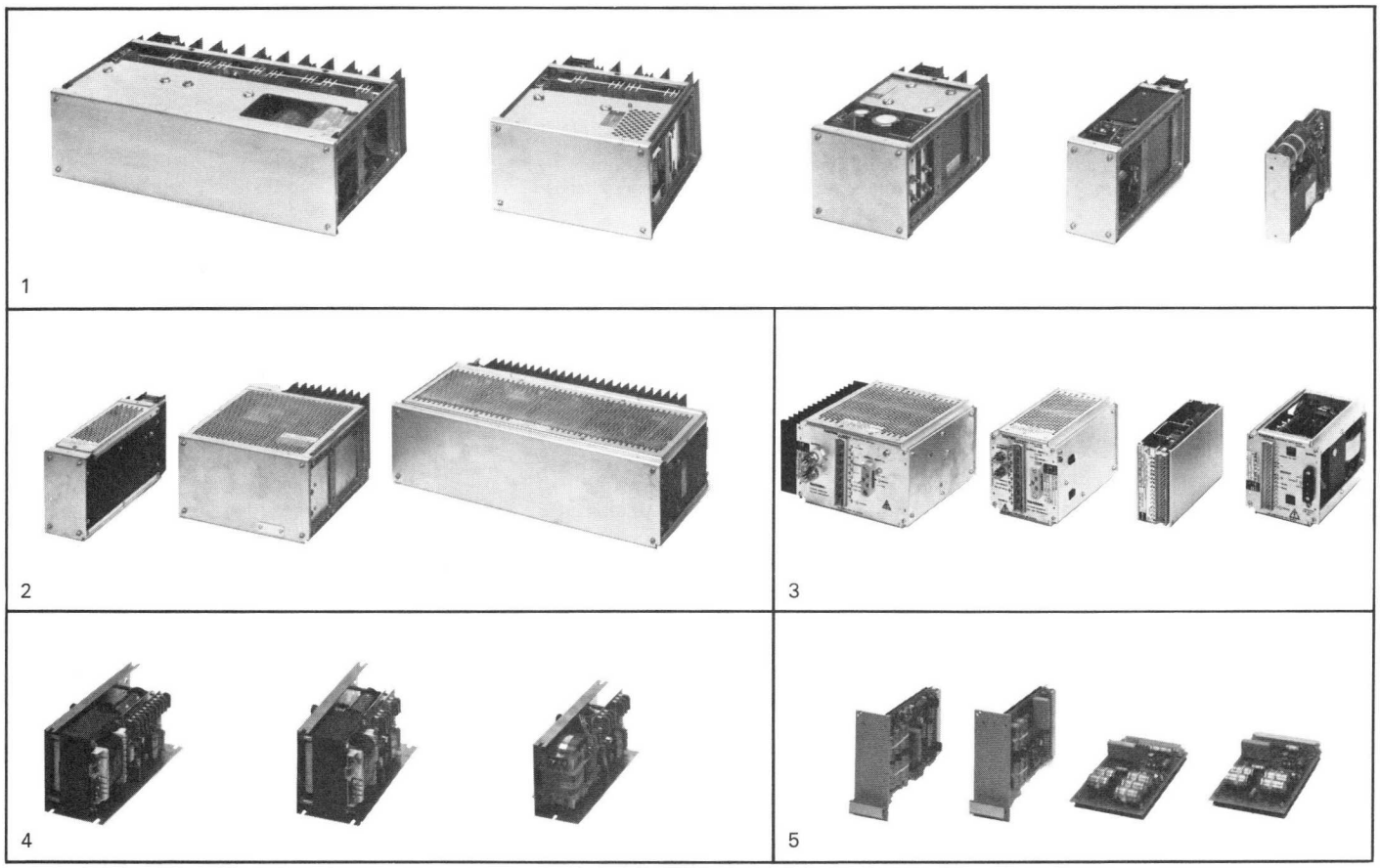
	Range I	Range II
CONSTANT VOLTAGE OPERATION		
Output voltage	0...125V	0...250V
Resolution	< 20mV	< 40mV
Stability against mains variations		
With ±10% mains variations, max. change of output voltage incl. short term drift	⩽0.05% or 5mV*	⩽0.05% or 10mV*
Internal resistance		
Static	⩽ 5mΩ	⩽ 10mΩ
Dynamic 100 Hz (sinusoidal 80 ⇆ 100 %)	⩽100mΩ	⩽100mΩ
1kHz	⩽400mΩ	⩽400mΩ
10kHz	⩽500mΩ	⩽500mΩ
100kHz	⩽ 1.4Ω	⩽ 1.4Ω
250kHz	⩽ 1.7Ω	⩽ 1.7Ω
Recovery rime		
For a sudden increase from 80% load to max. load or for a corresponding decrement	⩽100ms ⩽200mV$_{RMS}$	⩽100ms ⩽200mV$_{RMS}$
Ripple voltage	(E_{out}=75...125V) ⩽ 0.2%+50mV$_{RMS}$ (E_{out} ⩽ 75V)	(E_{out}=75...250V) ⩽0.2%+50mV$_{RMS}$ (E_{out} ⩽ 75V)
Temperature coefficient (0...35°C)	⩽0.01%/°C or 1mV/°C*	⩽0.01%/°C or 2mV/°C*
CONSTANT CURRENT OPERATION		
Output current	0...10A***	0...5A***
Resolution	< 6mA	< 3mA
Stability against mains variations		
With ±10% mains voltage variations max. change of output current incl. short term drift	0.1% or 3mA*	0.1% or 2mA*
Stability against load variations		
With load variations of 0...100% max. change of output current	< 10mA	< 10mA
Ripple current	< 40mA	< 40mA
Temperature coefficient	< 0.05%/°C or 1mA/°C*	< 0.05%/°C or 0.5mA/°C*
GENERAL		
Series/parallel connection	only at m/s operation	only at m/s operation
Remote programming/sensing	•	•
Master/slave operation	•	•
Ambient temperature	60°C max.**	60°C max.**
Overvoltage protection		
Supply		
At derated output current	220V/48.5–62Hz	
Dimensions (w × h × d)		
Built-in model	444 × 176 × 340mm (PE 1213/00) (17.5 × 7 × 13.4-in)	
Rack model 19-in	482 × 178 × 365mm (PE 1213/10) (19 × 7 × 14.4-in)	
Weight	48kg (50 for PE 1213/10) (106lb)	

* *whichever is greater*

** *at derated output current*

*** *at* T_{amb}=45°C

Modular power supplies



The Philips range of modular power supplies for OEM and other applications is one of the most comprehensive and versatile available – both mechanically as well as electrically.
Typical examples from a range totalling over 50 different modular units are shown above. Full performance specifications appear in the following pages, for the complete range of units.

1. Series-regulated, standard 19-in types
Section 1 shows, from left to right, 6/6, 3/6, 2/6, 1/6 and 1/12 (of 19-in width) modules for mounting into standard 19-in racking. Details of this range will be found opposite.

2. Switched-mode, standard 19-in types
Section 2 shows 1/6, 3/6 and 6/6 modules of the switched mode series for fitting into standard 19-in racking. These are described fully on p 242.

3. DIN 41494 styling
Section 3 shows the 40-T, 20-T and 10-T switched-mode, plus 20-T series-regulated modules, styled for Eurodimension DIN 41494, 19-in rack mounting (T = 5.08mm). These are described on p 239 (series-regulated types) and p 242 (switched-mode versions).

4. Economy series
Section 4 shows three of the range of series regulated power supplies for direct mounting into an equipment. These are described on p 246.

5. Eurocards
Section 5 shows the series of Eurocards based on standard 100 × 160mm pcb plug-ins. The illustration shows two boards fitted with front panels, which occupy a 10-T space (T = 5.08mm). These units are described on p 245.

Mechanical accessories
Various types of associated packmounting, front panels, etc. are described on p 248.

Series regulated types

Series regulated units are available in both standard 19-in rackmount and DIN 41494, 19-in configurations.

Standard 19-in rackmount types

The width of the standard 19-in types relates to the power output and the range of modules are designated 1/12th, 1/6th, 2/6th, 3/6ths and 6/6ths. A table of outputs appears on p 215. All units have the same height and depth. Three of the range are illustrated below, both individually and rack-mounted. These units may also be mounted directly into an equipment. When 19-in racking is used there is a choice of front panels and rack adapters. These are described and illustrated on p 248 and p 249.

DIN 41494, 19-in rackmount types

These units can be mounted into 19-in rack systems which are constructed to DIN 41494 (IEC publication 297 Euronorm). This allows the widest possible choice of racking arrangements available from all of the popular European suppliers. They are currently available in 20-T versions (T=5.08mm).

In addition, mounting holes are provided in the top, bottom and rear of each unit to allow them to be built directly into an equipment, if required.

Power outputs and performance specifications for both types appear on the following pages.

Outputs match market needs

As shown in the table, the units have nominal output voltages that correspond to definite market segments, i.e. 5, 12, 24, 30 and 48V. The output current has been optimised for these levels since in the great majority of cases this is the voltage that will be used (For example, 5V is standard for TTL circuits and 24V for memories and relays.)

Extra mechanical flexibility

Extra mechanical flexibility is provided by the 1/12 units. As shown in the previous table, they are available with 5, 12 and 24V nominal outputs, plus as a dual output −15V: 0: +15V unit.

They can be fixed directly into the

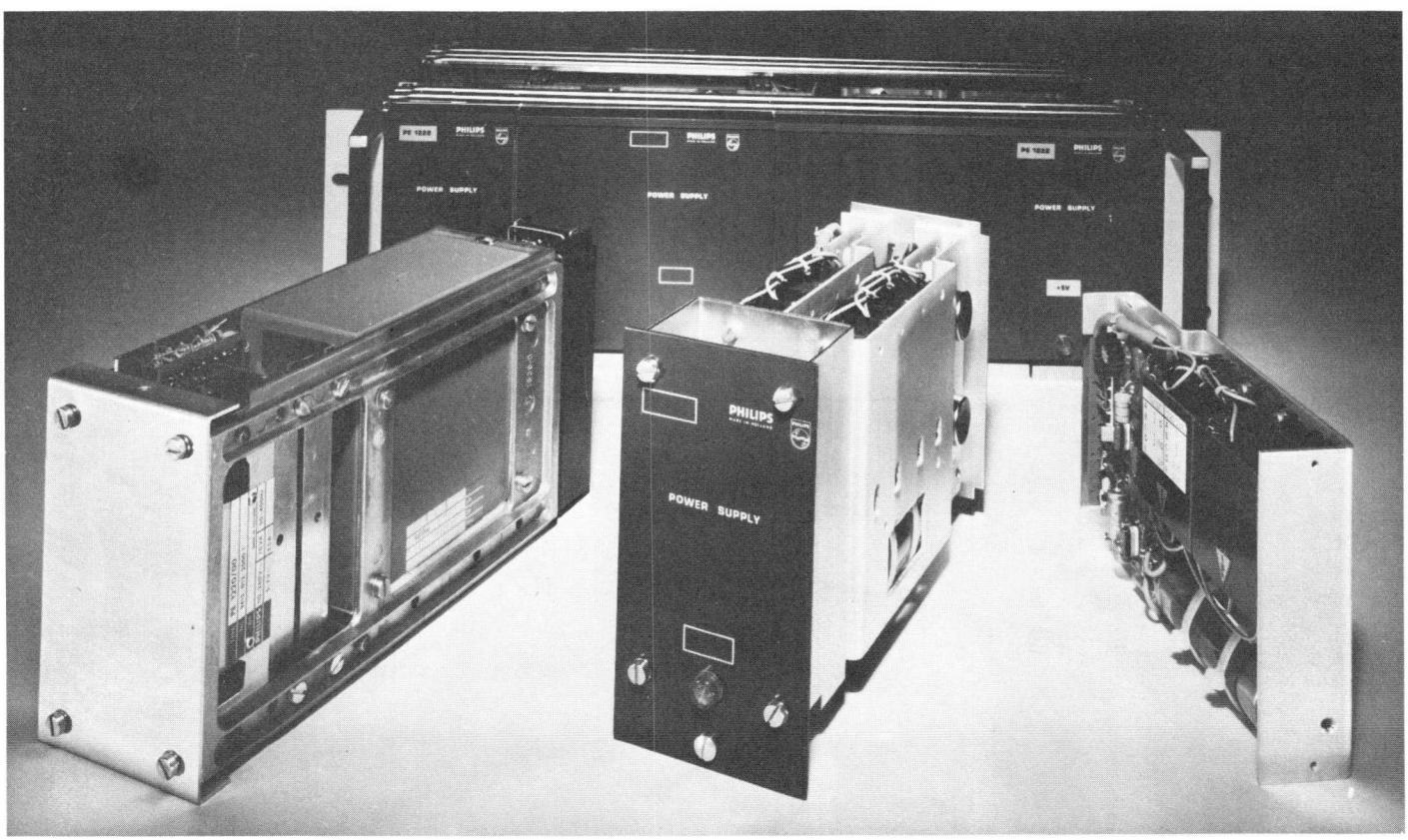


Illustration shows, front, left to right; a 1/6th module in its basic execution: two 1/12th modules forming a 1/6th module with locking screw; a 1/12 model in its basic execution. At the rear is a 19-in rack, extra rigid version PM 9707, fitted with 1/6, 2/6 and 3/6 modules by swivel catches.

equipment, or mounted back-to-back for 19-in rack mounting. Like the 1/6 units, there is an identical choice of front panels and 19-in adapters depending on the rigitidity needed.

Standard and optional features

Both remote sensing and remote control are standard features, the latter using either voltage or resistor analog programming. Optional is BCD programming using D/A converter PE 1390.
Over-voltage protection in the form of a crowbar is provided as standard on the 5V units and is optionally available on the remainder of the range.

Versatile operation

The 1/6 to 6/6 units display the foldback current-limiting characteristic of fig. 1. This can be adjusted by combinations of resistor and voltage tap changes in order to produce characteristics such as A'B'C' and A"B"C. The dual output unit has a similar characteristic with a mirror image, both outputs can be set individually, the two outputs moving in step to prevent damage to the load in the case of a short circuit on just one output.

TECHNICAL SPECIFICATION FOR SERIES – REGULATED, STANDARD 19-IN RACKMOUNT, MODULAR UNITS

(See also table on p 241)

Mains
Voltage: 110, 125, 200, 220 and 240V
Frequency: 50...400Hz (PE 1216/17 50...60Hz only)

Interference level
Input: Below K-curve in accordance with VDE 0875

Operation
Series: limitation to a maximum of 250V
Parallel: No limitation

Regulation
Load: from 0...100%: ±0.1%
Line: for ±10% change: < 0.05%

Series-regulated units to 20T DIN 41494 dimensions shown both unmounted (rear view) and contained in racking, complete with frontplates.

PARD (ripple and noise)
$< 0.5mV_{RMS}$/ $< 1.5mV_{p-p}$

Temperature coefficient
< 0.01%/°C

Output impedance
At 250kHz: < 250mΩ

Output terminals
Floating with respect to earth, both '+' and '–' may be connected to earth

Remote sensing
The units can compensate for a voltage drop in the power leads of 1V each

Remote programming
Either with a resistance of 1kΩ/V or with an external voltage source of 1V/V

Additional functions
– overvoltage monitoring
– access of unregulated DC
– sequencing

Temperature range
0...+70°C specified operating ambient temperature
–25...+70°C operating temperature
–40...+85°C storage

Safety
In accordance with IEC 348

Mechanical set-up
The units are taken up in modules of the Philips universal 19-in building system. See page 21.

Dimensions and weights

Module width	*Dimensions H × D × W mm*	*Weight (kgs)*
1/12	105 × 170 × 34 mm	0.65
1/6	116 × 260 × 70 mm	3.0
2/6	116 × 260 × 140 mm	4.7
3/6	116 × 260 × 210 mm	8.6
6/6	116 × 260 × 420 mm	18.0

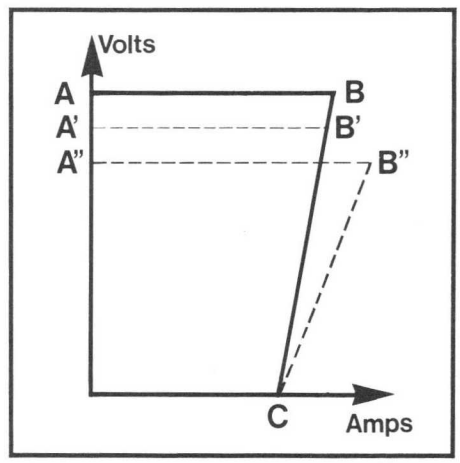


Fig. 1.

TECHNICAL SPECIFICATION FOR SERIES – REGULATED MODULAR UNITS TO DIN 41494 DIMENSIONS

(See also table on p 241)

Mains
Voltage: 110, 127, 220, 237V
Frequency: 48.5...62Hz

Interference level
RFI: acc. to VDE 0875 K level

Par/series connection
Two or more units may be connected in series and/or parallel.

Ripple
$\leqslant 1mV_{eff}$

Stability against mains variations
(of ±10% mains and load variation from no load to full load):
⩽ 0.1%

Overvoltage protection
Overvoltage protection in the form of a crowbar is provided as standard for all units.
Setting range for a 5V unit 6...10V
other units 10...30V

Remote sensing: standard for all units

Transient suppression
The units have an excellent suppression of transients on the mains.
For pulses of 10μsec pulse width and load between half load and full load the suppression of asymetric transients is 40dB. The suppression for symetric transients is 80dB.

Overcurrent protection
The units are protected by a self restoring automatic overcurrent protection, which makes them completely short circuit proof.

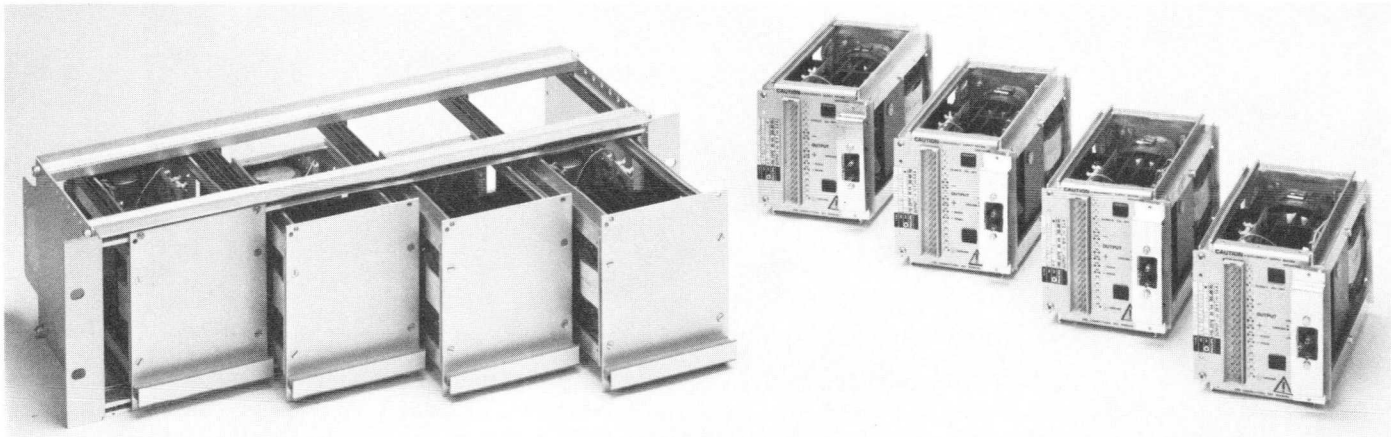
Temperature coefficient
0.02%/°C

Mechanical characteristics
All units are developed for mounting into 19-in rack systems according to DIN 41494. That means that they can be mounted in rack systems of Siemens, Elrack, ITT, ISEP, Schroff, Intermass, Knürr, Vero, A.K.A., Philips and many others.

Dimensions
(h × d × w in mm)
110 × 174 × 20T for all units
1T = 5.08mm

Connectors
32 pole connector acc. to DIN 41612 order /00 (e.g. PE 1257/00)
For 31 pole connector acc. to DIN 41617 order /10 (e.g. PE 1257/10)

Quality and safety
Acc. to IEC 348 class 1 and IEC 68



SUMMARY OF SERIES-REGULATED UNITS

Nominal output voltage	Output voltage range	Output current at nominal voltage and 55°C ambient	Output current at nominal voltage and 70° ambient	Fraction of 19-in or T-dim. (T=5.08mm)	Type nr.
TABLE A STANDARD 19-IN RACKMOUNT TYPES					
Single output-series regulated					
5V	2...16V	0.85A	0.7A	1/12	PE 1216
	2... 7V	4.0A	2.5A	1/6	PE 1220
	2... 7V	7.5A	6.0A	2/6	PE 1221
	2... 7V	16.0A	10.0A	3/6	PE 1222
	2... 7V	30.0A	20.0A	6/6	PE 1223
12V	2...16V	0.3A	0.3A	1/12	PE 1216
	2...29V	0.45A	0.4A	1/12	PE 1217
	5...17V	2.5A	1.7A	1/6	PE 1224
	5...17V	5.5A	4.6A	2/6	PE 1225
	5...17V	11.0A	6.0A	3/6	PE 1226
	5...17V	20.0A	14.0A	6/6	PE 1227
24V	2...29V	0.3A	0.3A	1/12	PE 1217
	10...26.5V	1.8A	1.5A	1/6	PE 1228
	10...26.5V	3.3A	2.6A	2/6	PE 1229
	10...26.5V	6.5A	5.5A	3/6	PE 1230
	10...26.5V	12.5A	9.5A	6/6	PE 1231
30V	15...33V	2.4A	1.7A	2/6	PE 1233
	15...33V	5.2A	4.1A	3/6	PE 1234
	25...33V	11.0A	7.5A	6/6	PE 1235
48V	20...52V	1.2A	0.5A	1/6	PE 1236
	20...52V	1.8A	1.4A	2/6	PE 1237
	20...52V	4.0A	3.1A	3/6	PE 1238
	20...52V	7.6A	6.0A	6/6	PE 1239
Dual output-series regulated					
−15V; 0; +15V	2×2...29V	2×0.45A	2×0.4A	2×1/12	2×PE 1217
−15V; 0; +15V	2×4.5...16.5V	2×2.0A	2×1.5A	2/6	PE 1232
TABLE B DIN 41494 SERIES					
Single output-series regulated					
5V	2... 6.5V	4.2A	2.9A	20T	PE 1257
12V	5...15.5V	2.4A	1.9A	20T	PE 1260
24V	10...28V	1.4A	1.1A	20T	PE 1263
Dual output-series regulated					
±12V	+6.5...+19V −4.5...−19V	1.2A	0.9A	20T	PE 1266 IT=5.08mm

Switched mode power supplies

High conversion efficiency gives low heat dissipation

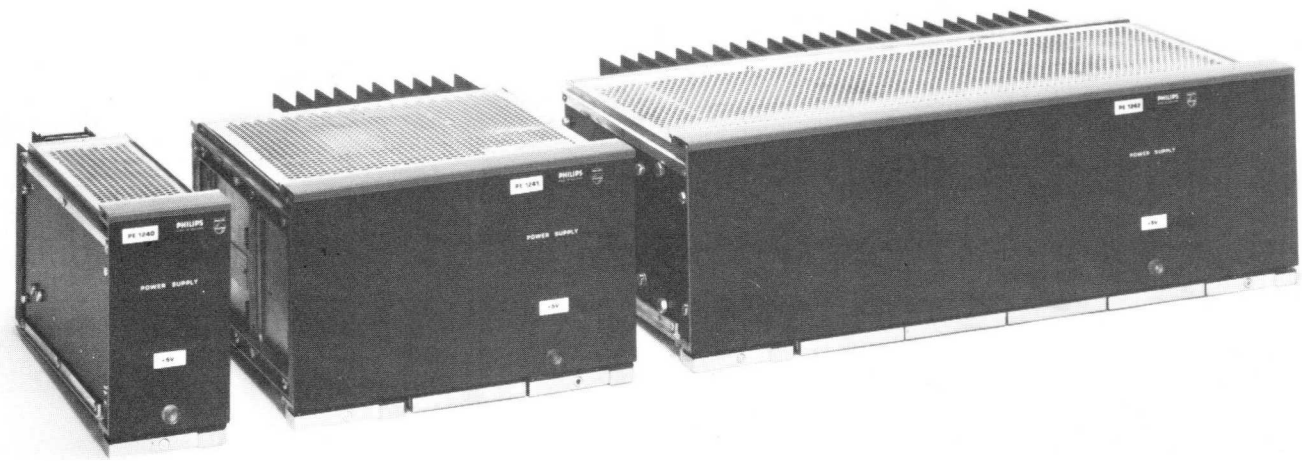
Inaudible 25kHz switching

Low rfi ensures minimal mains/load pollution

Normal convection cooling (fan unit can give up to 40% power gain)

Multipole connector offers various system possibilities

Flexible mechanical system offers wide choice of accessories



1/6th, 3/6th and 6/6th switched mode units for standard 19-in rackmount, fitted with swivel-catch front panels.

Long term investment in a dedicated research and development programme has resulted in the establishment of this range of modular, switched-mode power supplies (SMPS). The availability of these direct conversion units complements the existing Philips series of conventional modular power supplies, giving the user an even wider choice of power sources. All the initial problems thrown up by the switched mode concept have been effectively resolved. Thus, radio frequency interference (rfi) mains pollution, high inrush currents, ripple and noise, etc. have all been minimised.

Elimination of the mains transformer, the use of specially selected components plus well-tried designs have produced the major benefits associated with SMPS. Notably, greatly increased power densities from considerably smaller packages.

More flexibility

The addition of the new switched mode modules to DIN 41494 Eurodimensions increases the flexibility of this series and allows the user a virtually universal choice of rackmounts from most European manufacturers.

Efficiency

From 72% at 5V up to 79% at 24V

Power density

Over 50 watts per liter convection cooling. This figure can for some models be increased to approx. 70 watts per liter if mounted in an airstream with approx. 1 meter per second airflow (e.g. by using Philips fan unit PE 1373+PE 1374). These high figures prove to be conservatively rated if compared with some less reliable SMPS designs. A packaging density of approx. 50 watts per liter is considered, within Philips experience, to be the optimum choice to achieve compactness, long-term reliability and safety.

Radio frequency interference

Radiated rfi is minimized by a special construction, which employs good rfi shielding of critical components and ensures that stray radiation from the SMPS is virtually eliminated. (Owing to the lack of international rules. Philips have developed a very stringent approach to measurement of this source of radiation).

Conducted rfi

On both mains and output is better than the relevant VDE and IEC specifications/recommendations.

Safety

Since no 50Hz mains transformer has been employed and the incoming mains voltage ($220V_{AC}$) is rectified directly, special attention has been paid to safety. The 50Hz leakage current to earth remains for all units below $0.5mA_{RMS}$ ($0.7mA_{pk}$).

Inrush current

The higher power ratings (3/6 and 6/6 modules) are equipped with a special soft-start circuit which reduces high-inrush currents to a minimum at turn-on (also at mini-mains interruptions). This feature contributes considerably to the lifetime of input rectifiers, line circuit breakers and fuses.

TECHNICAL SPECIFICATION FOR SWITCHED MODE POWER SUPPLIES

INPUT

Input voltage and frequency
Nominal 220V_{AC} (190...242) 48...440Hz (19-in series)
(190...260) 48...440Hz
(DIN 41 494 types)

Inrush-current (worst case)

Inrush-current	A_{pk}
PE 1240/43/46	⩽ 80
PE 1241/44/47	⩽ 38
PE 1242/45/48	⩽ 30
PE 1258/61/64	⩽ 45
PE 1259/62/65	⩽ 45
PE 1267/68/69	⩽ 10

OUTPUT

Output voltage
See table 1
Setting tolerance
V_o nominal ±1%

Output current
See table 1

Regulation	PE 1240/48	PE 1258/69
Source effect (at ±10% mains):	±0.2%	±0.2%
Load effect At load variations from 10% to 100%:	0.3%	0.2%
At load variations from 0 to 10%:	1%	0.3%
Combined source (±10% mains) and load (10%-100% load) effect:	±0.4%	±0.3%

PARD (ripple and noise)
⩽ 50mV_{p-p} (measured with 50MHz bandwidth oscilloscope)
⩽ 12mV_{RMS}

Temperature coefficient
±0.02%/°C

Dynamic behaviour and transient response
See table 2

Turn-on delay time
PE 1240...1248 ⩽ 150ms
20T and 40T widths ⩽ 350ms
10T widths ⩽ 100ms
During turn-on and turn-off there is no overshoot on the output

Ambient temperature
Specified operating temperature: 0...70°C
Operating temperature: −20...+70°C
Storage temperature: −40...+85°C

Energy reserve
At nom. load and 198V_{AC} mains voltage:
⩾30ms (PE 1259/62/65)
⩾15ms (PE 1258/61/64)
⩾20ms (PE 1267/68/69)

Over current protection
The units are protected by a self restoring automatic over current protection, which makes them completely short circuit proof

Over voltage protection
The units are protected against over voltage by a circuit, which interrupts the drive of the power transistors

Remote programming
The output voltage can be programmed by using an external resistor or with an external voltage

Remote sensing
In case of remote sensing the units can compensate voltage losses in the power leads of max. 0.5V per lead wire

Radio frequency interference (rfi)
To the mains according to VDE 0875
Interference level below N-12dB (all units except 10T which are level N)
At the output according to IEC draft of sub committee 22 E8

Series/parallel connection
Two or more units may be connected in series and/or parallel.

DIMENSIONS AND WEIGHTS

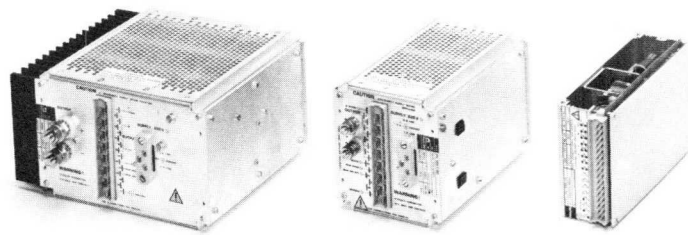
(Philips 19-in rackmount)

module width	dimensions h × d × w (mm)	weight kg.
1/6	116 × 260 × 70 (4.75 × 10.2 × 2.8-in)	2.1 (4.6lb)
3/6	116 × 260 × 210 (4.75 × 10.2 × 8.3-in)	8.5 (18.7lb)
6/6	116 × 260 × 420 (4.75 × 10.2 × 16.5-in)	12.8 (27.2lb)

(DIN 41494 Eurodimensions)

10T	100 × 171 × 50.3	0.58 (1.3lb)
20T	110.5 × 190 × 100.6	2 (4.4lb)
40T	110.5 × 193 × 198	3.5 (7.7lb)

(1T = 5.08mm)



Size 40T, 20T and 10T switched mode modules to DIN 41494 dimensions.

TABLE 1

V_o nominal set at delivery	Setting range	I_o at V_o nom. T_{amb} ⩽50°C Convection cooled	I_o at V_o nom. T_{amb} ⩽70°C Convection cooled	I_o at V_o nom. T_{amb} ⩽50°C 1m/sec forced air	Fraction of 19-in width	Type
V	V	A	A	A		
Philips standard 19-in rackmount						
	4...6	20	10	24	1/6	PE 1240
5	4...6	65	30	80	3/6	PE 1241
	4...6	130	65	156	6/6	PE 1242
	10...15	9	4.5	11	1/6	PE 1243
12	10...15	26	13	34	3/6	PE 1244
	10...15	60	30	72	6/6	PE 1245
	20...27	4.5	2.2	5.5	1/6	PE 1246
24	20...27	16	8	2	3/6	PE 1247
	20...27	32	16	38	6/6	PE 1248
DIN 41494 Eurodimensions						
	4...6.3	18*	9	30**	20T	PE 1258
5	4...6.3	40*	22	60**	40T	PE 1259
	4...6.3	6*	3	7**	10T	PE 1267
	4...16	8*	4	11**	20T	PE 1261
12	4...16	18*	10	27**	40T	PE 1262
	7...16	3*	1.5	3.5**	10T	PE 1268
	4...28	5*	2.5	7.2**	20T	PE 1264
24	4...30	11*	6	16.5**	40T	PE 1265
	18...28	1.6*	1	11.75**	10T	PE 1269

* at ⩽55°C convection cooled
** at ⩽55°C, 1m/sec forced air

TABLE 2. DYNAMIC BEHAVIOUR AND TRANSIENT RESPONSE

Philips 19-in rackmount

Type	Load variations of $I_{nom.}$	50% → 100% $\frac{dI}{dt} \geqslant 0.5A/\mu s$	100% → 50% $\frac{dI}{dt} \geqslant 0.5A/\mu s$	10% → 100% variation $V_o \leqslant 1\%$	100% → 10%
PE 1240	recovery time*	2ms	1.5ms		
	voltage var.	250mV	150 mV		
	$\frac{dI}{dt}$			0.02 A/μs	0.04 A/μs
PE 1241	rec. time*	1.2ms	1.2ms		
	volt. var.	200 mV	200 mV		
	$\frac{dI}{dt}$			0.025A/μs	0.08A/μs
PE 1242	rec. time*	1.5ms	1.5ms		
	volt. var.	500 mV	500 mV		
	$\frac{dI}{dt}$			0.06 A/μs	0.13A/μs
PE 1243	rec. time*	1.5ms	1 ms		
	volt. var.	130 mV	100 mV		
	$\frac{dI}{dt}$			0.01 A/μs	0.02A/μs
PE 1244	rec. time*	1.2ms	1.2ms		
	volt. var.	300 mV	100 mV		
	$\frac{dI}{dt}$			0.025A/μs	0.08A/μs
PE 1245	rec. time*	1.5ms	1.5ms		
	volt. var.	1200 mV	500 mV		
	$\frac{dI}{dt}$			0.05 A/μs	0.1 A/μs
PE 1246	rec. time*	2 ms	1 ms		
	volt. var.	100 mV	50 mV		
	$\frac{dI}{dt}$			0.005A/μs	0.01A/μs
PE 1247	rec. time*	1.2ms	1.2ms		
	volt. var.	150 mV	100 mV		
	$\frac{dI}{dt}$			0.025A/μs	0.08A/μs
PE 1248	rec. time*	1.5ms	1.5ms		
	volt. var.	800 mV	350 mV		
	$\frac{dI}{dt}$			0.02 A/μs	0.05A/μs

DIN 41494 Eurodimensions

		10% to 100%	100% to 10%	50% to 100%	100% to 50%
PE 1258	rec. time*	2ms	3ms	1ms	1ms
	volt. var.	500mV	500mV	200mV	200mV
PE 1261	rec. time*	2ms	3ms	1.2ms	1.2ms
	volt. var.	400mV	300mV	300mV	100mV
PE 1264	rec. time*	2ms	3ms	1.2ms	1.2ms
	volt. var.	450mV	400mV	200mV	150mV
PE 1259	rec. time*	2ms	3ms	1ms	1ms
	volt. var.	500mV	500mV	200mV	200mV
PE 1262	rec. time*	2ms	3ms	1.2ms	1.2ms
	volt. var.	400mV	300mV	300mV	100mV
PE 1265	rec. time*	2ms	3ms	1.2ms	1.2ms
	volt. var.	450mV	400mV	200mV	150mV
PE 1267	rec. time*	2ms	1ms	1ms	0.5ms
	volt. var.	400mV	200mV	200mV	100mV
PE 1268	rec. time*	2ms	1.5ms	1ms	1ms
	volt. var.	300mV	150mV	150mV	100mV
PE 1269	rec. time*	2ms	1.5ms	1ms	1ms
	volt. var.	200mV	100mV	100mV	100mV

* to within 0.5% of final value

Standard Eurocard size 100×160mm

Choice of 5, 12, 24 or ±15V outputs

Choice of 32 or 31 pin connectors (Din 41 612 and 41 617 respectively)

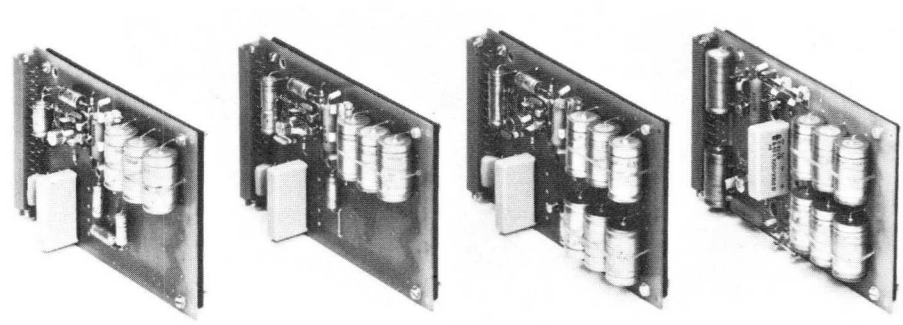
Overcurrent protection

Optional crowbar protection

High 75 000 hr MTBF

Eurocard Power Supplies

The Eurocards are designed for OEM and other applications where years of trouble-free operation are essential. They meet the DIN 41494 standards and are available with 31 or 32 pin connectors to cover the great majority of needs.
Overcurrent protection makes the cards completely short circuit proof. An optional crowbar provides the protection for the associated circuitry. Adaption to the various versions of system front plates is easily achievable.



Optimum reliability

The high 75000 MTBF is the result of Philips considerable experience as the major European power supply manufacturers. This experience covers every aspect of design, component derating factors, worst case analysis, accepted quality levels and procedures for life testing as well as burn in and production line testing. It is also worth noting that the worst case designs provide considerable reserve in the specification when the unit is working under normal conditions.

TECHNICAL SPECIFICATION

Input voltage
187–242V, 50–60Hz
If used in connection with associated transformer.

Stability
0.1% for the single output versions
0.2% for the dual output version
At line and load variations of ±10% and 0...100% respectively.

Ripple voltage
1mV$_{tt}$ PE 1271
2mV$_{tt}$ PE 1272 PE 1273 PE 1274

Temperature coefficient
0.02%°C

Recovery time
50μs
With sudden load variation of 20% of full load.

Parallel connection
Cards can be connected in parallel.

Overcurrent protection
Cards are protected by an overcurrent protection, which makes them completely short circuit proof.

Overvoltage protection
Optional crowbar units, which can be mounted very easily, can be supplied under typenr. PE 1378 and PE 1379. See accessories.

Remote sensing
Provisions are made in the layout of the print to enable remote sensing.

Connector
For 32 pins according to DIN 41612 order ../00 (e.g. PE 1271/00)
For 31 pins according to DIN 41617 order ../10 (e.g. PE 1271/10)

Dimensions
Eurocard size 100×160mm
Width: 10T including crowbar
1T = 5.08mm

ACCESSORIES

Associated transformers
PE 1368 for card PE 1271
PE 1369 for card PE 1272
PE 1370 for card PE 1273
PE 1371 for card PE 1274

Crowbar
PE 1378 for cards PE 1272...PE 1274
PE 1379 for card PE 1271

All units are subjected to a tough series of mechanical, climatic and safety tests in order to meet IEC 68 and IEC 348 regulations.

Type	Output Voltage		Current at nom. voltage		
	Nom.	Max.	45°C	55°C	70°C
PE 1271	5V	6 V	2.2 A	2 A	1.65A
PE 1272	12V	15.5V	2.2 A	2 A	1.65A
PE 1273	24V	28.5V	1.15A	1.1A	1 A
PE 1274	±15V	±15.5V	2×1.15A	2×1.1A	2×1 A

Economy class modular power supplies PE 1250 to 1255

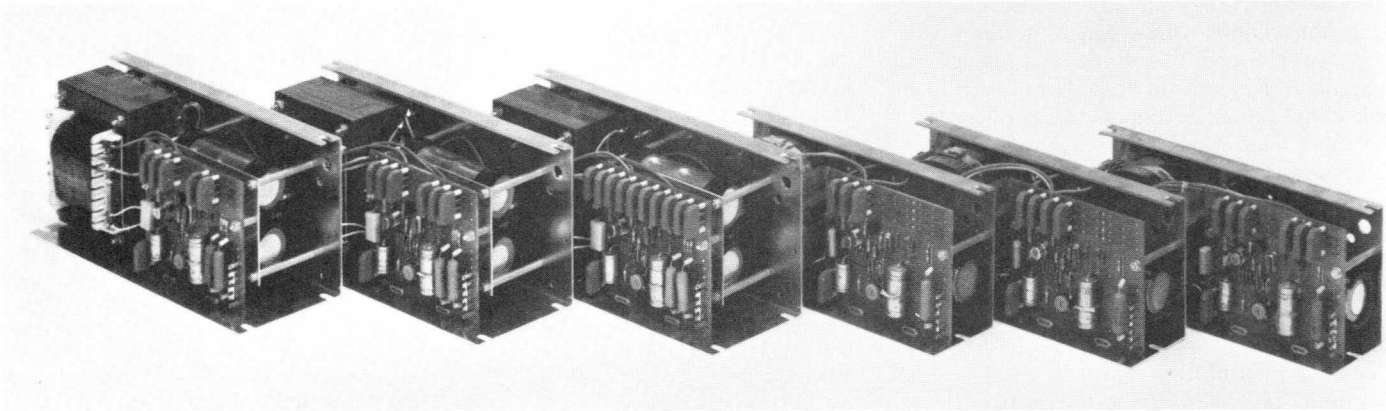
Extremely economic price-performance ratio

Wide range of voltages and currents

Compact size

Designed for OEM applications

Universal mechanical set-up



While the standard range of Philips modular power supplies meets the most demanding OEM requirements with respect to both electrical and mechanical properties, there are many applications where such sophisticated circuit components are neither needed nor economically justifiable. For these applications Philips have developed a range of lower cost supply modules, featuring more basic specifications and a simpler mechanical construction. The design philosophy for this economic range is the same as for the standard range in that it offers the same convenient output voltages which fit the great majority of applications, namely 5, 12 and 24V_{DC}.

Electrically the units are adequate to power normal logical circuits, including TTL. The outputs are short-circuit proof and feature a foldback current limiting characteristic. To keep the cost down, an overvoltage protection is not included as standard, but can be built in as an option. A second output voltage level can be selected on each supply.

Mechanically these supply modules are very simple. Each unit features a 2× folded sheet aluminium frame which serves both as a mounting base for all components and a heat sink. The range currently includes three different output voltages, each in two frame sizes, to suit different output power requirements.

TECHNICAL SPECIFICATION

INPUT

Line voltages and frequencies
110 – 128 – 220 – 238V + and −10%
50...400Hz + and −3%

Protection
Thermal fuse on the transformer

Power consumption
At nominal mains voltage

PE 1250: 75VA	*PE 1253*: 135VA
PE 1251: 80VA	*PE 1254*: 160VA
PE 1252: 80VA	*PE 1255*: 165VA

OUTPUT

Voltage and current
See table

Protection
Current foldback method, self-recovering when overload is removed

Overvoltage protection
As an option (crowbar PE 1372)

Stability including short term drift
Line (±10%) < 0.1%
Load (0⇄100%) < 0.1%

Output impedance
At sinusoidal load variations from 80% of full load up to full load and a frequency of:
1kHz ⩽ 0.02Ω
10kHz ⩽ 0.10Ω
100kHz ⩽ 0.25Ω
250kHz ⩽ 0.25Ω

Temp. coefficient
⩽ 0.02%/°C

Recovery time
⩽ 50μs for square-wave load variations from 80% to 100%

Ripple and noise
⩽ 1mV_{RMS} (⩽ 3mV_{p-p})

Output terminals
Floating
The "+" or "−" terminal may be connected to the chassis, if desired
Max. 100V_{DC}

Remote sensing
Possible; the units can compensate voltage losses up to 0.5V per lead wire

Remote programming
Possible with:
– an external resistor R_{ex} = 1kΩ per Volt V_o
– an external voltage source of V_{ex} = 1V per Volt V_o

Series connection
Possible with two or more units up to 100V_{DC} with respect to earth

Parallel connection
Several units can be connected in parallel

GENERAL

Ambient temperature
Specified
operating temp. 0...+70°C
Operating temp. −25...+70°C
Storage temp. −40...+85°C

Safety
In accordance with IEC 348 (class I)

Interference level
Below the K curve in accordance with VDE 0875

Climatological and mechanical tests
In accordance with IEC 68

Test voltage
Input 2250V-50Hz with respect to chassis
Output 750V-50Hz

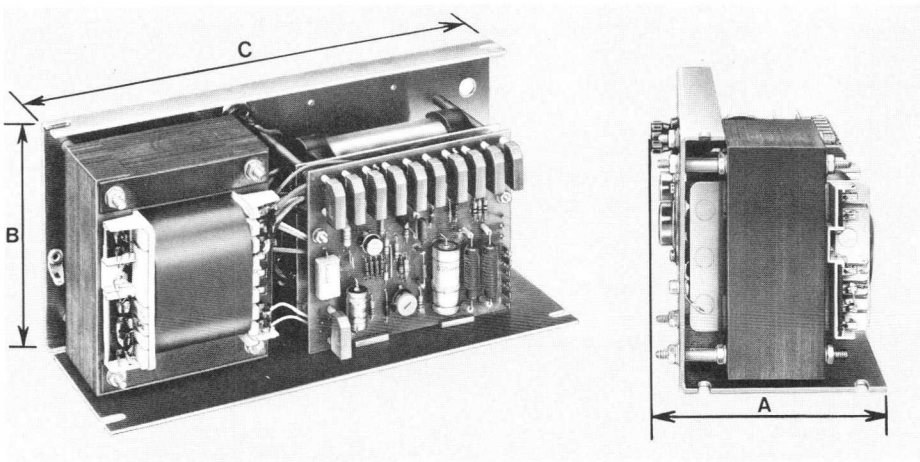
Cooling
Convection cooled, no fans or external heatsinks required
The air convection may not be impeded

Dimensions and weight

	PE 1250 to PE 1252	PE 1253 to PE 1255
A:	74mm	98mm
B:	91mm	106mm
C:	206mm	230mm
Weight:	1.5kg	3kg

Type	Nominal output voltage	Max. output currents at V_o nominal					
		$T_{amb}=40°C$		$T_{amb}=55°C$		$T_{amb}=70°C$	
		I_o	I_{os}	I_o	I_{os}	I_o	I_{os}
PE 1250	5V*	4 A*	2 A	3 A	1.5A	1.4A	1 A
	6V	3.6A	1.9A	2.7A	1.5A	1.2A	1 A
PE 1251	12V*	2.5A*	1.4A	2.3A	1 A	1 A	1 A
	15V	2.1A	1.1A	2 A	0.7A	0.6A	0.6A
PE 1252	18V	1.8A	1 A	1.6A	0.8A	0.9A	0.8A
	24V*	1.5A*	0.8A	1.4A	0.6A	0.8A	0.6A
PE 1253	5V*	6 A*	2 A	4.5A	1.5A	2.5A	1 A
	6V	6 A	2 A	4.5A	1.5A	2.2A	1 A
PE 1254	12V*	4 A*	1.5A	3.4A	1.2A	1.2A	1 A
	15V	3.5A	0.4A	2.6A	0.5A	0.6A	0.6A
PE 1255	18V	2.8A	1.2A	2 A	1.2A	0.9A	0.7A
	24V*	2.5A*	0.7A	2 A	0.7A	0.8A	0.7A

* Values at delivery.



Mechanical system and accessories

MECHANICAL SYSTEM

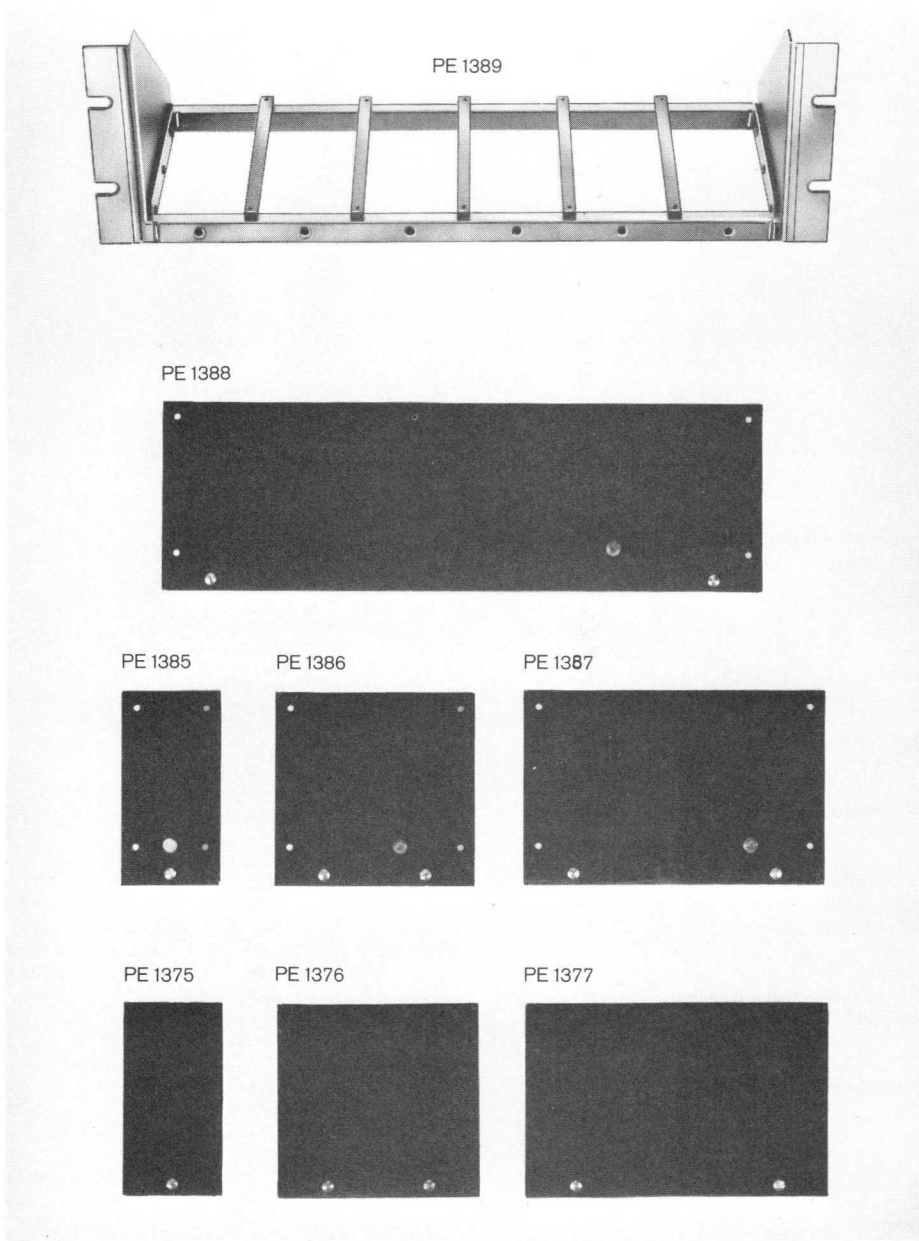
The type numbers given below refer to the basic units. It is in this form that the modules must be ordered i.e. the form for direct mounting into equipment or test gear.
When the units are needed for mounting into 19-in rack systems there is a choice of front panels and adapter units.
The appropriate panels are mounted directly onto the basic unit after the steel cover has been removed. These front panels all contain a pilot lamp to indicate that output voltage is present. Blank panels can also be ordered as and when necessary. Two $\frac{1}{12}$th units can be mounted side by side using adapter PE 1380. This combined unit is then mechanically equivalent to a $\frac{1}{6}$th module.
Two 19-in rack mounting systems are available, one employing self-retaining screws as shown opposite and one using swivel catches as illustrated on p. 227. This latter system allows the modules to be removed very easily and is extremely rigid and attractive. The swivel catches can also be locked in position with Allen-screws.

Accessories for system employing self-retaining screws

Rack adapter	PE 1389
$\frac{1}{6}$ front panel	PE 1385
$\frac{2}{6}$ front panel	PE 1386
$\frac{3}{6}$ front panel	PE 1387
$\frac{6}{6}$ front panel	PE 1388
$\frac{1}{6}$ blank panel	PE 1375
$\frac{2}{6}$ blank panel	PE 1376
$\frac{3}{6}$ blank panel	PE 1377

Accessories for system employing swivel catches

Rack adapter	PM 9707
$\frac{1}{6}$ front panel	PE 1381
$\frac{2}{6}$ front panel	PE 1382
$\frac{3}{6}$ front panel	PE 1383
$\frac{6}{6}$ front panel	PE 1384



PE 1373/74 Modular fan unit

$\frac{1}{6}$ blank panel	PM 9721N
$\frac{2}{6}$ blank panel	PM 9722N
$\frac{3}{6}$ blank panel	PM 9723N

Front panels PE 1381...1384 are supplied with a packet of self-adhesive stickers containing all output values, both positive and negative, as well as the Philips type numbers of the appropriate module.

NB. When the air circulation is limited then there is a possibility that the output must be derated. For more details contact your local Philips specialist.

Accessories for 1/12th modules

PE 1378 Crowbar 10...28V
PE 1379 Crowbar 6...10V
PE 1380 Adapter
PE 1381 Front panel
PE 1385 Front panel

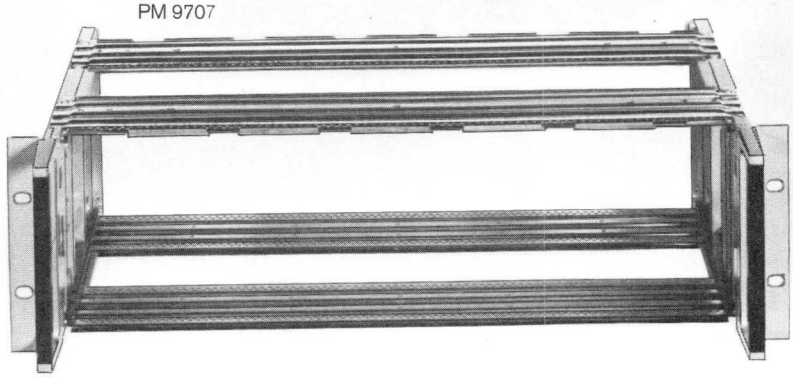
Dimensions and weights

Module width	*Dimensions h × d × w*	*Weight (kg)*
$\frac{1}{12}$	105 × 170 × 34mm	0.65
$\frac{1}{6}$	116 × 260 × 70mm	3.0
$\frac{2}{6}$	116 × 260 × 140mm	4.7
$\frac{3}{6}$	116 × 260 × 210mm	8.6
$\frac{6}{6}$	116 × 260 × 420mm	18.0

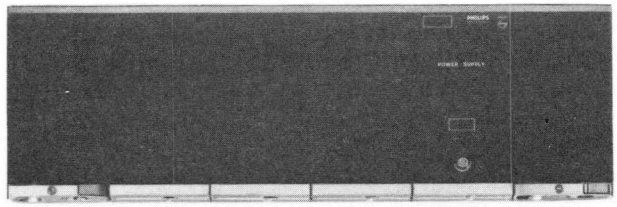
MODULAR FAN UNIT PE 1373/74

The Philips modular OEM supplies can be operated at full output specifications at ambient temperatures up to 55°C (up to 70°C at derated output current). This condition is normally obtained when the overall circuit design allows a natural convection cooling of all circuit components. OEM equipment, however, has very often to be as compact as possible,

PM 9707

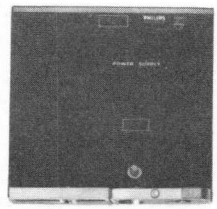


PE 1384

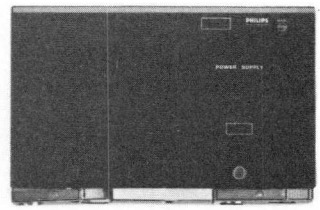


PE 1381

PE 1382

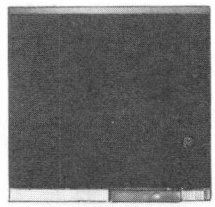


PE 1383

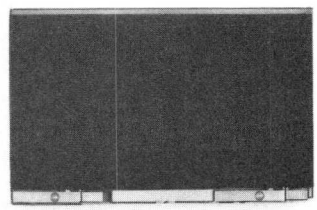


PM 9721N

PM 9722N



PM9723N



DIGITAL PROGRAMMING MODULE PE 1390

Philips have developed a modular digital-to-analog converter for programming the output voltages of their standard range of OEM supplies. Designated the PE 1390, the unit converts 16 bit BCD coded signals at TTL or HNIL level to a resistance output of 0 to 39.99kΩ. This output resistance is used to replace the internal resistor setting of the power supply modules. The converter includes a discharge circuit for the output capacitor of the power supply. When selecting a lower voltage, the charge of the capacitor will therefore not delay the settling time and the outputs setting only takes 10ms.

INPUT DATA

Supply voltage
110 and 220V (+10% and −15%); 50–60Hz

Input logic
16 bit BCD at TTL (DTL) or HNIL level; changeable by internal wiring

Logic levels
−2V to +0.8V or −2 to +4.5V for logic one; +3V to +6.5V or +7.5V to +18V for logic zero

Transfer signal
Negative-going pulse of at least 0.5μs

Reset signal
Negative-going pulse of at least 0.5μs

Output range
0 to 39.99kΩ adjustable in steps of 10Ω. Possibility for range extension with two optional resistors

Tolerance
Less than ±0.5% +4Ω for output higher than 800Ω; less than ±0.5% +1/2 LSB +4Ω for output below 800Ω

Temperature coefficient
Less than 75ppm or 0.3Ω/°C, whichever is greater

Programming time
About 10ms; depends on power supply and application

Ready signal
About 10ms negative-going pulse

Discharge circuit
A circuit is built-in to discharge the output capacitor of the power supply with 2.5A (only suitable for models PE 1220 to PE 1231 and PE 1233 to PE 1239).

Dimensions and weight
(w × h × d) 70 × 116 × 270mm
2.7 × 4.6 × 10.6-in
0.8kg (0.3lb)

and the layout does not always allow for a free air flow. It may therefore be necessary to integrate a fan into the cabinet in order to keep the ambient temperature within specified limits.
Philips have designed a special fan unit to go with their modular range of OEM supplies. The fan housing can be built into a 19-in rack, where it takes the full 19-in width and one E height (44mm). The depth is 260mm. The unit is mounted underneath the power supply modules and can be equipped with two ventilators.

To keep the cost down and to enable the designer to choose his own brand of fan and motor on which he may have standardized, the ventilator unit is delivered completely wired but without fan and motor under the designation PE 1373. The fans and motors can be obtained separately under the designation PE 1374.
PE 1373 can be wired for 220V or 110V simply by connecting 2 × PE 1374 either in series or parallel.

TECHNICAL SPECIFICATION OF PE 1374

Volts	Phase	Hz	RPM	Watts	Running current (Amps)	Locked rotor current (Amps)	Bearing
115	1	50 60	2700 3200	14 13	0.18 0.15	0.26 0.22	Ball

AC voltage stabilizers PE 1610, PE 1611 and PE 1612

Electronic/magnetic system

High 0.1% output stability regardless of line voltage, frequency and load variations

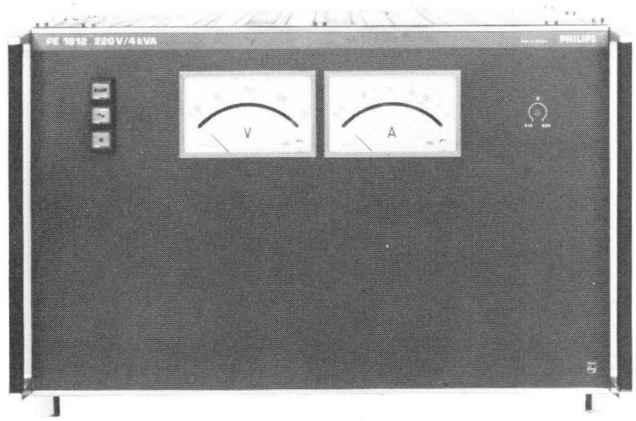
Mains transient suppression

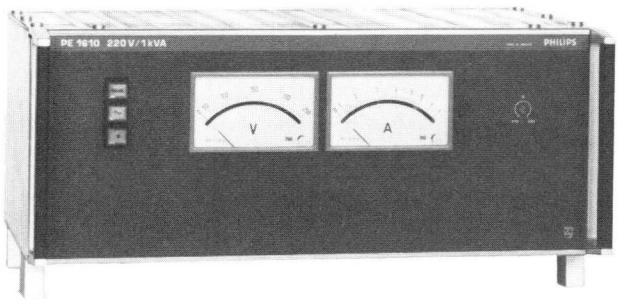
Output distortion completely independent of line distortion

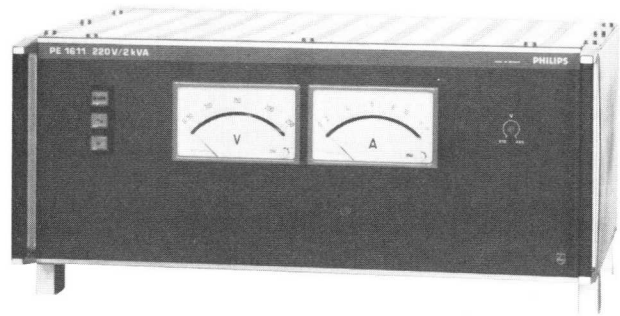
Galvanic separation between input and output

Fast response time

Automatic operation







Regulating the line supply and suppressing line transients are vital with modern electronic equipment. Line variations, and surges resulting from switching large items of equipment, can wreak havoc with control circuits.
Philips offer two methods to solve the problem, depending on the degree of stability required, and the load involved; the PE 1400 series constant voltage transformers and the PE 1610 series AC voltage stabilizers.
The PE 1400 series are magnetic systems offering 1% line stability and very good transient suppression. Output distortion is completely independent of line distortion. The PE 1600 series combines the advantages of electronic control plus the magnetic system in the PE 1400 series. The result is a high 0.1% stability, combined with good transient suppression, and gives the possibility of varying the combination of stability and transient suppression to suit the application. The PE 1610 series is frequency independent, and can handle inductive loads with no problems. So whatever the problem, and whatever degree of stability is required, Philips can provide a total solution.

The Philips electronic AC voltage stabilizers PE 1610...1612 have been designed to cope with worst-case power supply conditions. They provide a high 0.1% output stability with input variations between −15% and +10%.
Maximum output powers of 1, 2, and 4kVA are available. The output voltage is adjustable from 215 to 225V_{RMS}. Dis-

tortion is less than 4%, and is practically independent of mains distortion. Even a squarewave input is converted to a sinewave output with very low distortion.
Mains transient suppression of up to 40dB symmetric and 60dB asymmetric spikes makes the PE 1610 series ideal for working with TTL or CMOS circuitry, where spikes on the line have to be avoided.
Built-in overvoltage protection switches off the stabilizer if the output exceeds a preset limit, and there is overload protection through current limiting. Remote sensing is possible if the voltage drop in the current-carrying leads is less than 1V. Units can be operated in parallel without special coupling arrangements; three phase combinations require an optional coupling unit.

Automated control
The units are operated through magnetic contactors, allowing remote control of all functions, using a separate automation box PE 1694.

Operation
The stabilizers are designed as constant voltage transformers, and incorporate a special feedback control circuit. A sensing circuit provides a DC voltage which is proportional to the rms value of the stabilizer output.
This DC voltage is compared to a fixed reference voltage in a differential amplifier, and the resulting output signal is fed to a triac control circuit. The triac is built into a resonant circuit at the secondary side of the transformer, and its firing angle is varied in such a way as to counteract any change.

TECHNICAL SPECIFICATION

INPUT

Voltage
187...242V_{RMS}

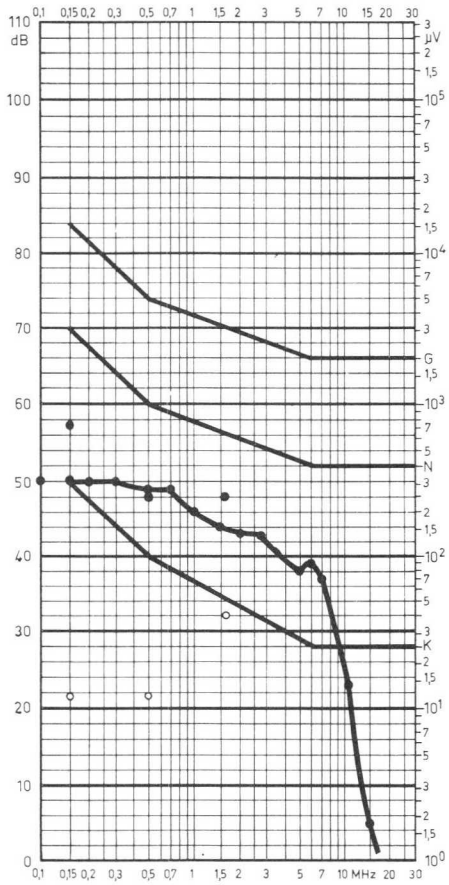
Frequency
50Hz ±3% or 60Hz ±3% (adjustable)

Current

	PE 1610	*PE 1611*	*PE 1612*
Full load, max.	8A	15A	30A
Short circuit max.	13A	25A	55A

Power consumption
PE 1610: 1150W
PE 1611: 2200W
PE 1612: 4450W

Mains protection
General fuse:
PE 1610: 10A
PE 1611: 16A
PE 1612: 35A
Remote control fuse: 2A



Mains interference level according to VDE 0875

OUTPUT

Voltage
215...225V_{RMS}; adjustable with controls on front panel

Resolution
±100mV

Power
PE 1610: 1kVA
PE 1611: 2kVA } resistive load
PE 1612: 4kVA

Current limiting
Max. short circuit current:
PE 1610: 8A
PE 1611: 20A
PE 1612: 40A

Overvoltage protection
If the output voltage increases to more than 245V the stabilizer is switched off.

Transient suppression
For pulses of 10µs pulse width and load between half load and full load, the suppression of asymmetric transients is typ. 60dB; the suppression of asymmetric transients is typ. 40dB.

Stability
In case of individual variation of one of the following electrical magnitudes and a constant value of the other, within the limits indicated, the maximum deviation of the output voltage is ±0.1%
– Line voltage, between 187 and 242V
– Line frequency variation + or −3%
– Load, between no load and full load

Temperature coefficient
< 0.01%/°C at an ambient temperature between 0 and 45°C

Distortion
< 4% independent of line distortion

Recovery time
< 240ms at a sudden voltage variation of 5% or a load variation of 20%. It is the time between the moment at which one of the above variations takes place and the moment at which the rms value of the output voltage deviates permanently less than 0.1% of the adjustable value.

Response time
< 2 periods at a sudden mains variation of 5% or a load variation of 20%. It is the time between the moment at which one of the above variations takes place and the moment at which the deviation from the output voltage has been reduced to 37% of the original value.

GENERAL

Ambient temperature
0...45°C

Cooling
By natural air circulation

Signalization
Lamps in the pushbuttons 'kVA' and '~' indicate respectively that the stabilizer is working or that the mains is connected directly to the output.

Meters
V and A meters indicate the true RMS value of the output voltage and current.

Remote sensing
The apparatus can work in remote sensing with appropriate connections. Voltage loss in the lead between load and stabilizer should not exceed 5V.

Mains switch
Two magnetic relays
– one for switching on the stabilizer
– one for connecting the mains directly to the output

Parallel and three-phase operation
The stabilizer provides a galvanic separation between input and output. Parallel use of two stabilizers is permitted with the master-slave method (without coupling unit). A three-phase coupling unit serves to couple three single phase AC stabilizers in order to stabilize the coupled voltages of a three-phase line.

Stabilizer

output power	type of stabilizer	coupling transformer
3kVA	3 × PE 1610	PE 1692
6kVA	3 × PE 1611	PE 1692
12kVA	3 × PE 1612	PE 1693

Environment
In accordance with IEC 66, publication 359 and IEC 68

Safety
In accordance with IEC 348

Mains interference
Conforming VDE 0875 (N level)

Mechanical aspects
Delivered as table model. Can be mounted in a 19-in rack.

Dimensions and weights

	PE 1610	PE 1611	PE 1612
Height:	4E	4E	6E
Width:	444mm	444mm	444mm
Depth:	300mm	405mm	520mm
Weight:	37kg	62kg	113kg

Accessories
Brackets for 19-in rack mounting plug for connecting remote control box or automation box.

10kVA AC voltage stabilizer PE 1604/50

High, 10kVA output

Electronic/magnetic system

Excellent, 0.1% stability

Full overload protection

Can operate in 3-phase system

In addition to the PE 1610...PE 1612 family of AC stabilizers there is the 10kVA model PE 1604/50.

TECHNICAL SPECIFICATION

Output voltage: 210...240V; screwdriver adjustment on the frontpanel

Output power: 10kVA at mains variation of −15%...+10%
20kVA at mains variation of −8%...+5%

The tolerances of the mains voltage variations apply to the set output voltage and are valid for the following limits:

Stability: 0.1% with load variations ranging from no load to full load or with mains variations from −15% to +10% or −8% to +5% depending on the output power rating selected.

Response time: Any variation in the output voltage due to an instantaneous variation in the mains voltage of 5% or a step change in the load of 20% will be regulated within 80ms to less than 37% of its peak variation.

Recovery time: Any variation in the output voltage due to an instantaneous variation in the mains voltage of 5% or a step change in the load of 20% will recover within 240ms to less than 0.1% of its set value.

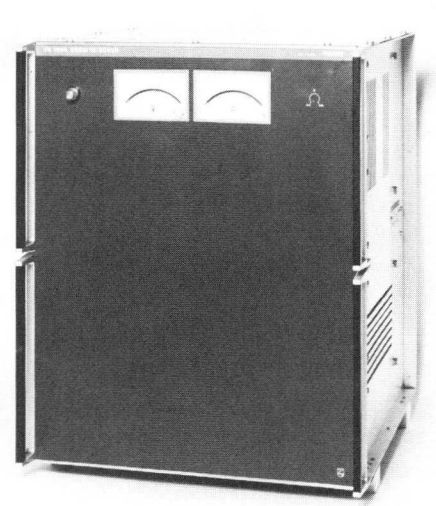
Distortion: The harmonic distortion of the output voltage will be less than 3% at any mains voltage in the specified range and any load between no load and full load. The mains frequency may have any value between 48.5 and 51.5Hz.

Overvoltage protection: An electronic protection unit will block the amplifier, whenever the output voltage exceeds a preset value between 220V and 260V, adjustable at the rear of the instrument. The result will be that the output voltage drops to a low value, depending on the load and input voltage conditions.

Overload protection: The feed-back amplifier unit is protected from overloads by means of fuses. In addition, transformers have thermal overload protection.

Remote sensing: The instruments are fitted with extra terminals for remote sensing, in order to compensate voltage drops in long supply lines between the stabilizer and the load.

Ambient temperature: The stabilizers are suitable for continuously supplying the rated power at an ambient temperature of 45°C, within the specified limits of the mains voltage (−15% to +10% or −8% to +5%).



Temperature coefficient: The temperature coefficient will be less than 0.01%/°C.

Three-phase operation: To stabilise a three-phase network with neutral, three stabilizers may be star-connected, each stabilizing one phase. In the case of asymmetrical loads, however, the opposite phase angles change and consequently the line voltage changes as well. To keep both the phase angle and the line voltage stable, a three-phase coupling unit, PE 1693, is available.

Dimensions and weight:

Width	482mm	(19-in)
Height	532mm	(21-in)
Depth	456mm	(18-in)
Weight	148kg	(325lb)

−8%...+5%	Nominal output voltage	−15%...+10%
193...220.5V	210V	178.5...231V
202.5...231V	220V	187...242V
211.5...241.5V	230V	195.5...253V
221...252V	240V	204...264V

Optimum combinations of line stability and transient suppression

Very high transient suppression for short pulse widths. Attenuation factors of 250 and higher

Stabilized output even for very low input voltages (see graph)

Mains 'hold' for short trip outs

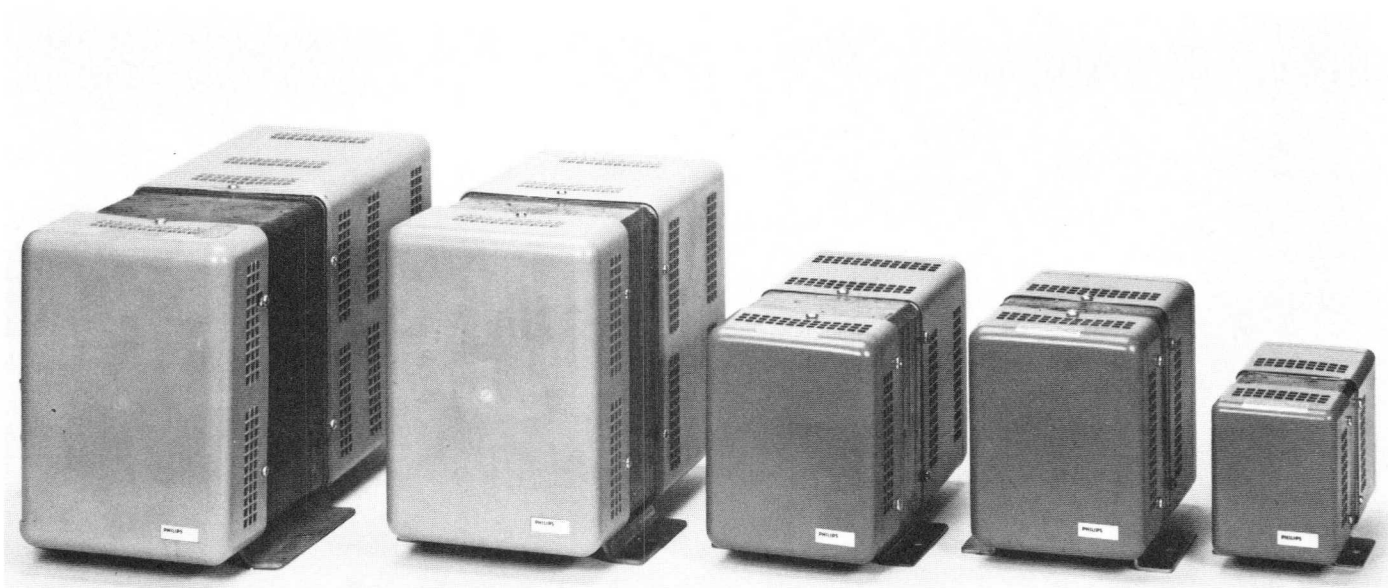
Compact 'monocore' construction

Sinewave outputs with $<$3% distortion

Each model suitable for 50 and 60Hz mains frequencies

Short circuit proof due to automatic overload protection

Constant voltage transformers PE 1400 to 1404



Improving a poor line supply

If equipment is liable to be used in areas where the AC supply is poor, this range of CVTs will counteract adverse line conditions by either minimizing or completely eliminating voltage swings of an unacceptable level, either up or down. Figure 1 shows how even a square wave input is converted into a sinewave with a distortion of only approx. 5%.

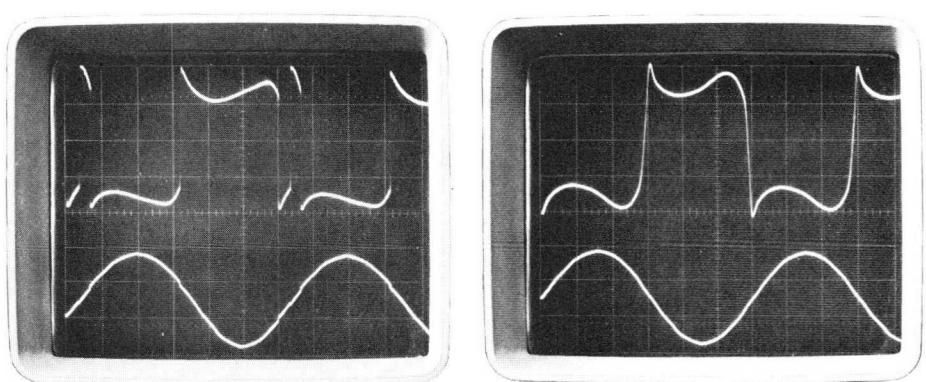
Mains surges

When large items of equipment are switched on, a locally generated mains supply may fall to a very low value before the generator can make up the new demand. Figure 2 shows how a Philips CVT model PE 1402 can 'hold up' the mains supply. For example, on half load with an input of only 100V the output is only about 6% down from the nominal value. For all models this figure is less than 10%.

Mains transients

Switching on equipment such as lifts and machine tools and even SCR equipment often causes transients and for many applications such as computers and digital equipment this can cause an expensive component failure. Philips CVT's are

Fig. 1. Oscillograms show how even a square wave input is converted into a sinewave having low distortion.



offered in alternative versions, therefore, whereby very high transient suppression is achieved with a slight loss in line stability. This is illustrated in figure 3. The suppression varies with the pulse widths and loads, but a typical improvement for a 11 μs pulse is from an attenuation factor of 60 (−30dB) to over 110 (approx. −40dB) for only a slight loss in stability from 1 to 2% (for ±10% mains variations).
For shorter pulse widths the improvement is even greater. The attenuation factor rises from around 100 to over 250 for a 1.3μs pulse.
This improvement in transient suppression is physically achieved by disconnecting the compensation winding, which is simply a matter of arranging the terminals. You can therefore choose the optimum combination of line stability and transient suppression to match the application.

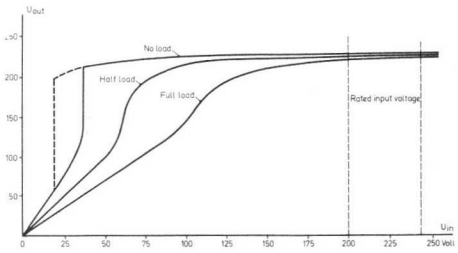


Fig. 2. Illustrates input/output voltage characteristics of model PE 1402.

Mains 'hold'

It is not uncommon for the mains supply to trip out for part of a cycle, a condition which is disastrous for computers and digital equipment. A Philips CVT effectively holds up' the mains supply under these conditions.

Both 50 and 60Hz operation

A simple rearrangement of the terminals converts a Philips CVT from 50 to 60Hz or vice versa. Therefore only one model need be stocked and fitted, making your equipment suitable for export to both 50 and 60Hz markets.

Compact construction

There is no competitive CVT on the market which approaches the compact dimensions of the Philips models. Less valuable space is therefore taken up in your equipment.

Special models can be made on request to suit customer requirements with respect to different power ratings, input and/or output voltages, mains voltage variations, stability, size, etc.

Special executions also function as constant voltage mains transformers

If the output of your conventional mains transformer is rectified, then for many applications, it is possible to use a special model stabilizer. These units deliver a square wave output, and must obviously be wired-up to suit the individual voltage requirements.
For original equipment manufacturers these models thus allow all the advantages of transient suppression, stability and mains hold to be achieved extremely economically. Units are currently available with output capacities from 30 to 700VA.

N.B. Very latest research has shown that for rise times of less than 1.3μs the attenuation factor is > 100, with the winding connected, and > 250 when disconnected. See fig. 4.

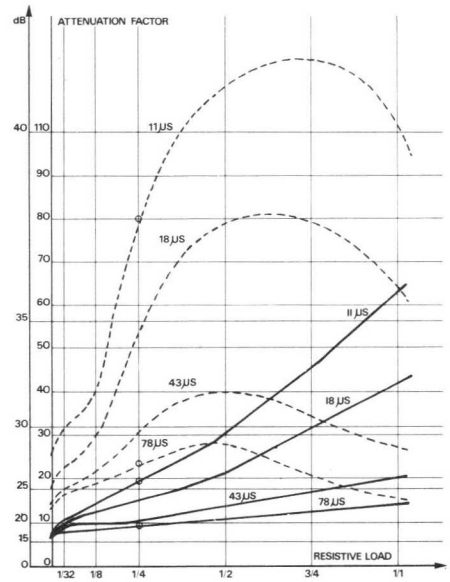


Fig. 3. Dotted lines show suppression with compensation winding disconnected, for transients having rise times from 11 to 78μs. Solid lines show suppression with winding connected. Thus for ¼ load and on 11μs transient, the improvement is from an attenaution factor of approx. 20 to 80.

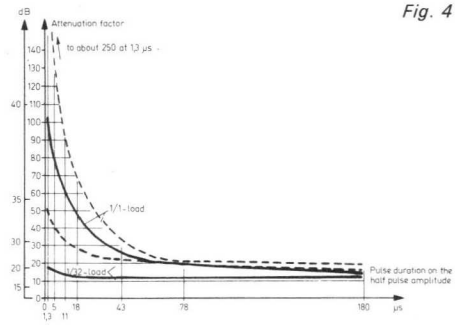


Fig. 4

Constant voltage transformers

Power rating	Input voltage[2])	Frequency	Output[1]) voltage[2])	Output voltage fluctuations at:[3]) ±10% mains variations (a)	(b)	±10% mains and 0⇄ 0%⇄100% load variations power factor=1 (a)	Power factor	Response time	Distortion	Dimensions w × h × d	Type
VA	V	Hz	V	%		%	inductive	ms	%	mm	
0... 100	220/240	50/60	220/240	< 1	< 2	< 2.5	0.7...1	< 30	< 3.5	112 × 130 × 200	PE 1400
0... 200	220/240	50/60	220/240	< 1	< 2	< 2.2	0.7...1	< 30	< 3.5	160 × 181 × 210	PE 1401
0... 400	220/240	50/60	220/240	< 1	< 2	< 2.0	0.7...1	< 30	< 3.5	160 × 181 × 240	PE 1402
0... 850	220/240	50/60	220/240	< 1	< 2	< 1.7	0.7...1	< 30	< 3.5	200 × 256 × 322	PE 1403
0...1500	220/240	50/60	220/240	< 1	< 2	< 1.5	0.7...1	< 30	< 3.5	200 × 256 × 370	PE 1404

[1]) At an input voltage of 220V/50Hz, 1/2 load with a power factor 1.
[2]) 240V only for use at max. transient suppression i.e. line stability 2% and typical transient suppression −40dB.
[3]) a) Typical transient suppression −30dB.
b) Typical transient suppression −40dB.

Designed for 19-in rack systems constructed to DIN 41494

Switched mode technology for high efficiency ⩾65 . . 70%

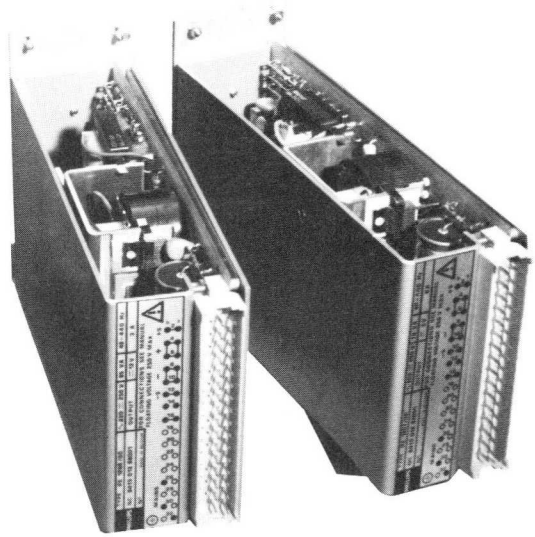
High transient suppression 75dB sym 65dB asym

Interference N level to VDE 0875 (input) and IEC 478-3 (output)

new

DC/DC converters
PE 1100 5V/6A
PE 1101 12V/3A

These DC/DC converters, designed to power 5V or $12V_{DC}$ circuits from 24V buses or batteries, are the forerunners of a new range of DC/DC power supplies. Features include galvanic separation, high-efficiency switched-mode technology and modular construction for DIN 41.494 Euro-style, 19-in standard rack-mounting.
PE 1100 and PE 1101 are both contained within the 10T standard width modules and have 32-pin input/output connectors. Special attention has been paid to safety and quality standards and careful selection of components and overall mechanical design have produced a predicted MTBF of 50000 hours. All units undergo thorough mechanical and climatic tests (see tables 2 and 3).
In addition, both units have built-in overload protection and can be operated in series or parallel hanks. Remote programming, sensing and on/off are standard.



TECHNICAL SPECIFICATIONS

Applicable to both models unless otherwise indicated

INPUT DATA

Input voltage
Nominal $24V_{DC}$ (18-30V)

Efficiency
PE 1100 ⩾ 65%
PE 1101 ⩾ 70%

Output Data
See table 1

GENERAL

Regulation
Source effect: ⩽ 0.1%
With mains voltage variation of + or −10%
Setting effect 0.1%
Load effect: ⩽ 0.2%
At load variation from no load to full load and vice versa
Settling effect 0.1%
Combined source: ⩽ 0.3%

Pard (ripple and noise)
⩽ $12mV_{RMS}$
⩽ $50mV_{p-p}$
Including HF spikes
Measured with 30MHz bandwidth oscilloscope

Temperature coeffient
⩽ 0.02%/°C

Turn-on delay time
⩽ 200mS

Overshoot
During turn-on and turn-off there is no voltage overshoot on the output

Ambient temperature
Specified operating temperature 0...55°C
Operating temperature −15°C...+70°C
Storage temperature −40°C...+85°C

Overcurrent protection
The units are protected by a self restoring automatic overcurrent protection, which makes them completely short circuit proof

Overvoltage protection
The units are protected against overvoltage by a circuit, which interrupts the drive of the power transistors.
On delivery the OVP is adjusted on: PE 1100 between 5.8V and 6.1V adjustable up to 7V
PE 1101 between 13.5V and 14.5V adjustable up to 18V

Remote programming
The output voltage can be programmed by means of an external resistor of with an external voltage

Remote sensing
In case of remote sensing the units can compensate voltage losses in the power leads.

Remote on-off
The output voltage will fall down to 0, if an external voltage of 10-15V at 6mA is applied

Series/parallel connection
Two or more units may be connected in series and/or parallel. The voltage between any one of the output terminals and earth may not exceed 130V DC or AC. The output terminals are floating with respect to earth. Either the '+' or the '−' terminal may be earthed

Table 1 OUTPUT DATA Output voltage current

V_o nominal set at delivery	Setting range	$T_{amb} \leq 55°C$ convection cooled	$T_{amb} \leq 70°C$ convection cooled	Forced air 1mtr/s temp 55°C	Fraction of width	Type
5V 12V	4-6.3V 4-16V	6A 3A	3A 1.5A	7A 3.5A	10T 10T	PE 1100 PE 1101

1T=5.08mm

Dynamic behaviour and transient response

Load variations in % of I_{nom}	10% to 100% 100% to 10%	50% to 100% 100% to 10%
$\frac{dI}{dt}$ 0.5A/µs		
recovery time* overshoot max	2ms 500mV	1ms 200mV

* *to within 0.5% of final value*

Radio frequency interference RFI
To the mains according to VDE 0875 N level. At the output according to IEC 478-3

Transient suppression
The units have an excellent suppression of transients on the mains as an example, a voltage peak on the mains with a $\frac{dV}{dt}$ of 600V/µsec and a pulse width of 80 µsec appears on the output leads suppressed by a factor of approx. 75dB symmetrically and 65dB asymmetrical (tested with interference generator schaffner NSG 221)

DIMENSIONS AND WEIGHT

(w × h × d) 50.3 × 100 × 171.1mm
0.58kg

Mounting
These units can be mounted into 19-in racksystems which are constructed to DIN 41494 (IEC publication 297 Euronorm), that means they are suitable for systems as Intermas, Siemens, Isep, Schroff, Vero, Knurr, Transrack, Elma and Philips.
Also frontplates (10T) of these systems can be used. They can also be supplied free-standing for building directly into an equipment.
Mounting holes M3 are therefore provided on the top, underneath and at the rear.

Rear connections
Input/output connections are made via a 32-pole connector acc. to DIN 41.612

Safety and quality
In accordance with:
VDE 0804 safety requirements for telecommunications systems, VDE 0760 and IEC 435 safety requirements for data processing equipment, VDE 0411 and IEC 348 safety requirements for electronic measuring equipment and IEC 68 class I (see tables 2 and 3).

Documentation
All units are issued with operating manuals based on IEC publication 478.

Table 2

	Frequency	Amplitude in mm	Acceleration	Time	Referene
Vibration test	10-150Hz	0.7p/p	50m/sec² max.	30 min each direction	IEC 68 test Fc.

Bump test	Number of bumps	Acceleration	Reference
	1000 in each direction	100m/sec.²	IEC 68 test Eb

Table 3

Climatic test program	Temperature	Relative humidity	Time after reaching temperature equilibrium	See footnote	Mains voltage	Mains freq.	Reference
Reference	15°-35°C	45-75%	–	²)	nominal	50Hz	IEC 68-1-5.3.1.
Dry heat test Equipment operating	+55°C	50%	2h	²)	+10%	50Hz	IEC 68-2-2 test Bd
Cold test Equipment operating	−10°C	–	2h	¹)	±10%	50Hz	IEC 68-2-1 test A-1d
Damp heat steady state operating	40°C	90%	10 days	²) after recondi-tioning			IEC 68-2-3 test Ca
Cyclic damp heat test. Equipment switched off	25°-40°C	90-100%	21 days	²) after recondi-tioning			IEC 68-2-30 test Db
Storage test	−40°C +70°C	50%	72 h 6 h	²) after recondi-tioning ²) after recondi-tioning			IEC 68 test Ab + test Bb

¹) = operating
²) = operating within specification

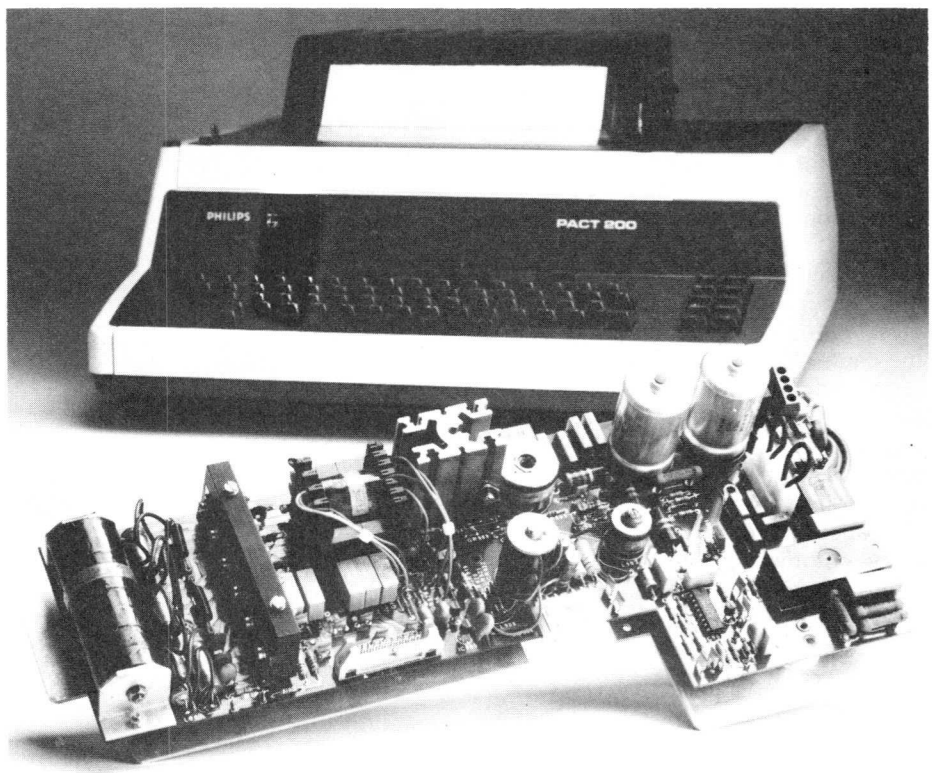
new
Custom-designed power supplies

Introduction

In addition to the comprehensive range of standard power supplies, special designs can be undertaken to meet specific customer needs. Therefore, when it is not possible to meet a power supply problem from the normal stock item units, our team of experienced designers will investigate individual requirements.

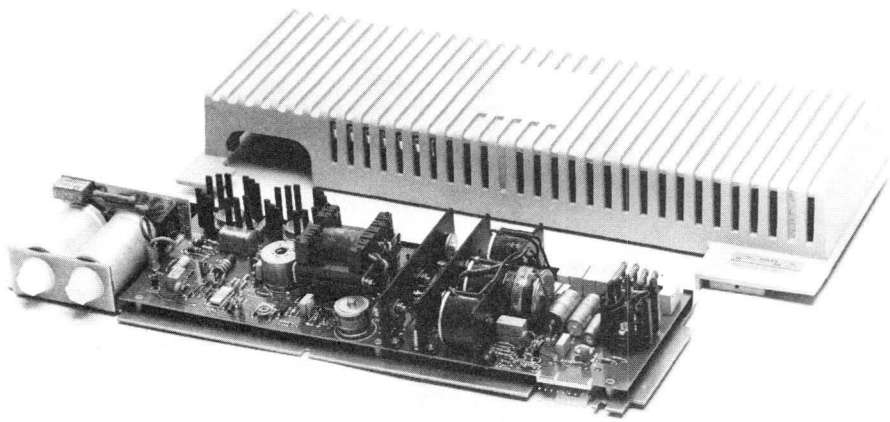
Since the 'tailor-made' types vary tremendously in electrical and mechanical design and performance, it is only possible to give some examples of some of the units already supplied. It should be noted that the type numbers quoted serve as a guide only – it is not possible to order these units as in the case of standard power supplies. Enquiries should be made to your NATIONAL PHILIPS ORGANIZATION using the address list which appears at the back of this catalog.

The individual 'tailor-made' units that appear in this section are only a small selection of those power supplies that have already been designed and supplied to customers in various parts of Europe. However, they are intended to demonstrate the very wide range of applications that have already been satisfied by our custom-design service.



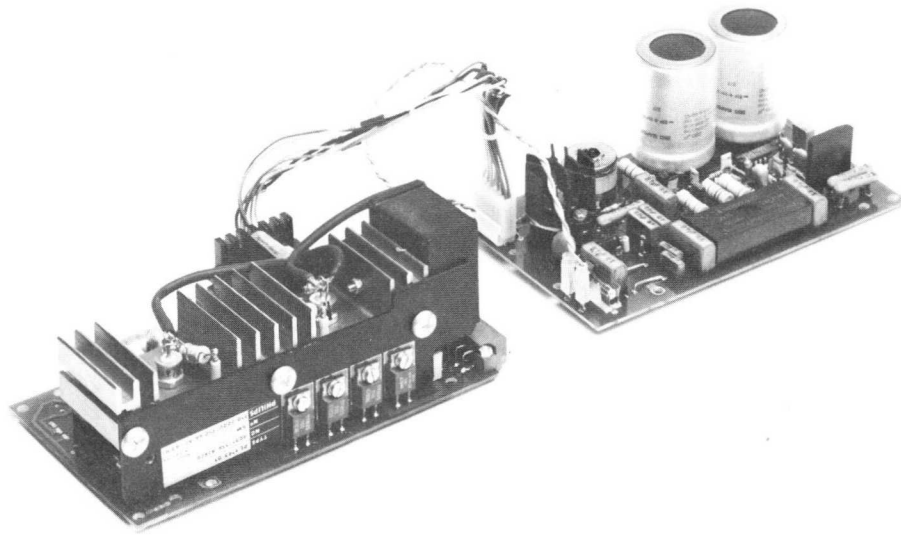
This switched-mode power supply was designed for operation in a very restricted space. An important feature is the extremely high reliability requirement and high noise-suppression factor. It is for operation in the Philips Fact 200 telex machine.

Special note: These units can not be ordered in the normal way. Enquiries should be made to your NATIONAL PHILIPS organization. An address list appears at the end of this catalog.



The PE 1705 is a switched mode power supply for use in a cashier station with a microprocessor printing and display unit. Outputs are (DC) 5V/4.5A, 12V/1A, 24V/2.5A and 72V/0.5A.

Microcomputer power supply PE 1727



Microcomputer power supplies
Designated PE 1727 this design resulted from a demand for microcomputer applications. Its nominal 100W output is suitable for driving several peripherals and can be upgraded when forced air cooling is used. It is very reliable and versatile in application and is extremely compact.

It is mounted on two Eurocards with three interconnecting cable harnesses. This gives the user the opportunity to mount the cards in several different ways, depending on the mechanical limitations of his own equipment. Natural cooling is adequate when the cards are mounted vertically. When fitted in the horizontal plane, forced air cooling is necessary. This also applies where it is decided to increase output power on the nominal 5V or 12V outputs.

Mains interference is low and meets level N-12 according to VDE 0805.

Special note: These units can not be ordered in the normal way. Enquiries should be made to your NATIONAL Philips organization. An address list appears at the end of this catalog.

TECHNICAL SPECIFICATION

INPUT

Input voltage
110/120V ±15% solderable

Frequency
47 to 63Hz

Allowed transients
Max. 1.5kV/50μs asymmetrically

OUTPUT

(The +5V, −5V and ±12V outputs are specified separately)

+5V
Output voltage
+5V adjustable 0...+5% (common for +5V and ±12V outputs)

Load
1.5 to 10A, with forced air cooling the maximum load may be increased to 15A but consult factory

Regulation
Within ±3% for load change 15...100%, and mains ±15% and specified temperature range

Ripple (PARD)
Less than 100mV$_{p-p}$ measured at the load with a decoupling capacitor on 220nF and a 50MHz bandwidth oscilloscope

Overvoltage protection
The unit is protected against overvoltage by a circuit, which interrupts the drive of the power transistor.

+12V
Output voltage
+12V adjustable 0...+5% (common for +5V and ±12V outputs)

Load
0.5A to 2A, with forced air cooling or reduction of −12V load, the +12V load may be increased

Regulation
Within ±3% for load change 25...100%, and mains ±15% and specified temperature range

Ripple (PARD)
Less than 200mV$_{p-p}$ (measured with 50MHz bandwidth oscilloscope)

−12V
Same specification as +12V output

−5V
Output voltage
Separately adjustable from −5V to −9V.
Note this output has common return line with −12V

Load
0 to 0.5A

Regulation
Within ±1% for load change 0 to 100%, and mains ±15% and specified temperature range.

Ripple (PARD)
Less than 50mV$_{p-p}$ measured with a 50mHz bandwidth oscilloscope

GENERAL

Isolation
All outputs are isolated from the mains and from each other except −5V which has common return with the −12V output

Short circuit protection
All outputs are short circuit proof

Energy reserve
10ms at nominal input voltage and 100% load

Mains interference
Below VDE 0875 curve N-12 (when mounted in a cabinet with an extra filter on the mains inlet)

Safety
In accordance with IEC 435 class I.

Ambient temperature
According to specification: 0...+50°C
Storing: −40...+70°C

Environmental specifications
In accordance with IEC 68-2

Cooling
Self-convection for specified output power with forced air cooling the maximum load may be increased

DIMENSIONS

Each card has the dimensions 100×160mm, the heights are 58 and 63mm respectively. When the cards are mounted in Eurorack (DIN 41494) the minimum spacing should be 18T.

Connectors
Mains input: Schroff 69001-651
Output: DIN 41612 Type D

500V isolation input-output-ground

MTBF >100 000 h

5V, 14V or 22V output

Undervoltage alarm

Adjustable current limiter

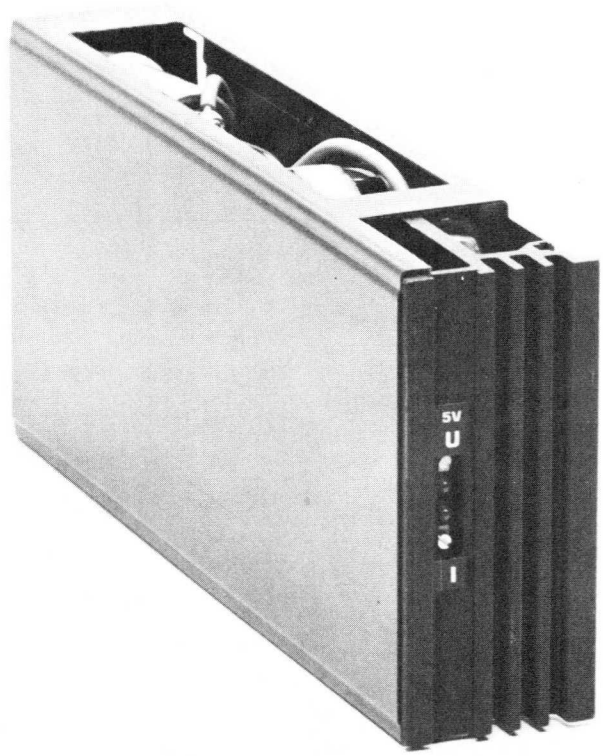
DC/DC Converters PE 1715/16/17

The PE 1715/16/17 meet the demand for ultra-reliable power supplies with good input filtering to reduce ripple and protect against transients. Designed for use with TTL logic and in situations where, for example, noise-sensitive units like transmitters or telephone exchange equipments are connected to the same source.

Careful design has reduced the asymmetric current to below 200mA$_{p-p}$ (measured in short-circuit mode between input and output/ground).

For parallel operation, a variable current limiter, adjustable on the front panel, can be set between 20 and 140% of nominal output current. This provides equalized load-sharingplus protection against excessive current in systems under fault conditions. The status is LED-indicated.

Special note: These units can not be ordered in the normal way. Enquiries should be made to your NATIONAL Philips organization. An address list appears at the end of this catalog.



PE 1715

TECHNICAL SPECIFICATION

INPUT

Input voltage
DC 18V-30V

Input ripple
The ripple produced on the supply line is less than 200mA$_{p-p}$

Input transients
Maximum 500V discharge from an external 0.1μF capacitor with 1...2Hz rate between input terminals

Isolation
500V$_{AC}$ between input-output-ground

OUTPUT

Output voltage
PE 1715 5V adjustable ±10%
PE 1716 14V adjustable ±10%
PE 1717 22V adjustable ±10%

Output current

	40°C	55°C
PE 1715	10 A	8 A
PE 1716	4 A	3.2A
PE 1717	2.5A	2.0A

Output ripple (PARD)
Measured with balanced oscilloscope (100MHz BW)
PE 1715 100mV$_{p-p}$
PE 1716 300mV$_{p-p}$
PE 1717 300mV$_{p-p}$

Regulation

Source effect	18V-30V	±1%
Load effect	50-100%	±2%
Load effect	100-5%	⩽ 10%
Temperature coefficient		±0.02%/°C

Current limitation
Adjustable from 20% to 140% of nom. load. Overload is indicated by a LED in the front.
The output is short circuit proof.

Overvoltage protection
The converters are protected against overvoltage by a circuit, which interrupts the drive of the power transistor

Undervoltage alarm
Free relay contacts that open when the output voltage is below 4.7V ±0.1V.
PE 1715 4.7V ±0.1V
PE 1716 12.6V ±0.3V
PE 1717 19.6V ±0.6V
LED indication on the front panel.

GENERAL

Energy reserve
5ms at maximum load and nominal input voltage

Efficiency
⩾ 75% at maximum load

MTBF
Calculated according to MIL 217B at 40°C better than 100 000h.

Temperature ambient
0...55°C within specifications
0...70°C functioning with 50% load
−40...+85°C storage

DIMENSIONS AND WEIGHT

(w × h × d) 40 × 91.2 × 210mm
approx. 0,9kg

Connectors
Amphenol Tuchel T2002

CV transformer with rectifier PE 1431

PE 1431

Compact monocore construction

Suitable for 50Hz and 60Hz mains frequencies

High ambient temperature operation

Very high transient suppression

Galvanic separation between input and output

This unit was custom-designed as a pre-stabilizer and is used in areas with a poor AC supply and where transients, sudden voltage surges and/or drops may be dangerous for the electronic circuitry. Indeed the unit is not only a stabilizer but is also acting as a filter. The unique feature of 'mains hold' when a short mains drop out occurs, makes this unit specially suitable for use with data handling equipment.

TECHNICAL SPECIFICATION

Input
The nominal input voltage is adjustable for 110V, 210V, 238V_{AC}, 50Hz or 60Hz. The choice of wanted voltage and frequency is achieved by a simple rearrangement of the terminals.

Output
Voltage: 28V_{DC}
Current: 5A

Stability
The output voltage fluctuations are $\leqslant \pm 1.5\%$ for a $\pm 10\%$ mains variations and $\leqslant \pm 8\%$ for load variations from no load to full load.

Ripple voltage
$\leqslant 2V_{p-p}$
Facilities for long or short distance load connections are provided

Insulation voltages
- Between primary winding and earth: 2000V_{AC}/50Hz
- Output: The output terminals are floating with respect to earth
- The test voltage between secondary and earth is 1500V_{AC}/50Hz

GENERAL

Ambient temperature
−20°C to +55°C
(without derating)

Dimensions (mm)
(w × h × d)
with covers 160 × 181 × 206
without covers 160 × 181 × 191

PE 1806

Eurocard design employing 32-pin connector to DIN 41612

High ambient temperature operation

Powered from rectifier or battery

Over current protection

MTBF: over 120 000 hrs

The Euro-system design makes this card suitable for use in mechanical building systems according to DIN 41494.
As other cards with e.g. ±15V outputs are also available, the modular approach of building up a complex but flexible power supply system, powered from one single mains transformer with rectifier, is possible.
Designed for a very high MTBF of over 120000h, this DC/DC converter is an extremely reliable unit.

DC/DC converter without galvanic separation PE 1806

TECHNICAL SPECIFICATION

Input
36V_{DC} ±10%

Output
Voltage: 5V_{DC}
Current: 6A

Stability
The output voltage fluctuations are < 0.3% for ±10% input voltage variations and < 1.5% for load variations of no load to full load.

Ripple
< 50mV_{p-p} (bandwidth 30MHz).
Short circuit protection

GENERAL

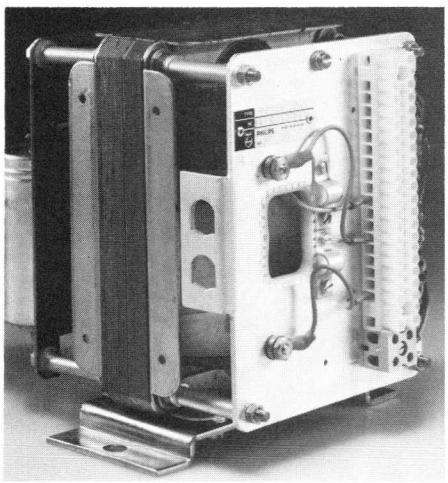
Ambient temperature
0-60°C (without derating)

Dimensions (mm)
(w × h × d) 37.5 × 100 × 167

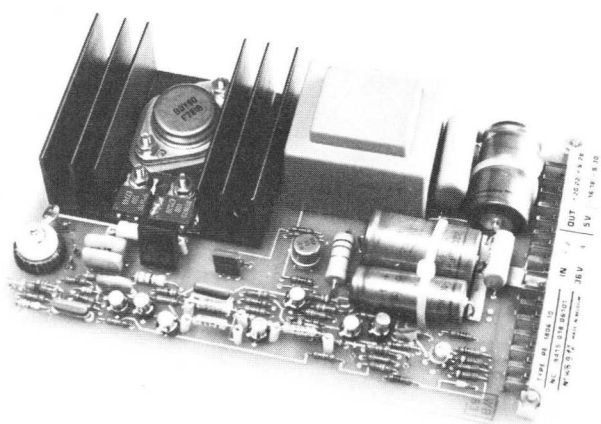
Safety
According to IEC 348

Note:
Other input voltages, other dimensions connector according to customer whishes are possible for quantity orders. Crowbar is optional.

PE 1431



PE 1806



Special note: These units can not be ordered in the normal way. Enquiries should be made to your NATIONAL Philips organization. An address list appears at the end of this catalog.

Measuring Mechanical Quantities

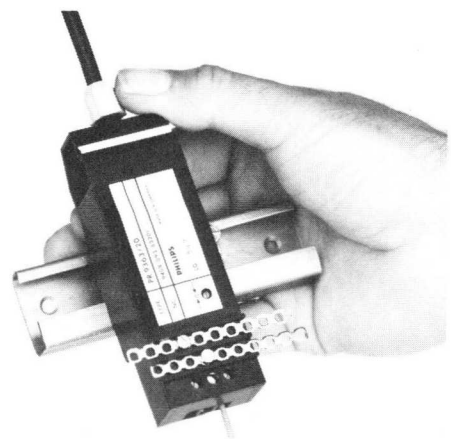
Introduction

Philips offer a complete range of equipment specially designed for measuring mechanical parameters. This equipment forms the subject matter of a separate catalogue: *Electronic Measurement of Mechanical Quantities*. Some contents of this catalogue are shortly mentioned here, as in many instances the measurement of mechanical parameters complements the test and measuring functions. For complete information, please order the above mentioned catalogue from your local Philips organisation or write to: Philips GmbH Werk für Meßtechnik, 2000 Hamburg 73, Meiendorferstrasse 205, P.O. Box 730 370, Dept. CM.

A comprehensive, modular range
As explained in the table alongside, the Philips equipment for measuring mechanical quantities is built up in a modular way, and measuring chains can be easily assembled to meet the exact application requirement.
The complete range of general purpose transducers for detection of the mechanical quantities can be used either with general purpose, high accuracy, laboratory type measuring bridges, or with special, extremely compact industrial signal converters, which are designed for trouble-free operation, also in the harshest environment. Special purpose transducers and electronics are available for solving specific measuring problems in particular fields. Switching units may be used for connecting a large number of measuring points to the same measuring bridge or bridge amplifier and contactless transmission systems enable a problem-free transfer of the transducer output from rotating or moving machine parts. The output signals of the measuring bridges or bridge amplifiers may be displayed or recorded on a wide range of equipment, as described in this Test and Measuring catalogue.

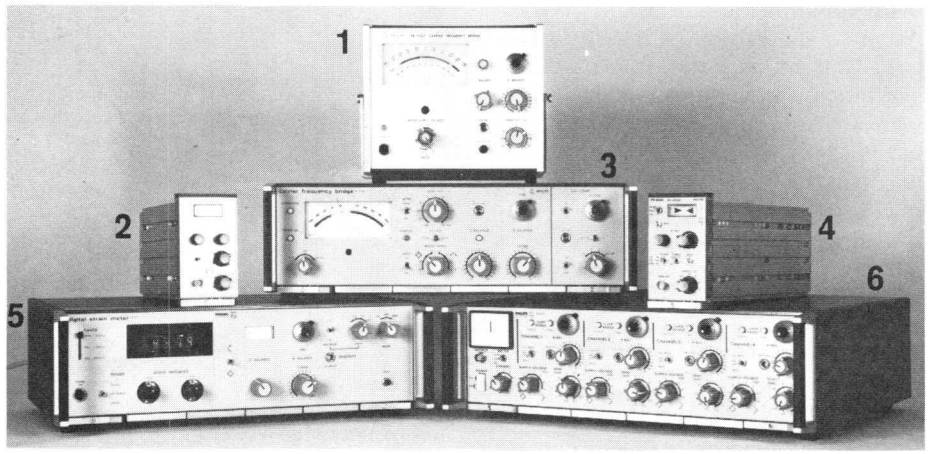
Detection	**Measurement Switching**	**Indication Recording Data Logging**	**Application**
General Purpose Transducers for: Torque Force Strain Pressure Temperature Displacement Acceleration Vibration Rotation	**Industrial Signal Transmitters** Converters Amplifiers Limit detectors Peak-hold units Power supply units etc.	Digital voltmeters Indicators Recorders Oscilloscopes Magnetic tape Data loggers etc.	**Industrial measuring Chains** Mechanical engineering General industry OEM's etc.
	Universal Electronics Converters Measuring bridges Bridge amplifiers Switching units Contactless transmission system		**General Purpose Measuring** Research and development labs. Education General industry etc.
Special Purpose Transducers for: Relative displacement Eccentricity Radial or axial displacement Web tension etc.	**Special Purpose Electronics** Displacement amplifiers Web tension signal converters, etc.		**Rotational Machinery Supervision** **Web Tension Measurement**

Transducers
Philips have a very complete range of general purpose and special purpose signal transducers for the measurement of all mechanical parameters, dynamic and static. These signal transducers convert any change in the mechanical quantity into a proportional change of electrical quantity, e.g. resistance, inductance or capacitance, which is evaluated by the measuring bridge or bridge amplifier. Illustrated here is a strain gauge type transducer for torque measurement.



Measuring bridges for all applications

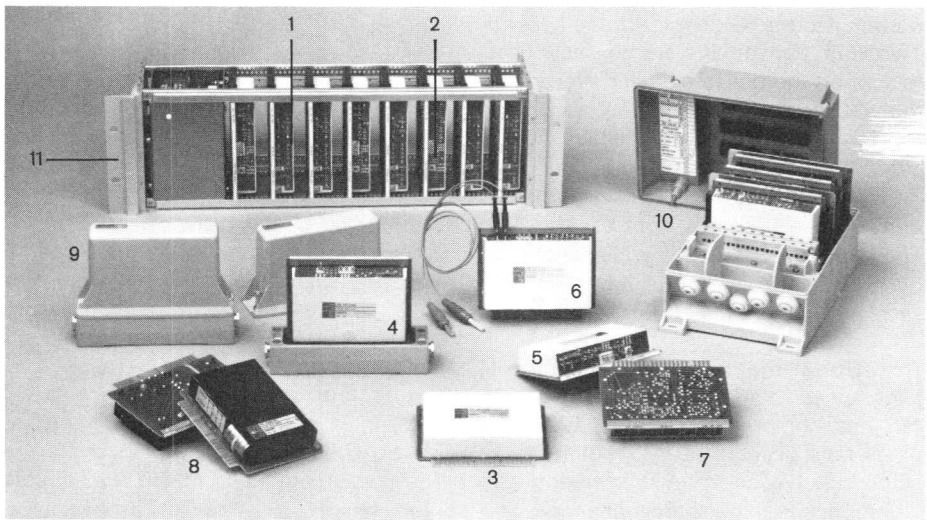
Illustrated here is a range of measuring bridges and bridge amplifiers designed for exacting research and development applications in the laboratory or for measurements in industry and in the field. It includes carrier frequency bridges with trouble-free balancing and phase adjustment, allowing highly accurate measurement of dynamic signals up to 1kHz; as well as easy-to-use DC bridges for measurement of static or quasi-static signals or dynamic signals above 1kHz.



1. *Universal Measuring Bridge PR 9307*
2. *Carrier frequency Amplifier PR 9340*
3. *Precision Measuring Bridge PR 9308*
4. *Compact DC Bridge Amplifier PR 9335*
5. *Digital Measuring Bridge PR 9321*
6. *Four-Channel Strain Amplifier PR 9330*

Industrial converter system

This range of extremely compact building blocks for the measurement of industrial parameters has been specially designed for reliable, accurate and trouble-free operation, also in the most difficult environment. The range not only includes bridge amplifiers for all parameters, but also a wide selection of associated equipment, such as limit detectors, peak-hold units, power supply units etc. All modules have the same diemensions are very easy to install and to use, also without any special knowledge of electronics.



1. *Displacement Converter PR 9871*
2. *Strain Converter PR 9872*
3. *RPM Converter PR 9873*
4. *Vibration Converter PR 9874*
5. *Temperature Converter PR 9875*
6. *Limit Detector PR 9877*
7. *Peak-Hold Unit PR 9878*
8. *Power Supply Unit PR 9880*
9. *Industrial Housing PR 9870*
10. *Industrial Housing PR 9890*
11. *19-in Mounting Rack*

Recording equipment

High speed, single and multichannel recorders are available for accurate registration of the measuring bridge or bridge amplifier output signals. PR 9038 Series recorders, for instance, are available with up to 8 channels and a wide choice of paper speeds. They have a high sensitivity and are equipped with DC amplifiers enabling static and quasistatic as well as purely dynamic processes up to 300Hz to be recorded.

Stroboscopes

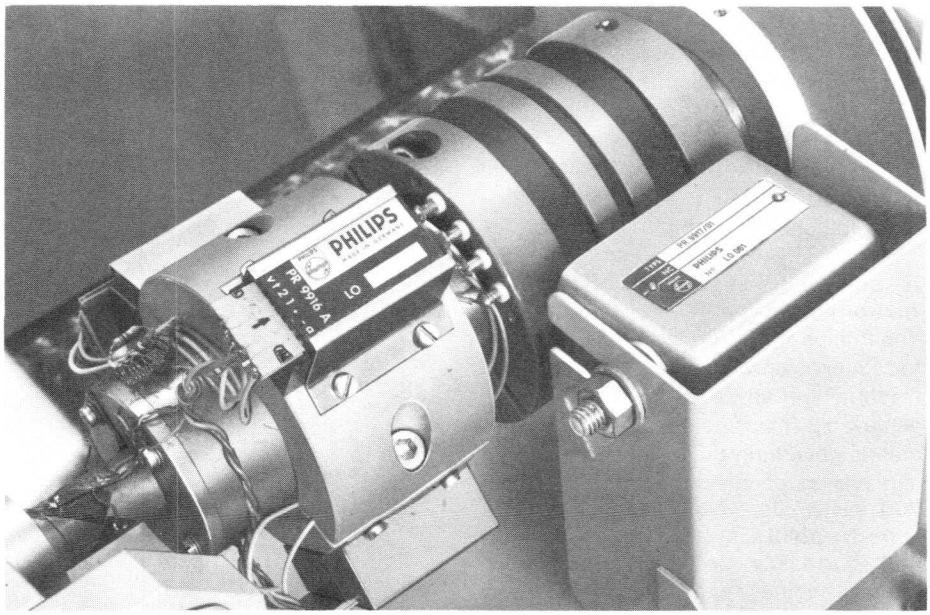
A choice of two stroboscopes is available, either with battery or mains power supply. Both are lightweight and offer wide flash frequency ranges.

Contactless Transmission System

This system is used for amplification and contactless transmission of very small signals from a rotating part to a stationary part.

The change in the transducer resistance alters an oscillator frequency, and the resulting signal is transmitted through a coil wound around the moving or rotating part.

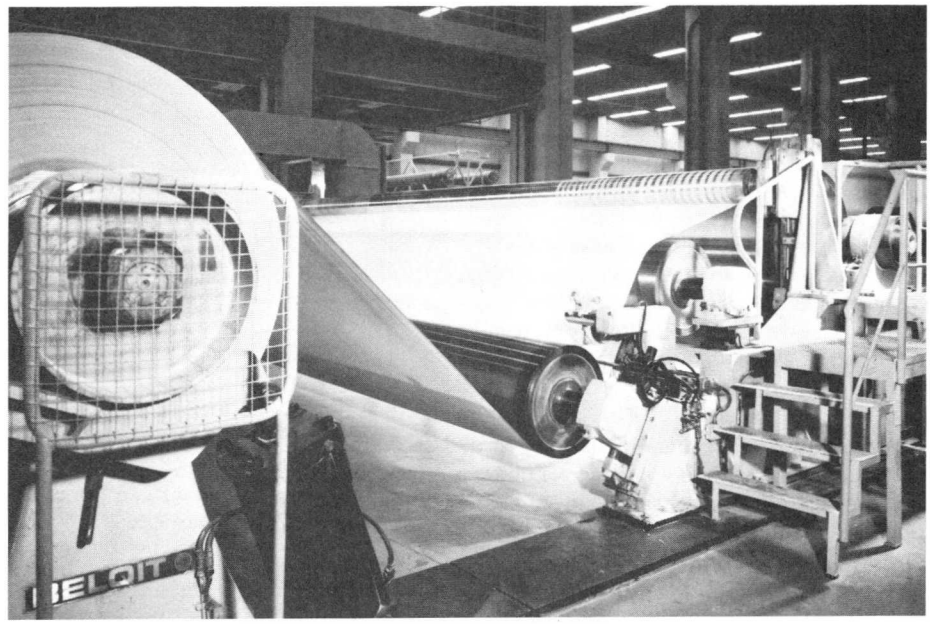
The receiving part consists of a receiving coil and a discriminator which demodulates the frequency change to provide a DC voltage directly proportional to the original resistance change in the transducer. Battery and mains operated systems are available.



Torque measuring setup using the small size building blocks of the contactless transmission system for continuous operation.

Web tension measurement

Accurate supervision of tensile strength is of vital importance in the production and processing of paper, textiles, plastic, wire and similar products. Only if the tension is held correct, is it possible to maintain the quality of the finished product at a consistantly high level. Philips have developed a special range of equipment which provides an ideal way to monitor, indicate and control web tension at all stages of production. This equipment is very accurate and reliable, extremely robust, and is easy to install in any production line – old or new.



Operation

Philips web tension measuring systems are based on force transducers which produce an electrical signal that is proportional to the mechanical force applied. Two such transducers are normally used to support the pulley or roller over which the web passes. They operate according to the magneto-elastic principle and include no moving parts.

Force transducers are available for measuring tensile strengths from 0...10000N. They are very robust, withstand high overloads and operate reliably under the severest environmental conditions.

Rotational machinery supervision

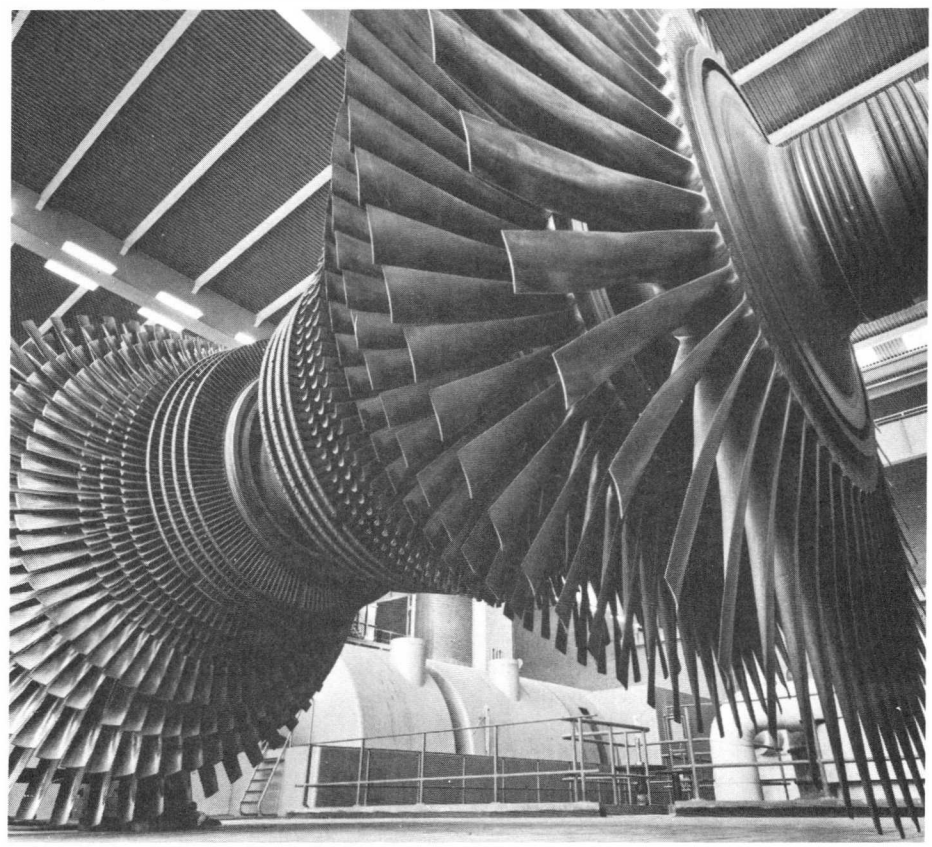
High speed rotational machinery such as turbines, compressors, pumps, diesel engines, fans, gear boxes, etc., requires constant supervision of displacement and vibration levels of shafts, bearings and housings. Philips have a complete range of transducers, amplifiers and associated equipment that can be used to form inexpensive measuring chains, tailored to the exact requirement of such monitoring systems. This equipment provides the information which is needed to take remedial action before serious faults develop, to generate alarms when pre-set levels are exceeded or to automatically control the shut-down of the machine before dangerous situations are realized. It can also be used as an aid to machine development or to simplify fault finding.

A supervisory system for all kinds of turbomachinery

The Philips RMS 700 system is designed for supervision and protection of turbomachinery of any size and speed. This is achieved by measurement of all vital parameters governing the running status and supervision of ensuing data. The RMS 700 system is equally suitable for the largest turbines used in power stations and in industry, down to compressors, pumps, engines, water-, gas- and small steam turbines, fan blowers, ventilators, centrifuges, generators and other industrial rotating machinery. With a single system it is possible to supervise static or dynamic conditions. This includes the absolute and relative, axial and radial shaft displacement, relative shaft and absolute bearing vibration, foundation vibration, housing and shaft expansion, as well as relative displacement between shaft and housing, thrust bearing wear, rpm, bearing and oil temperatures, steam and oil pressures, valve positions and wear and tear of all other bearings.

Measuring chain

The output signals from the transducers are modulated onto a 5kHz carrier frequency and fed to a signal converter, which provides a DC output from 0 to 100mV, suitable for display on an indicating instrument. The converter features two controls for tare and sensitivity adjustment. By plugging in an additional printed circuit board into the converter module, an amplified output signal is made available for control purposes. A second plug-in card can be added if a contact signal is required at a predetermined level of web tension. It can be used to actuate an alarm when a web breakage occurs.



Part number index

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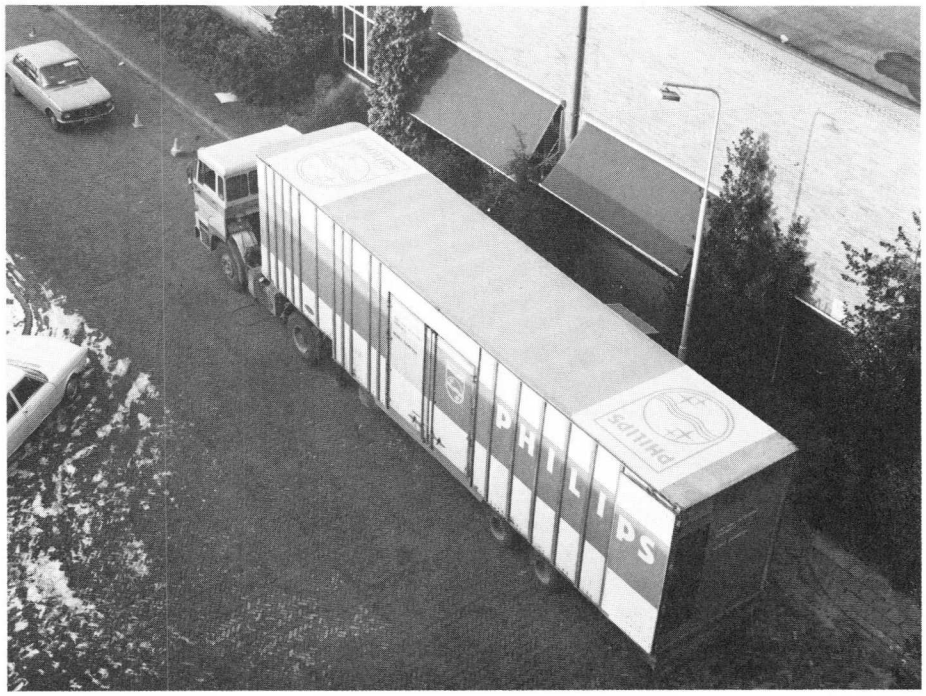
Zambia: Philips Electrical Ltd., Professional Equipment Division, P.O.B. 553 Kitwe; tel. 2526/7/8

The T&M travelling exhibition

The T&M travelling exhibition is equipped with most T&M instruments and travels some 50,000km every year. At least 10,000 visitors pass through it annually. Its average time on the road over the last few years has been approximately 40 weeks, out of 52. During 1979 it visited: Greece, Italy, The United Kingdom, Bulgaria, Jugoslavia, Belgium France, Rumania, Austria, Germany, Hungary, Spain, Portugal and Norway.



Should this mobile exhibition be visiting your area the local Philips national organization will announce its arrival dates in advance by posters and through the local press.

In the event of its visiting your locality you will have the opportunity to see a working demonstration of almost any instrument in the T&M range.

Mobile exhibition of Philips "Test and Measuring Instruments"

Exhibition programme

Dear Sirs,

We kindly invite you herewith to visit our Mobile Exhibition, which will show you in operation more than 60 instruments belonging to our range of "Electronic Test and Measuring Equipment".

As you may learn from the schedule, specified alongside, our demonstration van will be parked in 8 towns in Romania from Monday, 11th June 1979 till Friday, 22nd June 1979.

Further more we can give you information about the rest of our programme, such as Electron Microscopes, X-ray Diffraction, X-ray Spectrometry, P.T.V. equipment, Emission Spectrometry, Process Control equipment, Measurement of Mechanical Quantities, Industrial X-ray, Security Screening Systems, Pollution Measuring equipment.

We sincerely hope that you will find the time to come and see us at the exhibition.

Yours faithfully,
p.p. N.V. Philips Gloeilampenfabrieken
M.L. van Glabbeek

PHILIPS

View of the interior of the T&M travelling exhibition showing some of the equipment used for demonstrations.

Alternative battery types

It sometimes happens that Philips batteries may not readily be available to users of Philips instruments. In order to assist in seeking alternative battery types, this table shows the equivalent type numbers for other manufacturers' batteries. These are classified (normal, heavy, super-duty, etc) and the appropriate voltages and dimensions are also shown.

Voltage	Dimensions in mm.	IEC nr	Neda nr.	Quality	Philips	Duracel	Ever-ready
1.5V pen light	50 × 14∅	R6 R6 R6 LR6 R6 MR6	15F 15 15D 15A 15M	Flash light Normal duty Heavy duty Alkaline Super duty Mercury	R6TI R6ND R6HD R6SD	M15F M15HD MN1500 ZM9	915 1015 1215 E91 E9
1.5V	50 × 25∅	R14 R14 R14 LR14 R14	14F 14 14D 14A	Flash light Normal duty Heavy duty Alkaline Super duty	R14TI R14ND R14HD R14SD	M14F M14HD MN1400	935 1035 1235 E93
1.5V	61 × 34∅	R20 R20 R20 LR20 R20	13F 13 13D 13A	Flash light Normal duty Heavy duty Alkaline Super duty	R20TI R20ND R20HD R20SD	M13F M13HD MN1300	950 1050 1250 E95
9V	49 × 27 × 17	6F22 6F22	1604 1604D 1604A 1604M	Normal duty Heavy duty Alkaline Mercury	6F22ND 6F22HD	M1604 M1604HD MN1604 TR146X	216 1222 522 E146XX

IEC = International Electrotechnical Commission (Pub 86)
Neda = National Electronic Distributors Association (USA)

Please send this card to
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in your country
Or to:

N.V. PHILIPS' GLOEILAMPENFABRIEKEN
TEST AND MEASURING INSTRUMENTS DEPT.
EINDHOVEN - Holland

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Please: Arrange a demonstration ☐ Send a quotation ☐ Send a brochure ☐
Send a data sheet ☐ on the following instruments:

80/81

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address .....

country .....

company .....

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PHILIPS

17 JAN 1980

Prijslijst bij catalogus test and measuring instruments

December 1979

Typenummer	Omschrijving	Blz.	Prijs (excl. O.B.)
LDB 4101	Digitale cassetterecorder met interface	-	f 6.630,--
MDCR	Mini-digitale cassetterecorder	-	f 350,--
MINI-LOG 4	Compacte intrumentatierecorder, 4 kanalen	-	f 11.000,--
PE 1213 t/m 1274	Modulaire voedingseenheden	237 t/m 245	op aanvraag
PE 1373 t/m 1390	19" kast montage accessoires	248 t/m 249	op aanvraag
PE 1400	Magnetische wisselspanningsstabilisator, 100 VA	253	f 460,--
PE 1401	Magnetische wisselspanningsstabilisator, 200 VA	253	f 610,--
PE 1402	Magnetische wisselspanningsstabilisator, 400 VA	253	f 825,--
PE 1403	Magnetische wisselspanningsstabilisator, 850 VA	253	f 1.465,--
PE 1404	Magnetische wisselspanningsstabilisator, 1500 VA	253	f 2.160,--
PE 1534	Regelbare gelijkspanningsvoeding (tafelmodel): 350-3500, 10mA	236	f 3.825,--
PE 1535	Regelb. gelijkspanningsvoeding (tafelmodel); 0-40 V, 0,5 A	230	f 465,--
PE 1536	Regelb. gelijkspanningsvoeding (tafelmodel); 0-20 V, 2 A	230	f 820,--
PE 1537	Regelb. gelijkspanningsvoeding (tafelmodel); 0-40 V, 1 A	230	f 820,--
PE 1538	Regelb. gelijkspanningsvoeding (tafelmodel); 0-75 V, 0,5 A	230	f 820,--
PE 1539	Regelb. gelijkspanningsvoeding (tafelmodel); 0-20 V, 6 A	230	f 1.295,--
PE 1540	Regelb. gelijkspanningsvoeding (tafelmodel); 0-40 V, 3 A	230	f 1.295,--
PE 1541	Regelb. gelijkspanningsvoeding (tafelmodel); 0-75 V, 1,6 A	230	f 1.295,--
PE 1542	Regelb. 3-voudige gelijksp. voeding (tafelmodel) 0-20 V, 1A	230	f 1.420,--
PE 1604/50	Wisselspanningsstabilisator; 10 of 20 kVA	252	f 11.500,--
PE 1610	Wisselspanningsstabilisator; (19" model); 1 kVA	250	f 4.795,--
PE 1611	Wisselspanningsstabilisator (19" model); 2 kVA	250	f 5.950,--
PE 1612	Wisselspanningsstabilisator (19" model); 4 kVA	250	f 9.800,--
PE 1642	Gelijkspanningsstabilisator, 0-20 V, 0-2 A	232	f 3.150,--
PE 1643	Gelijkspanningsstabilisator, 0-20 V, 0-45 A	234	f 5.600,--
PE 1644	Gelijkspanningsstabilisator, 0-40 V, 0-10 A	232	f 3.150,--
PE 1645	Gelijkspanningsstabilisator, 0-40 V, 0-25 A	234	f 5.600,--
PE 1646	Gelijkspanningsstabilisator, 0-75 V, 0- 6 A	232	f 3.150,--
PE 1647	Gelijkspanningsstabilisator, 0-75 V, 0-14 A	234	f 5.600,--
PE 1648	Gelijkspanningsstabilisator, 0-150 V, 0-3 A	232	f 3.150,--
PE 1649	Gelijkspanningsstabilisator, 0-150 V, 0-7 A	234	f 5.600,--
PM 2412A	Universeelmeter	106	f 340,--
PM 2434	Gelijkspannings-microvoltmeter	125	f 2.295,--
PM 2441	Digitale gelijkspanningsmeter	-	f 7.700,--
PM 2503	Elektronische multimeter	-	f 550,--
PM 2503GC	Elektronische mulitmeter, onderwijsuitvoering bestelnummer 9447 925 03011	-	f 875,--
PM 2504	Elektronische multimeter	108	f 1.300,--
PM 2505	Elektronische multimeter	110	f 550,-- rp
PM 2517E	Digitale multimeter (LED-uitvoering)	112	f 675,--
PM 2517X	Digitale multimeter (LX-uitvoering)	112	f 675,--
PM 2522A	Digitale multimeter	115	f 1.415,--
PM 2523	Digitale V-ohm meter, autom. meetgebiedkeuze	117	f 1.240,--
PM 2524	Digitale multimeter, autom. meetgebiedkeuze	118	f 2.250,--
PM 2526	Digitale RMS V-ohm meter, autom. meetgebiedkeuze	120	f 3.800,--
PM 2527	Digitale multimeter en RMS meter, autom. meetgebiedkeuze	122	f 4.850,--
PM 2554	Wisselspannings-millivoltmeter, 2 Hz - 12 MHz	126	f 1.800,--
PM 3207	Tweekanaals oscilloscoop, 15 MHz	40	f 1.750,--
PM 3211	Tweekanaals oscilloscoop, 15 MHz	42	f 2.550,--
PM 3212	Tweekanaals oscilloscoop, 25 MHz met 2 meetkoppen PM 8925	36	f 3.600,--
PM 3212B	Idem met ingebouwde oplaadbare batterijeenheid	36	f 4.700,--
PM 3214	Tweekanaals oscilloscoop, 25 MHz, met vertraagde tijdbasis met 2 meetkoppen PM 8925	38	f 4.310,--

Typenummer	Omschrijving	Blz.	Prijs (excl. O.B.)
PM 3214B	Idem met ingebouwde oplaadbare batterijeenheid	38	f 5.420,--
PM 3216	Tweekanaals oscilloscoop, 35 MHz met twee meetkoppen PM 8925	36	f 3.950,--
PM 3218	Tweekanaals oscilloscoop, 35 MHz met vertraagde tijdbasis en twee meetkoppen PM 8925	38	f 4.650,--
PM 3226	Tweekanaals oscilloscoop, 15 MHz	34	f 2.125,--
PM 3226P	Tweekanaals oscilloscoop, 15 MHz met meer X-Y mogelijkheden	34	f 2.820,--
PM 3233	Tweestraals oscilloscoop, 10 MHz, met vertragingslijnen	32	f 3.475,--
PM 3234	Tweestraals geheugen oscilloscoop, 10 MHz	30	f 8.100,--
PM 3240	Tweekanaals oscilloscoop, 50 MHz, met vertraagde tijdbasis met 2 meetkoppen PM 8927	-	f 6.575,--
PM 3240X	Tweekanaals oscilloscoop, 50 MHz, TV-uitvoering met 2 meetkoppen PM 8927	-	f 7.320,--
PM 3243	Tweekanaals geheugen oscilloscoop, 50 MHz, met "multiplier", met twee meetkoppen PM 8927	28	f 14.250,--
PM 3244	Vierkanaals oscilloscoop, 50 MHz met 4 meetkoppen PM 8927	26	f 9,775,--
PM 3262	Tweekanaals oscilloscoop, 100 MHz met "trigger view" met 2 meetkoppen PM 8935	23	f 7.550,--
PM 3263	Tweekanaals oscilloscoop, 100 MHz met digitale uitlezing van: Tijd/frequentie/pulsen met 2 meetkoppen PM 8935	23	f 11.650,--
PM 3265	Tweekanaals oscilloscoop, 150 MHz, met multipier met 2 meetkoppen PM 8935	21	f 12.160,--
PM 3266	Tweekanaals oscilloscoop, 100 MHz met snel transfergeheugen	18	f 17.500,--
PM 3500	Logic state/timing analyzer, 100 MHz inclusief 20 probes	57	f 22.000,--
PM 3540	Logic scope, 10 MHz state analyzer inclusief probes	60	f 8.500,--
PM 4000 A	Compact datalogger, basisuitvoering	131	f 14.300,--
PM 4001	Compact datalogger, o.a. voor rekstrookjes	131	op aanvraag
PM 4421	Universeel Microcomputer Ontwikkelsysteem	65	op aanvraag
PM 5107	Sinus-blokgenerator, geringe distorsie	142	f 1.140,--
PM 5108L	Functiegenerator	143	f 2.100,--
PM 5127	Functiegenerator	-	f 2.450,--
PM 5129	Functiegenerator	144	f 3.325,--
PM 5131	Functiegenerator, 2 MHz	149	f 1.525,--
PM 5165	LF zwaaigenerator, 0,1 Hz - 1 MHz	145	f 3.075,--
PM 5167	LF functiegenerator, 1 mHz - 10 MHz	147	f 4.650,--
PM 5171	Versterker en Lin/log converter	146	f 1.800,--
PM 5190	LF Synthesizer, 1 mH - 2 MHz	-	f 5.875,--
PM 5326	HF generator	161	f 3.725,--
PM 5326G	HF generator inclusief vaste marker 5,5 MHz	161	f 4.350,--
PM 5326 X	HF generator, teller tot 100 MHz	161	f 4.650,--
PM 5334	Wobbelgenerator	173	f 2.850,--
PM 5501	Zwart/wit- en kleurengenerator	167	f 1.200,--
PM 5509	Zwart/wit- en kleurengenerator	-	f 2.700,--
PM 5509S	Zwart/wit- en kleurengenerator voor kabel-TV	-	f 3.150,--
PM 5519	Zwart/wit- en kleurengenerator	168	f 3.000,--
PM 5519S	Zwart/wit- en kleurengenerator voor kabel-TV	168	f 3.500,--
PM 5520	Zwart/wit testgenerator	-	f 6.725,--
PM 5524	VHF/UHF-modulator	-	f 6.910,--
PM 5526	TV-zwaaigenerator	-	f 16.310,--
PM 5533	TV-signaalgenerator	214	f 12.120,--
PM 5534	Kleurengenerator	173	f 38.380,--
PM 5537	Video-testgenerator	215	f 22.725,--
PM 5539	TV-kleurenanalysator	216	f 7.425,--
PM 5545	PAL-encoder	215	f 12.950,--
PM 5546	Video-calibratiegenerator	215	f 14.030,--
PM 5548	Digitale video-niveaumeter	216	f 8.540,--
PM 5560	TV-demodulator	220	f 28.785,--
PM 5570	Video-testsignaalgenerator	216	f 28.280,--
PM 5575A	EBU-testlijngenerator	217	f 18.180,--
PM 5576A	EBU-testlijngenerator	218	f 13.635,--
PM 5577	Processor/ITS generator	218	f 26.310,--
PM 5578G	ITS-analysesysteem	218	f 42.420,--
PM 5579	Automatische stuureenheid voor PM 5578	-	f 19.440,--
PM 5580	IF-modulator	219	f 19.140,--
PM 5581	VHF-omvormer	219	f 5.555,--
PM 5582	VHF-omvormer	219	f 6.385,--
PM 5583	VHF-omvormer	219	f 3.635,--

Typenummer	Omschrijving	Blz.	Prijs (excl. O.B.)
PM 5592B	CATV-transmitter	220	f 18.890,--
PM 5597	VHF-modulator	219	f 3.830,--
PM 5598	UHF-modulator	219	f 6.464,--
PM 5705	Impulsgenerator, 10 MHz	210	f 1.540,--
PM 5712	Impulsgenerator, 50 MHz	208	f 2.775,--
PM 5715	Impulsgenerator, 50 MHz - 10 V	206	f 3.650,--
PM 5716	Impulsgenerator, 50 MHz - 20 V	203	f 6.575,--
PM 5771	Impulsgenerator, 100 MHz	201	f 7.050,--
PM 6302	RCL meetbrug	160	f 1.900,--
PM 6307	Wow- en fluttermeter	163	f 1.750,--
PM 6456	Stereogenerator	165	f 1.650,--
PM 6611/01	Universele counter 10 Hz - 80 MHz met tijdbasis-oscillator PM 9677	179	f 2.640,--
PM 6611/02	Idem met tijdbasisoscillator PM 9678	179	f 2.860,--
PM 6611/03	Idem met tijdbasisoscillator PM 9679	179	f 3.280,--
PM 6611/04	Idem met tijdbasisoscillator PM 9690	179	f 3.750,--
PM 6611/05	Idem met tijdbasisoscillator PM 9691	179	f 4.250,--
PM 6612/01	Counter/timer 10 Hz - 80 MHz met tijdbasisoscillator PM 9677	178	f 3.050,--
PM 6612/02	Idem met tijdbasisoscillator PM 9678	178	f 3.270,--
PM 6612/03	Idem met tijdbasisoscillator PM 9679	178	f 3.690,--
PM 6612/04	Idem met tijdbasisoscillator PM 9690	178	f 4.160,--
PM 6612/05	Idem met tijdbasisoscillator PM 9691	178	f 4.660,--
PM 6613/01	Universele counter 10 Hz - 250 MHz met tijdbasis oscillator PM 9677	178	f 3.360,--
PM 6613/02	Idem met tijdbasisoscillator PM 9678	178	f 3.580,--
PM 6613/03	Idem met tijdbasisoscillator PM 9679	178	f 4.000,--
PM 6613/04	Idem met tijdbasisoscillator PM 9690	178	f 4.470,--
PM 6613/05	Idem met tijdbasisoscillator PM 9691	178	f 4.970,--
PM 6614/01	Universele counter 10 MHz - 520 MHz met tijdbasis oscillator PM 9677	178	f 4.025,--
PM 6614/02	Idem met tijdbasisoscillator PM 9678	178	f 4.245,--
PM 6614/03	Idem met tijdbasisoscillator PM 9679	178	f 4.665,--
PM 6614/04	Idem met tijdbasisoscillator PM 9690	178	f 5.135,--
PM 6614/05	Idem met tijdbasisoscillator PM 9691	178	f 5.635,--
PM 6615/01	Universele counter 10 Hz - 1 GHz met tijdbasis oscillator PM 9677	178	f 5.150,--
PM 6615/02	Idem met tijdbasisoscillator PM 9678	178	f 5.370,--
PM 6615/03	Idem met tijdbasisoscillator PM 9679	178	f 5.790,--
PM 6615/04	Idem met tijdbasisoscillator PM 9690	178	f 6.260,--
PM 6615/05	Idem met tijdbasisoscillator PM 9691	178	f 6.760,--
PM 6616/01	Universele counter 10 Hz - 1 GHz met tijdbasis oscillator PM 9677	178	f 5.250,--
PM 6616/02	Idem met tijdbasisoscillator PM 9678	178	f 5.470,--
PM 6616/03	Idem met tijdbasisoscillator PM 9679	178	f 5.890,--
PM 6616/04	Idem met tijdbasisoscillator PM 9690	178	f 6.360,--
PM 6616/05	Idem met tijdbasisoscillator PM 9691	178	f 6.900,--
PM 6622/01	Timer/Counter DC-80 MHz met tijdbasisoscillator PM 9677	183	f 3.775,--
PM 6622/02	Idem met tijdbasisoscillator PM 9678	183	f 3.995,--
PM 6622/03	Idem met tijdbasisoscillator PM 9679	183	f 4.415,--
PM 6622/04	Idem met tijdbasisoscillator PM 9690	183	f 4.885,--
PM 6622/05	Idem met tijdbasisoscillator PM 9691	183	f 5.385,--
PM 6624/01	Timer/Counter DC-520 MHz met tijdbasisoscillator PM 9677	183	f 4.910,--
PM 6624/02	Idem met tijdbasisoscillator PM 9678	183	f 5.130,--
PM 6624/03	Idem met tijdbasisoscillator PM 9679	183	f 5.550,--
PM 6624/04	Idem met tijdbasisoscillator PM 9690	183	f 6.020,--
PM 6624/05	Idem met tijdbasisoscillator PM 9691	183	f 6.520,--
PM 6625/01	Timer/Counter DC-1 GHz met tijdbasisoscillator PM 9677	183	f 5.845,--
PM 6625/02	Idem met tijdbasisoscillator PM 9678	183	f 6.065,--
PM 6625/03	Idem met tijdbasisoscillator PM 9679	183	f 6.485,--
PM 6625/04	Idem met tijdbasisoscillator PM 9690	183	f 6.955,--
PM 6625/05	Idem met tijdbasisoscillator PM 9691	183	f 7.455,--
PM 6633	Voorversterker	197	f 1.700,--
PM 6636	Pre-scaler, 1 GHz	197	f 3.230,--

Typenummer	Omschrijving	Blz.	Prijs (excl. O.B.)
PM 6650B	Programmeerbare counter/timer DC-512 MHz met TCXO-oscillator	165	f 8.500,--
PM 6650A	Idem met oscillator PM 9680A	165	f 9.700,--
PM 6650E	Idem met oscillator PM 9681	165	f 10.300,--
PM 6661	Automatische 80 MHz counter	163	f 1.150,--
PM 6664/01	Automatische 520 MHz counter met standaardoscillator	163	f 1.850,--
PM 6664/02	Automatische 520 MHz counter met temp. geregelde kristal-oscillator	163	f 2.450,--
PM 6667/01	µP gestuurde 120 MHz counter	190	f 1.050,--
PM 6667/02	Idem met temp. geregelde kristaloscillator	190	f 1.575,--
PM 6668/01	µP gestuurde 1 GHz counter	190	f 1.675,--
PM 6668/02	idem met temp. geregelde kristaloscillator	190	f 2.200,--
PM 7000-serie	Microgolfmeetapparatuur	-	
	Aparte catalogus met prijslijst beschikbaar	224	
PM 7000X	Microgolfbank	224	f 16.160,--
PM 7001X	Microgolfbank	224	f 20.735,--
PM 8040	XY-recorder	91	f 3.700,--
PM 8041	Potentiometrische X-Y recorder, 2 mV/cm, A-4 formaat	91	f 4.210,--
PM 8110/0X	Miniatuur eenlijnsrecorder, 5 en 20 mm/minuut	60	f 1.630,--
PM 8110/2X	Miniatuur eenlijnsrecorder, 20 en 80 mm/uur	60	f 1.630,--
PM 8110/4X	Miniatuur eenlijnsrecorder, 20 en 80 mm/minuut	60	f 1.630,--
PM 8131	Potentiometrische X-Y recorder, 50 µV/cm, A-3 formaat	94	f 7.095,--
PM 8132	Potentiometrische X-Y recorder, 200 µV/cm, A-3 formaat	94	f 9.600,--
PM 8141	Potentiometrische X-Y recorder, 50 µV/cm, A-4 formaat	91	f 5.420,--
PM 8151	XY-plotter	95	f 12.200,-- rp
PM 8202/01) PM 9870M..)	Potentiometrische eenlijnsrecorder inclusief 1 standaard meetgebied 10 mV of groter	82	f 3.235,--
PM 8202/11) PM 9870M/..)	Potentiometrische eenlijnsrecorder met voorversterker inclusief 1 standaard meetgebied	58	f 3.810,--
PM 8202/21	Potentiometrische eenlijnsrecorder met meervoudig meetgebied type PM 9872/02	58	f 3.575,--
PM 8202/31	Potentiometrische eenlijnsrecorder met voorversterker en meervoudig meetgebied type PM 9872/02	58	f 4.150,--
PM 8210	Eenlijn-digitale printer recorder	86	op aanvraag
PM 8222/01) PM 9870M/..)	Potentiometrische tweelijnsrecorder inclusief 2 standaard meetgebied 10 mV of groter	82	f 4.950,--
PM 8222/21	Potentiometrische tweelijnsrecorder met 2 meervoudige meetgebieden type PM 9872/02	82	f 5.630,--
PM 8222/31	Potentiometrische tweelijnsrecorder met 2 voorversterkers en 2 meervoudige meetgebieden type PM 9872/02	82	f 6.780,--
PM 8236	Potentiometrische meerpuntsrecorder zonder inschuifeenheden en meetgebieden	88	f 8.800,--
PM 8251/02	Potentiometrische eenlijnsrecorder, meervoudig meetgebied vanaf 10 mV	80	f 2.610,--
PM 8251/22	Potentiometrische eenlijnsrecorder, meervoudig meetgebied meetgebied vanaf 1 mV	80	f 2.780,--
PM 8252/02	Potentiometrische tweelijnrecorder, meervoudig meetgebied vanaf 10 mV	80	f 4.140,--
PM 8252/22	Potentiometrische tweelijnrecorder met meervoudige meetgebieden vanaf 1 mV	80	f 4.490,--
PM 8501	Interfacekaart	-	f 610,--
PM 8502	Ovengestuurd kristal	-	f 2.325,--
PM 8503	Tekst-generator	-	f 2.525,--
PM 8504	Klok-generator	-	f 1.515,--
PM 8800	Probe-set	-	op aanvraag
PM 8810	Trigger-probe	-	op aanvraag
PM 8819	Probe-adaptor	-	op aanvraag
PM 8820	Probe-POD	-	f 925,--
PM 8901	Oplaadbare accuset voor PM 3212/14/16/18, PM 3232/33/34 PM 3240/40X, PM 3243/44, PM 3260/61/62/63/65/65E/66	53	f 2.050,--
PM 8910	Polaroidfilter voor PM 3212/14/16/18, PM 3240/40X, PM 3243/44, PM 3260/61/62/63/65/65E/66	53	f 24,--
PM 8921	Meetkop 1:1, kabellengte 1,5 m	46	f 113,--
PM 8921L	Meetkop 1:1, kabellengte 2,5 m	46	f 124,--
PM 8925	Meetkop 10:1, kabellengte 1,5 m	47	f 130,--
PM 8925L	Meetkop 10:1, kabellengte 2,5 m	47	f 155,--
PM 8927	Meetkop 10:1, kabellengte 1,5 m	47	f 202,--
PM 8927L	Meetkop 10:1, kabellengte 2,5 m	47	f 217,--

Typenummer	Omschrijving	Blz.	Prijs (excl. O.B.)
PM 8932	Hoogspanningsmeetkop 100:1, 5600 V, kabellengte 1,5 m	47	f 410,--
PM 8935	Meetkop 10:1, kabellengte 1,5 m	47	f 288,--
PM 8935L	Meetkop 10:1, kabellengte 2,5 m	47	f 309,--
PM 8940	Isolatieversterker	48	f 1.820,--
PM 8943	Fet-meetkop	49	f 1.950,--
PM 8960	Inbouwset 19" rekmontage voor PM 3240/40X, PM 3243/44, PM 3260/61/62/63/65//65E/66	51	f 350,--
PM 8962	Idem voor PM 3212/16	51	f 319,--
PM 8963	Idem voor PM 3214/18	51	f 310,--
PM 8971	Camera-adaptor t.b.v. camera PM 9380 voor PM 3211/12/14/16/18 PM 3240/40X, PM 3243/44, PM 3260/61/62/63/65E/66	52	f 228,--
PM 8972	Camera-adaptor t.b.v. PM 9381 voor PM 3211/12/14/16/18	-	op aanvraag
PM 8973	Camera-adaptor t.b.v. PM 9381 voor PM 3232/33/34	-	op aanvraag
PM 8976	Camera-adaptor t.b.v. PM 9381 voor PM 3240/43/44/61/62/63/65/66	-	op aanvraag
PM 8980	Kijkkoker, lang, voor PM 3211/12/14/16/18, PM 3240/40X PM 3243/44, PM 3260/61/62/63/63E/65/65E/66	51	f 110,--
PM 8991	Instrumentwagen voor PM 3211/12/14/16/18, PM 3240/40X PM 3243/44, PM 3260/61/62/63/65/65E/66	51	f 875,--
PM 8992/01	Opbergtas voor accessoires PM 3211/12/14/16/18, PM 3240/40X PM 3243/44, PM 3260/61/62/63/65/65E/66	51	f 160,--
PM 8994	Set probe-accessoires	51	f 50,--
PM 9011	Netsnoer	52	f 31,--
PM 9051	Overgang van BNC naar 4 mm	52	f 29,--
PM 9061	Adaptor BNC (female) naar BNC (female)	52	f 31,--
PM 9067	T-stuk adaptor	52	f 45,--
PM 9071	Kabel, 4 mm - 4 mm	52	f 50,--
PM 9072	Kabel, 4 mm - BNC	52	f 47,--
PM 9074	Kabel, BNC - BNC, 50 ohm	52	f 42,--
PM 9075	Kabel, BNC - BNC, 75 ohm	52	f 42,--
PM 9204	Oplaadbare batterijvoeding voor PM 2434	127	f 260,--
PM 9210	HF meetkop	127	f 420,--
PM 9212	Hulpstukken voor PM 9210	127	f 255,--
PM 9213	HF meetkop	127	f 95,--
PM 9216	Oplaadbare batterijvoeding voor PM 2522/2522A PM 2523/2524	127	f 490,--
PM 9218	Voedingseenheid voor PM 2504, PM 2513A en PM 2517	127	f 49,--
PM 9220	50-polige BCD verbindingskabel	127	f 310,--
PM 9230	BCD-ingang voor PM 2441	127	f 395,--
PM 9231	BCD-uitgang voor PM 2441	127	f 505,--
PM 9232	BCD-uitgang voor PM 2526	127	f 660,--
PM 9237	BCD-uitgang voor PM 2527	127	f 440,--
PM 9238	Bus-line interface voor PM 2527	127	f 1.250,--
PM 9239	Bus-line interface voor PM 2526	127	f 1.800,--
PM 9244	30 A shunt	127	f 139,--
PM 9245	Stroomtransformator, 100 A.	127	f 170,--
PM 9246	Hoogspanningsmeetkop	127	f 221,--
PM 9247	Temperatuuropnemer voor PM 2513 en PM 2514	102	f 325,--
PM 9248	Temperatuuropnemer voor PM 2513A, PM 2517, 2522A, PM 2524 PM 2526 en PM 2527	127	f 295,--
PM 9255	Analoge uitgang voor PM 2527	127	f 565,--
PM 9256	Hoogfrequent ingangseenheid voor PM 2526	127	f 104,--
PM 9257	Temperatuuringangseenheid voor PM 2526 en PM 2527	127	f 227,--
PM 9260	Stel meetsnoeren	127	f 39,--
PM 9263	Data hold probe voor PM 2513A, PM 2517 en PM 2522A	127	f 120,--
PM 9273	Draagtas voor PM 2412A, PM 2503, PM 2503GC, PM 2513A en PM 2514	127	f 70,--
PM 9276	Bescherming voor PM 2503, PM 2503GC en PM 2513A	127	f 44,--
PM 9278	Parattas voor PM 2517	127	f 70,--
PM 9326	Meetkoppenset 1:1 en 10:1, kabellengte 1 m	46	f 114,--
PM 9327	Meetkoppenset 1:1 en 10:1, kabellengte 2 m	40	f 122,--
PM 9339	HF meetkoppenset 10:1, kabellengte 1,5 m	46	f 231,--

Typenummer	Omschrijving	Blz.	Prijs (excl. O.B.)
PM 9355	Wisselstroom meetkoppenset	54	f 2.189,--
PM 9359	Inbouwset 19" rekmontage voor PM 3232/33/34	51	f 740,--
PM 9366	Kijkkoker voor rechthoekig scherm	51	f 27,--
PM 9379	Adaptor voor PM 3232/33/34 t.b.v. PM 9380	51	f 432,--
PM 9397	Oplaadbare accu voor PM 3000 en PM 3010	-	f 80,--
PM 9398	Netspanningsvoeding voor PM 3000 en PM 3010	-	f 244,--
PM 9410	ADC voor PM 4000	131	f 2.625,--
PM 9412	ADC voor PM 4000 (hoge resolutie)	131	f 3.150,--
PM 9414	Scannerkaart PT 100	131	f 1.025,--
PM 9415	Scannerkaart voor spanningen	131	f 850,--
PM 9416	Digitale ingangskaart	131	f 1.415,--
PM 9417	Scannerkaart voor thermokoppels	131	f 1.400,--
PM 9420	Aansluitblok voor spanningen	131	f 300,--
PM 9421	Aansluitblok voor PT 100	131	f 400,--
PM 9422	Aansluitblok voor thermokoppels	131	f 450,--
PM 9450	IEC interface	131	f 2.050,--
PM 9453	ASCII parallel interface	131	f 1.150,--
PM 9456	ASCII serieel interface (TTY)	131	f 2.100,--
PM 9460	Alarmrelais	131	f 700,--
PM 9470	Geheugenuitbreiding PM 4000	131	f 1.950,--
PM 9471	Kabelversterker	131	f 560,--
PM 9480	IEC kabel 1 m	131	f 350,--
PM 9481	IEC kabel 2 m	131	f 380,--
PM 9482	IEC kabel 4 m	131	f 375,--
PM 9483	IEC naar IEEE adapter kabel	131	f 515,--
PM 9490	CPU met basisprogramma	131	f 2.500,--
PM 9491	CPU met uitgebreide programma	131	f 4.500,--
PM 9537	Kabel BNC-Imp.trafo, radio	-	f 70,--
PM 9538	Kabel BNC-TV, connector 75 ohm	-	f 70,--
PM 9539	Kabel BNC-Imp.trafo, TV	-	f 70,--
PM 9581	50 ohm afsluiting, 3 watt	54	f 103,--
PM 9584	50 ohm T-stuk	-	f 118,--
PM 9585	50 ohm afsluiting, 1 watt	-	f 72,--
PM 9588	Set coax-kabels	-	f 485,--
PM 9601	Batterijeenheid voor PM 6667/68	198	f 475,--
PM 9602	Draagtas voor PM 6667/68	198	op aanvraag
PM 9662	Verbindingskabel	171	f 295,--
PM 9664	Achterpaneel	198	f 370,--
PM 9665B	Filter voor PM 6667/8	198	f 70,--
PM 9668	IF off-set unit	198	f 950,--
PM 9669/01	Inbouwset 19" rekmontage voor 1 eenheid voor PM 6610 serie en PM 6620 serie	127	f 144,--
PM 9669/02	Inbouwset 19" rekmontage voor 2 eenheden voor PM 6610 serie en PM 6620 serie	198	f 195,--
PM 9669/09	Inbouwset 19" rekmontage voor PM 6661 en PM 6664	127	f 195,--
PM 9672/01	Paraattas voor PM 2522, PM 2522A, PM 2523, PM 2524, PM 6610 en PM 6620 serie	127	f 120,--
PM 9673	Batterijvoeding/Oplaadeenheid voor PM 6610 en PM 6620 serie	198	f 660,--
PM 9674	BCD-uitgang voor PM 6610 en PM 6620 serie	198	f 835,--
PM 9675	Digitaal-Analoog omvormer voor PM 6610 en PM 6620 serie	198	f 1.665,--
PM 9676	Busline interface voor PM 6610 en PM 6620 serie	198	f 1.350,--
PM 9677	Tijdbasisoscillator voor PM 6610 en PM 6620	198	f 189,--
PM 9678	Tijdbasisoscillator voor PM 6610 en PM 6620 serie	198	f 410,--
PM 9679	Ovengeregelde tijdbasisoscillator voor PM 6610 en PM 6620	198	f 840,--
PM 9680A	Ovengeregelde tijdbasisoscillator voor PM 6645 en PM 6650	198	f 1.285,--
PM 9681	Ovengeregelde tijdbasisoscillator voor PM 6645 en PM 6650	198	f 2.550,--
PM 9684	BCD-uitgang voor PM 6650	198	f 1.270,--
PM 9685	Afstandsbediening voor PM 6650	198	f 845,--
PM 9686	IEC-bus interface voor PM 6650	198	f 2.500,--
PM 9687	Digitaal-Analoog omvormer voor PM 6650	198	f 1.740,--
PM 9690	Ovengeregelde hoge stabiliteits tijdbasisoscillator voor PM 6610 en PM 6620 serie	198	f 1.295,--
PM 9691	Tijdbasisoscillator	198	op aanvraag
PM 9706	6/6 kast voor o.a. PM 2441	127	f 300,--
PM 9713A	3/6 kast voor o.a. PM 5520 t/m PM 5548	198	f 395,--
PM 9714A	4/6 kast voor o.a. PM 6645 en PM 66550	198	f 350,--
PM 9716A	6/6 kast voor o.a. PM 6645 en PM 6650	198	f 465,--

Typenummer	Omschrijving	Blz.	Prijs (excl. O.B.)
PM 9721	1/6 blind paneel	198	f 45,--
PM 9722	2/6 blind paneel	198	f 56,--
PM 9831/03	Enkelvoudige inschuifeenheid	88	f 310,--
PM 9832/03	Zesvoudige inschuifeenheid	88	f 1.395,--
PM 9833/01	Multirange inschuifeenheid	88	f 925,--
PM 9834/01	"Set-point", eenheid, incl. volgpotiometer	88	f 600,--
PM 9835/01	Markeringseenheid, links	88	f 350,--
PM 9837/02	Volgschakelaar, dubbelpolig	88	f 470,--
PM 9838/00	Montagebeugels voor 19" rek	88	f 163,--
PM 9839/02	Inktwielen (4 stuks) voor PM 8235 en PM 8236	88	f 110,--
PM 9841/01	Remote control eenheid voor matrix	88	f 250,--
PM 984./..	Standaard meetbereik voor PM 8235 en PM 8236	88	f 185,--
PM 984./..	Niet-standaard meetbereik voor PM 8235 en PM 8236	88	f 380,--
PM 9854/01	Stroombron voor Pt 100 ohm opnemers	-	f 445,--
PM 9856/05	Inktpatronenset, blauw (10 stuks) voor PM 8110, PM 8222 en PM 8252	-	f 67,50
PM 9856/10	Inktpatronenset, blauw (10 stuks) voor PM 8040 PM 8041, PM 8131, PM 8132, PM 8141, PM 8235 en PM 8236	-	f 70,--
PM 9865R/10	Inktpatronenset, rood (10 stuks) voor PM 8041, PM 8131, PM 8141, PM 8235 en PM 8236	-	f 70,--
PM 9856S/10	Inktpatronenset, (2 st. rood, 2 st. blauw, 2 st. groen en 2 st. zwart) voor PM 8041, PM 8131, PM 8141, PM 8235 en PM 8236	-	f 70,--
PM 9857/05	Inktpatronenset, rood (10 stuks) voor PM 8202, PM 8222, PM 8251 en PM 8252	-	f 67,50
PM 9857B/05	Inktpatronenset, blauw (10 stuks) voor PM 8202, PM 2222 PM 8251 en PM 8252, inplaats van PM 9857/05	-	f 67,50
PM 9857/10	Inktpatronenset, rood (10 stuks) voor PM 8132	-	f 70,--
PM 9857/15	Inktset (10 stuks) voor markeringseenheid van PM 8202 en PM 8222	-	f 67,50
PM 9859/01	DC/AC omvormer voor PM 8110	-	f 725,--
PM 9860/01	Afschermkap voor PM 8202 en PM 8222	-	f 140,--
PM 9861	Afstandsbediening papiertransport TTL PM 8202 en PM 8222	-	f 235,--
PM 9862	Afstandsbediening penlift, markeringseenheid en stand-by (TTL) voor PM 8202 en PM 8222	-	f 225,--
PM 9863	Afstandsbediening papiertransport, penlift en markeringseenheid (maakcontacten) voor PM 8202 en PM 8222	-	f 125,--
PM 9864/01	Min. en max. alarmeenheid voor PM 8202	-	f 430,--
PM 9864/02	Min. en max. alarmeenheid voor PM 8222	-	f 780,--
PM 9865/01	Volgpotentiometer voor PM 8202 en PM 8222	-	f 237,--
PM 9866/01	Elektrische penlift voor PM 8202 en PM 8222	-	f 170,--
PM 9867	Montagebeugels 19" rek voor PM 8202/22 en PM 8251/52	-	f 41,--
PM 9868/05	Markeringseenheid, rechts voor PM 8202 en PM 8222	-	f 247,--
PM 9868/10	Markeringseenheid, links voor PM 8202 en PM 8222	-	f 247,--
PM 9870M/..	Standaard meetbereik voor PM 8202 en PM 8222	-	f 125,--
PM 9871/01	Voorversterker voor PM 8202 en PM 8222	-	f 575,--
PM 9872/02	Meervoudig meetbereik met nulpuntsonderdrukking voor PM 8202 en PM 8222	-	f 465,--
PM 9873	Lineariseringsunit v. Fe-Const. koppel voor PM 8202 en PM 8222	-	f 770,--
PM 9874	Lineariseringsunit v. NiCr-NiAl koppel voor PM 8202 en PM 8222	-	f 770,--
PM 9875B/01	Inktpatronenset, blauw (10 stuks) voor PM 8132	-	f 75,--
PM 9875R/01	Inktpatronenset, rood (10 stuks) voor PM 8132	-	f 75,--
PM 9879M/..	Niet standaard meetbereik voor PM 8202 en PM 8222	-	f 285,--
PM 9880/01	Montageplaat voor 19" rek voor PM 8110	-	f 67,50
PM 9881/01	40 dB signaalfilter voor PM 8110	-	f 67,50
PM 9884	Tijdbasiseenheid voor PM 8041, PM 8131 en PM 8141	-	f 750,--

Typenummer	Omschrijving	Blz.	Prijs (excl. O.B.)
PM 9885	Papiertransporteenheid voor PM 8041 en PM 8141	-	f 1.540,--
PM 9910/01	Set registratiepapier, inhoud 5 vouwboeken, voor PM 8110	-	f 36,--
PM 9920/00	Set registratiepapier, inhoud 5 vouwboeken	-	f 40,--
PM 9920/01	Set registratiepapier, inhoud 5 vouwboeken	-	f 40,--
PM 9920/03	Set registratiepapier, inhoud 5 vouwboeken	-	f 40,--
PM 9920/04	Set registratiepapier, inhoud 5 vouwboeken	-	f 40,--
PM 9940/02	Set registratiepapier, inhoud 5 rollen voor PM 8041 en PM 8141	-	f 50,--
PM 9940/03	Set registratiepapier, inhoud 5 rollen voor PM 8041 en PM 8141	-	f 50,--

Regeltransformatoren tafelmodel

Bestelnummer	Oud typenr.	Primaire spanning	Secundaire spanning	Secundaire stroom	Prijs (excl. O.B.)
2422 530 02401	E401 AB/010	220 V	0 - 255 V	1 A	f 180,--
2422 530 03401	E401 AB/020	220 V	0 - 255 V	2,5 A	f 220,--
2422 530 04401	E401 AB/040	220 V	0 - 255 V	5 A	f 285,-
2422 530 05401	E401 AB/080	220 V	0 - 255 V	8,5 A	f 345,--
2422 530 07411	E401 AB/200	220 V	0 - 255 V	23 A	f 910,--
2422 530 03405	E401 HB/020 *	220 V	0 - 255 V	2,5 A	f 275,--
2422 530 04405	E401 HB/040 *	220 V	0 - 255 V	5 A	f 335,--
2422 530 05405	E401 HB/080 *	220 V	0 - 255 V	8,5 A	f 395,--

Regelbare transformator met gescheiden wikkelingen

2422 529 00005		220 V	0 - 237 V	3 A	f 500,--
Accessoires regeltransformatoren					op aanvraag

* Voorzien van een aansluitsnoer met randaarde steker en een speciale kap met smeltveiligheidshouder en randaarde wandkontaktdoos voor afname van de secundaire spanning.

Prijswijzigingen voorbehouden.
Hiermede vervallen alle voorgaande noteringen.

Voor nadere inlichtingen
PHILIPS NEDERLAND B.V.
Afdeling Test- en Meetapp.
5600 PD Eindhoven
Telefoon 040 - 782808

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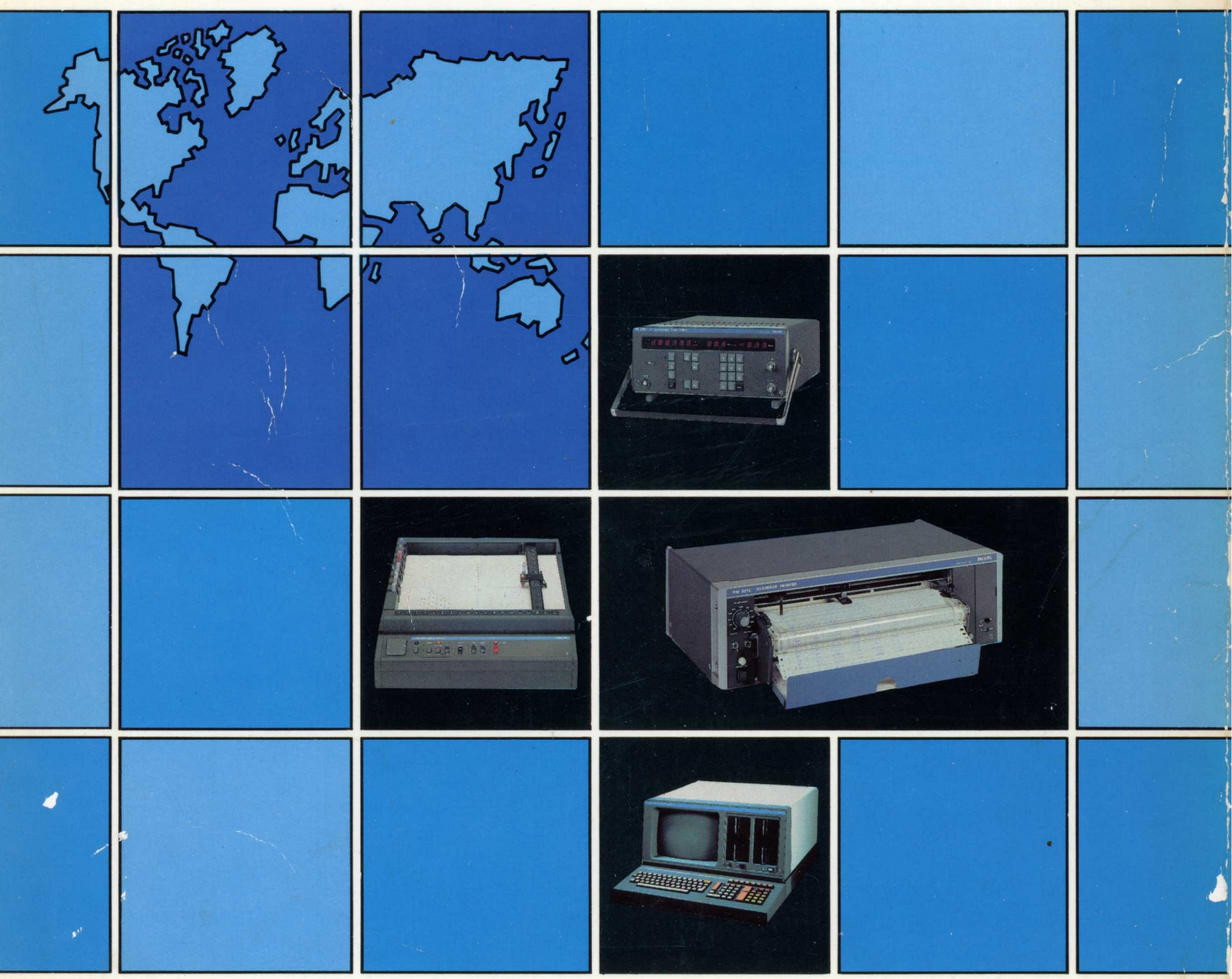

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