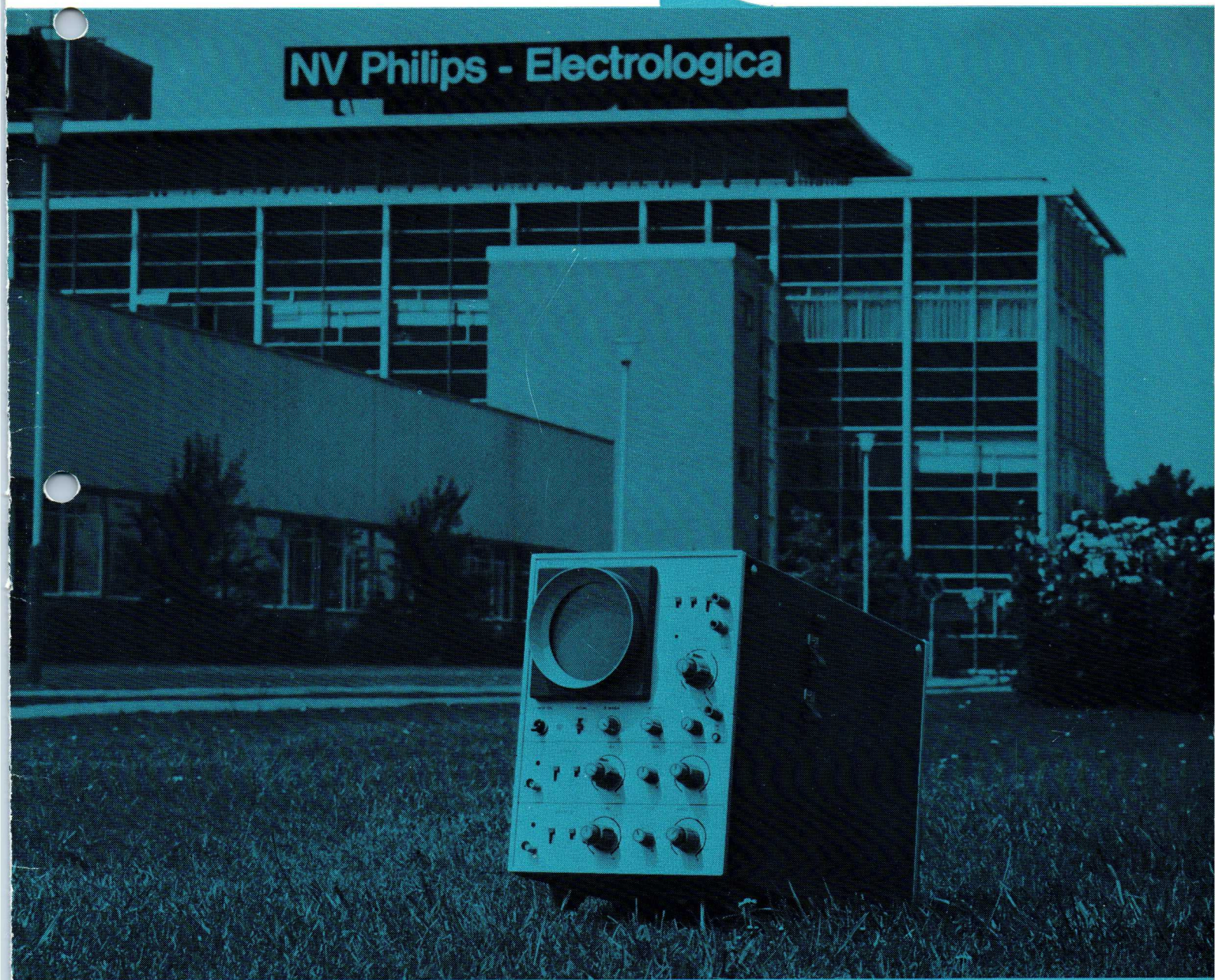
PHILIPS

electronic measuring and microwave notes



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electronic measuring and microwave notes

Introduction

The quarterly periodical Electronic Measuring and Microwave Notes, provides information about the application and design of Philips electronic measuring and microwave instruments and also surveys the new instruments which are regularly added to the Philips programme.
The information is intended to assist users in getting the maximum benefit out of instruments which they already possess and to help them in choosing new instruments which will best meet their particular measuring or microwave problems.

In this issue

General information

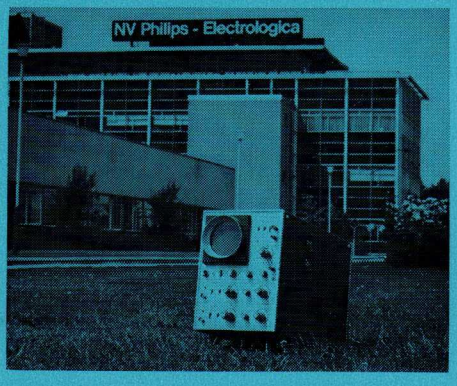
If you are interested in regularly receiving the periodical Electronic Measuring and Microwave Notes and also in more information about the instruments please ask your Philips organisation. If there is no Philips organisation in your country enquires may be sent to n.v. Philips, EMA Department, Eindhoven, the Netherlands.

Published by

n.v. Philips' Gloeilampenfabrieken, Eindhoven, the Netherlands

Editor

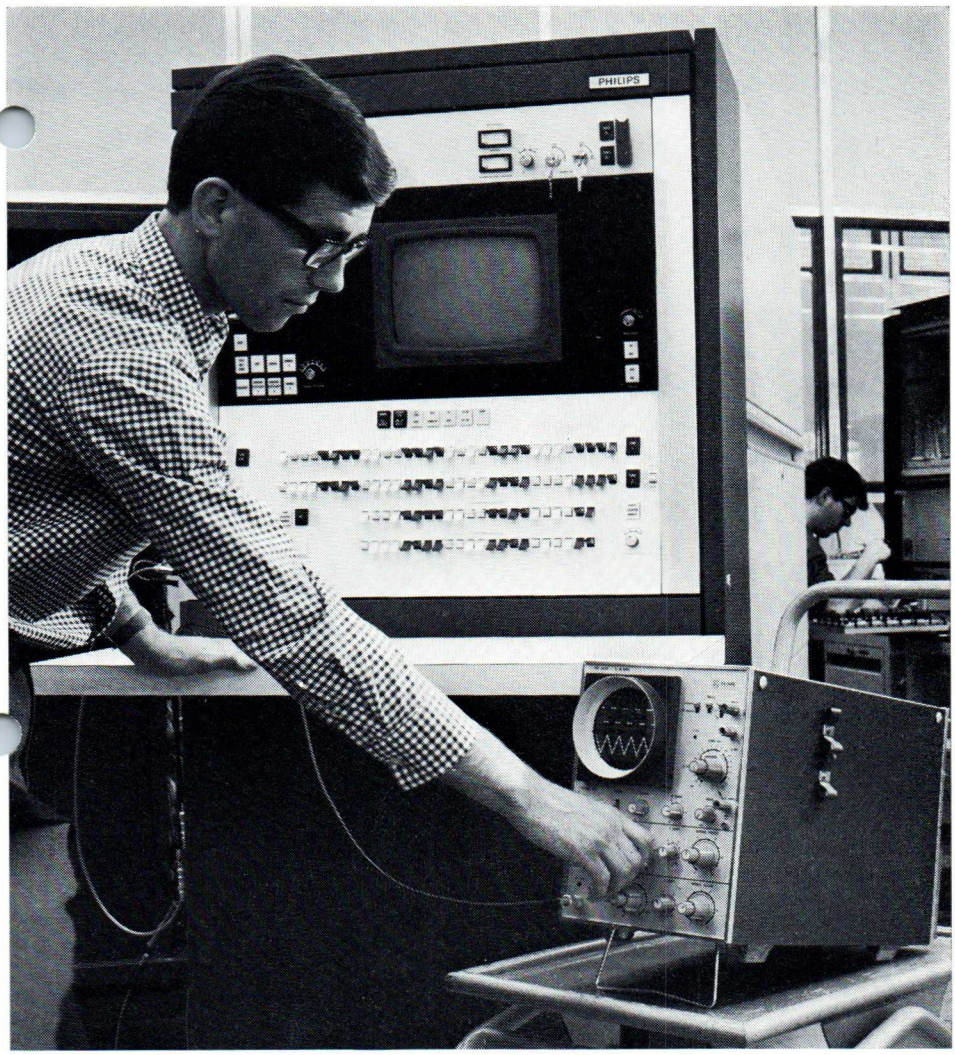
T. Sudar, n.v. Philips, EMA Department, Eindhoven.



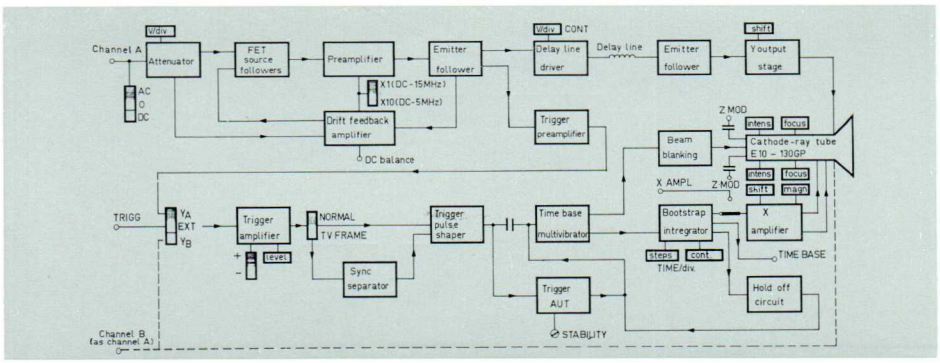
The front cover
of this issue shows new building of the computer factory at Apeldoorn.

A new wide band DC up to 15 MHz double-beam oscilloscope with delay line

by J. Overdorp and J. R. Vogel



1. Block diagram of the PM 3231 double-beam oscilloscope

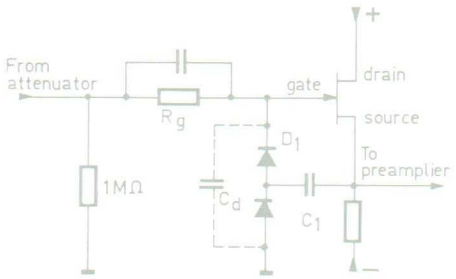


Rapid increase in the application of digital techniques has created a demand for economical and simply operated double-beam oscilloscopes permitting accurate measurement and comparison of the shape, amplitude, rise time, repetition frequency, etc. of pulses. This new double-beam oscilloscope will assist in meeting this demand. Block diagram is shown in fig. 1. The main features of the PM 3231 oscilloscope are:

1. *Two identical vertical channels*
2. *Fully transistorized*
3. *Bandwidth: DC up to 15 MHz at a maximum sensitivity of 10 mV/div*
   DC up to 5 MHz at a maximum sensitivity of 1 mV/div
4. *Field-effect transistor (FET) input both for the two vertical amplifiers and the external trigger input*
5. *Drift-compensation in the vertical amplifiers*
6. *Trigger mode:*
   Triggering with continuous variable level
   Automatic triggering (in absence of a trigger signal the time base starts "free running" and a bright trace is displayed)
7. *Delay-line, providing an effective delay on the screen of at least 50 nanosec*
8. *DC-coupled external trigger input*
9. *Max sweep speed: 200 nanosec/div*
10. *Horizontal magnification up to a maximum of 5x, the highest sweep speed thus becoming 40 nanosec/div*
11. *Fully stabilised power supply*

FET input with overload safeguard

Use is made in the input circuit of the vertical amplifiers of N-channel field-effect transistors circuited as source-followers, see fig. 2. To safeguard these against over loads, the gate is earthed with two series-connected diodes. The diodes become conductive at a negative voltage of −1.4 V. R_g acts as "gate current" limiter in the event of positive overloads. To eliminate the harmful capacitance C_d of the diodes, the signal voltage from the FET source is fedback via C_1 to the anode side of diode D_1, no signal current then passing through diode D_1.



2. The FET input safeguard

In virtue of these safeguards, voltage of up to 500 V_{pp} can be fed to the input without resultant risk to the oscilloscope.

Drift-compensation ("zero-line locking")
A new system of drift-compensation allows the "zero line" of the oscilloscope to be locked. Since the output level of the preamplifier can be further drift-free amplified without special measures thereby being required, the zero-line locking acts only on the preamplifier (see fig. 3).
If, after the normal high-ohmic attenuation of the Y_A signal, the amplifier receives E_i volts, the output voltage E_o amounts to $-A\,E_i$ in the normal state. If drift now gives rise to $\triangle e$ in the preamplifier, the voltage at point X becomes $E_x = {}^1/_2\,(E_i + E_o/A)$. The attenuator R_1R_2 attenuates the signal A times, equal to the amplification of the preamplifier. The drift is corrected by returning the voltage at point X, amplified and in counter-phase, to the preamplifier. The voltage at point II is the $E_{II} = -{}^1/_2\,B\,(E_i + E_o/A)$. At point I $E_I = E_i + \triangle e$. The difference between the voltages E_I and E_{II} is amplified $-A$ times, so that

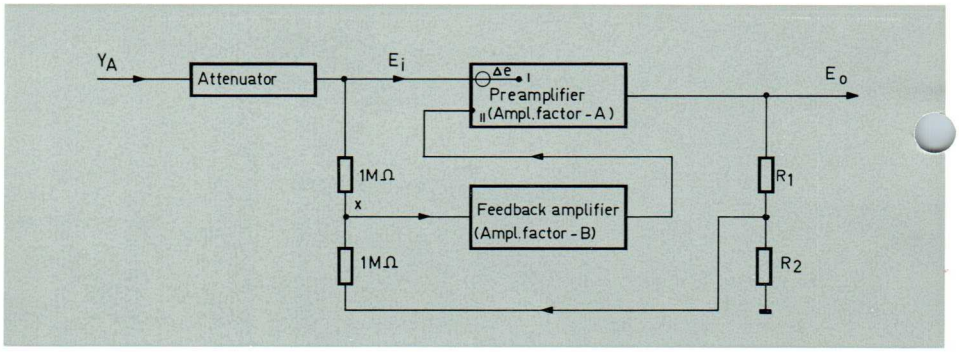
$$E_o = -A\,[(E_i + \triangle e) - \{-{}^1/_2\,B\,(E_i + E_o/A)\}]$$
$$E_o = -A\,E_i - A\triangle e - A\,{}^1/_2B\,E_i - A{}^1/_2B\,E_o/A$$
$$E_o + {}^1/_2\,A\,BE_o/A = -A\,E_i\,(1 + {}^1/_2B) - A\triangle e$$
$$E_o = -A\,E_i - \frac{A\triangle e}{1 + {}^1/_2B} = -A\left(E_i + \frac{\triangle e}{1 + {}^1/_2B}\right)$$

It follows from this that the drift reduction amounts to $1 + {}^1/_2\,B$. B is approximately 60, so the drift is reduced by a factor of approximately 30.

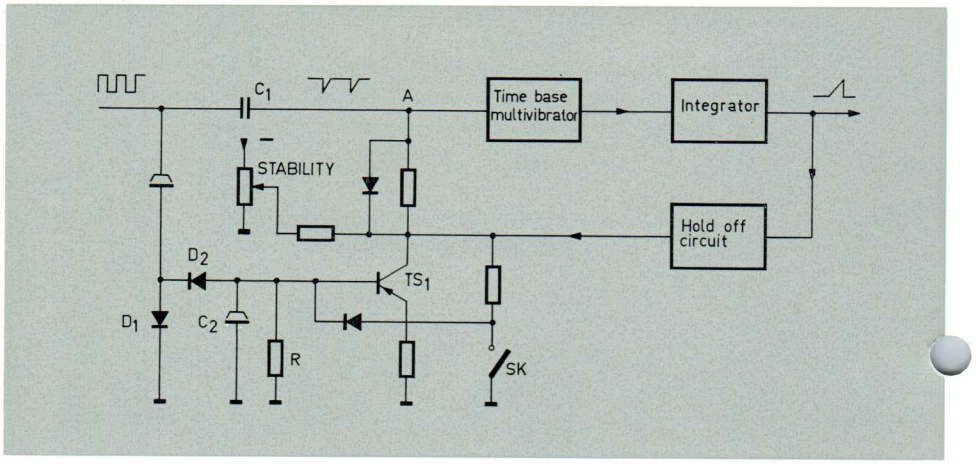
Triggering
A choice can be made from two methods of triggering, namely, internally from amplifier A or B, or externally. The external trigger input is DC-coupled to the trigger amplifier. The trigger signal passes via the selector switch (Y_A, Y_B or EXT) to the gate of an N-channel field-effect transistor connected as source-follower. This provides a high input impedance, for external triggering namely 1 MΩ; the input capacitance is 10 pF.
Also, by reason of this FET, the feedback of the trigger circuit on the signal to be triggered becomes nil. Choice can also be made between triggering on the positive or on the negative slope of the signal.
The level of the start-point is continuously adjustable on the screen with the aid of the levelling potentiometer. In the automatic triggering position ("AUT"), the start-point is at the zero level of the trigger signal.

In the position external triggering the signal can be levelled over 12 V_{pp}, a facility which experience has shown to be especially important in computer application.

Automatic time base trigger system
A new, automatic system ensures that the time base trace remains visible on the screen even when no trigger signal is present.
As soon as sufficient signal is present, the time base is switched to the triggered state (see fig. 4).
Contact SK is open in the "AUT" position. If no trigger signal is present, the level of point A is determined by the stabilising potentiometer ("STAB"), since in this case TS_1 receives no negative base voltage. This level at A causes the time base to run free. If the trigger multivibrator comes into operation, the base of TS_1 becomes negative through the action of the circuit D_1, D_2, C_2 and R. The level of point A thus becomes less negative and the time base multivibrator will switch over only by reason of the trigger pulses fed via C_1.
The lowest frequency at which the automatic time base trigger system still functions satisfactorily is governed by the time constant RC_2. In the PM 3231, the automatic system operates for sinusoidal voltages of 10 Hz up to 15 MHz.
The automatic time base trigger system is switched off when the levelling potentiometer is at the "level" position. Contact SK is then closed. The level at point A is then such that the time base multivibrator will switch over only by reason of the trigger pulses fed via C_1.

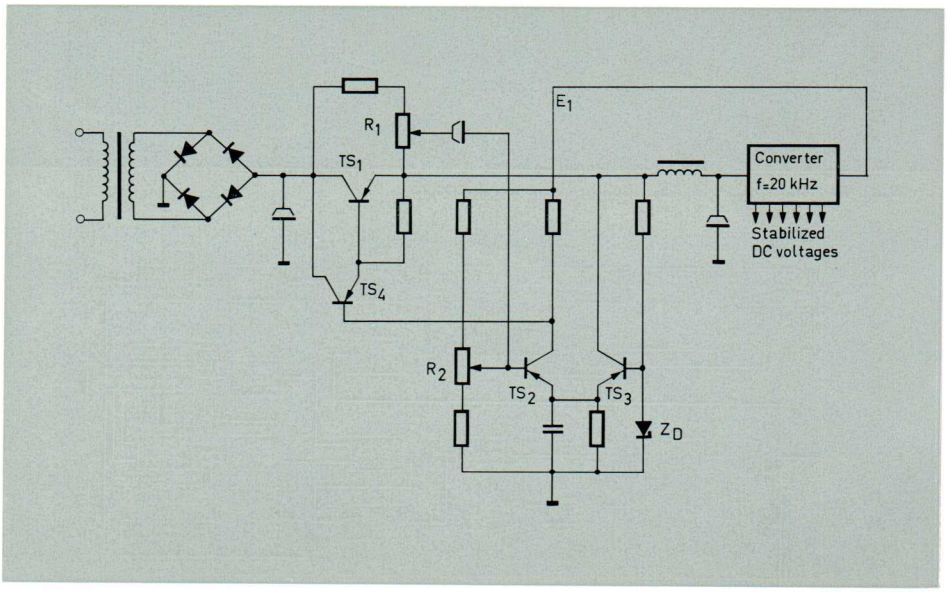


3 Drift compensation

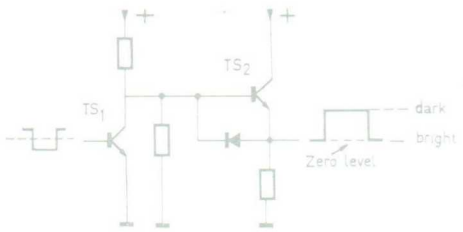


4. Automatic time-base system and time-base

6. Supply unit



5. Beam blanking



100 MHz pulse generator PM 5770

by L. E. Orrevall

Beam blanking

The time base multivibrator controls the opening and closing of transistor TS_1. An emitter follower TS_2 ensures that the screen is rapidly made bright despite the capacitive load of the beam blanking plates, see fig. 5. With this circuit, the period between the starting of the time base and the appearance of the bright image is only 50 nanosec.

Time base accuracy

A bootstrap integrator ensures a very linear time base. The time/div is adjustable in 20 set steps, the tolerance being within plus or minus 5%. Continuous adjustment between the steps is possible.

Stabilized power supply

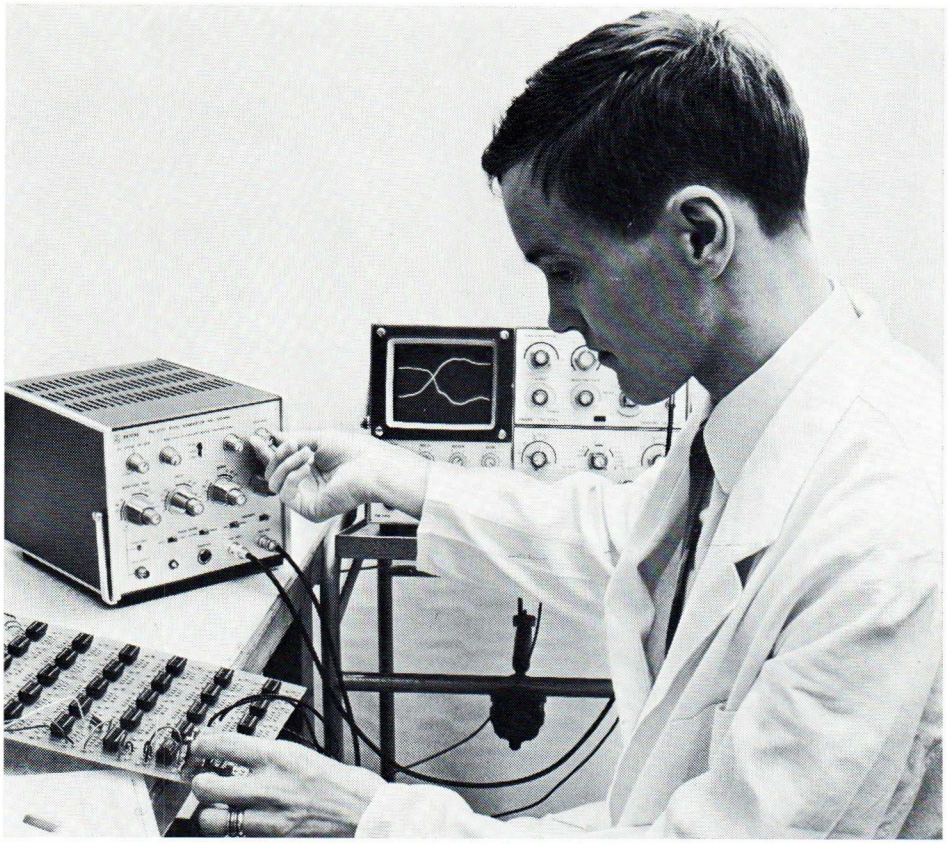
The power supply unit is so regulated as to equalise mains voltage functuations of plus or minus 15%, see fig. 6. The apparatus can be set by switch for the following mains voltages:

110 V, for voltages between 93 and 127 V, mains frequency 50 to 400 Hz

220 V, for voltages between 187 and 253 V, mains frequency 50 to 400 Hz

The output voltage of the converter is stabilized by comparing the secondary voltage E_1 with the reference voltage Z_D in a differential amplifier. This amplifier consisting of the transistors TS_2, TS_3 and TS_4 drives the series transistor TS_1, whilst the voltage E_1 is set to the correct value with R_2. The ripple voltage is set to a minimum with R_1. The converter is an inductive multivibrator which supplies all the voltages, including the high-voltage, for the apparatus. In the event of one of the voltages being short circuited, the converter generator switches off, the supply unit thus being safeguarded against short circuiting.

The E10-130GP cathode-ray tube employed is of the metal-backed phosphor type. This provides a brighter display, in consequence of which pulse shapes of low repetition frequency are still perceptible at high sweep speeds. The screen display may also be photographed with the aid of a camera (PM 9300) and adaptor. Accurate mounting together of the two electron guns ensures a registration error for both deflection systems of less than 0.6 degree in the centre of the screen.



Trends in two important categories of pulse generator can be summarised as an overall improvement in general purpose instruments, referring to basic characteristics such as frequency rise/fall time, pulse delay/width, etc; and, advancing specific areas of performance in special pulse generators. In the latter, exceptional characteristics such as 100 MHz prf (pulse repetition frequency), or sub-nano second rise time are obtained at the expense of limited lower frequency range, maximum pulse-width/delay in the order of a few hundred nano seconds and low duty cycle.

The specific target for the Philips PM 5770 was to achieve a practical combination, between the two categories. This meant extending the overall performance of a "general purpose" generator into areas previously obtainable only with "special purpose" models.

The result is a unique instrument as revealed by the following survey:

Repetition frequency	:	up to 100 MHz	but also	down to 1 Hz
Rise/fall time	:	down to $<$ 4 ns	,,	up to 100 μs
Delay/width	:	down to 5 ns	,,	up to 100 ms
Amplitude	:	up to 10 V	,,	down to 30 mV
Polarity	:	positive/negative	,,	normal/inverted
Basic features	:	external triggering	,,	synchronised gating
		single shot operation	,,	double pulse operation
		synchronising output	,,	DC-offset
Performance and design	:	most complete	,,	most compact weight only 7 kg

The above performance was accurately defined by a customer who discribed it as: "All the spec's I have seen somewhere but never realised in one box!"

Lay-out of the instrument

Fig. 1 shows the block diagram of the PM 5770 together with its functional controls and specification ranges. The block diagram is straight forward and complete in the sense that the operator is given the opportunity to vary all the basic pulse parameters.

Functional control arrangement

Fig. 2 shows the high standard achieved by ergonomic arrangement of the controls. Every item is logically placed relative to its purpose and sequence of use.

The upper part shows the details of an individual pulse. The lower part defines the relationship between sequential pulses (drawn in the double pulse mode).

All the parameters shown can be varied individually by means of the front panel controls.

Applications

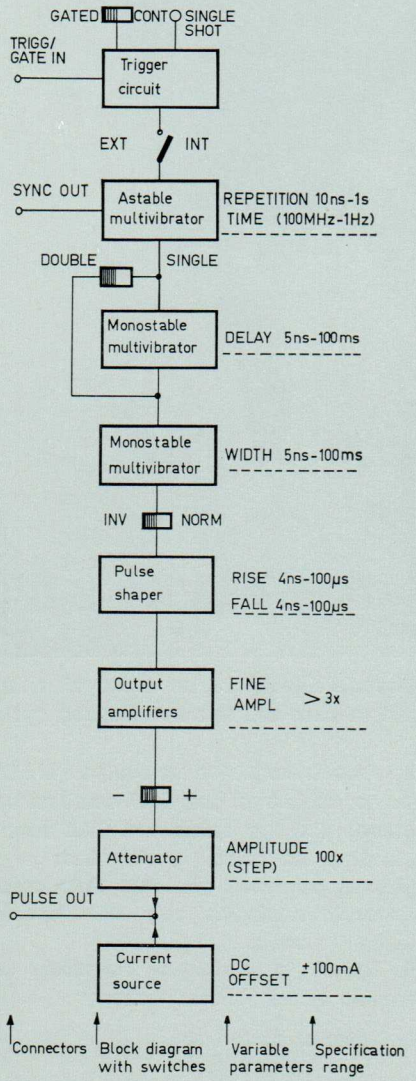
The PM 5770 can be used for all kinds of work with digital circuits. It is well suited for testing integrated circuits (IC) and systems built from IC's. The speed is sufficient for DTL and TTL circuits (and in many cases also E^2CL and ECL).

E^2CL - counter

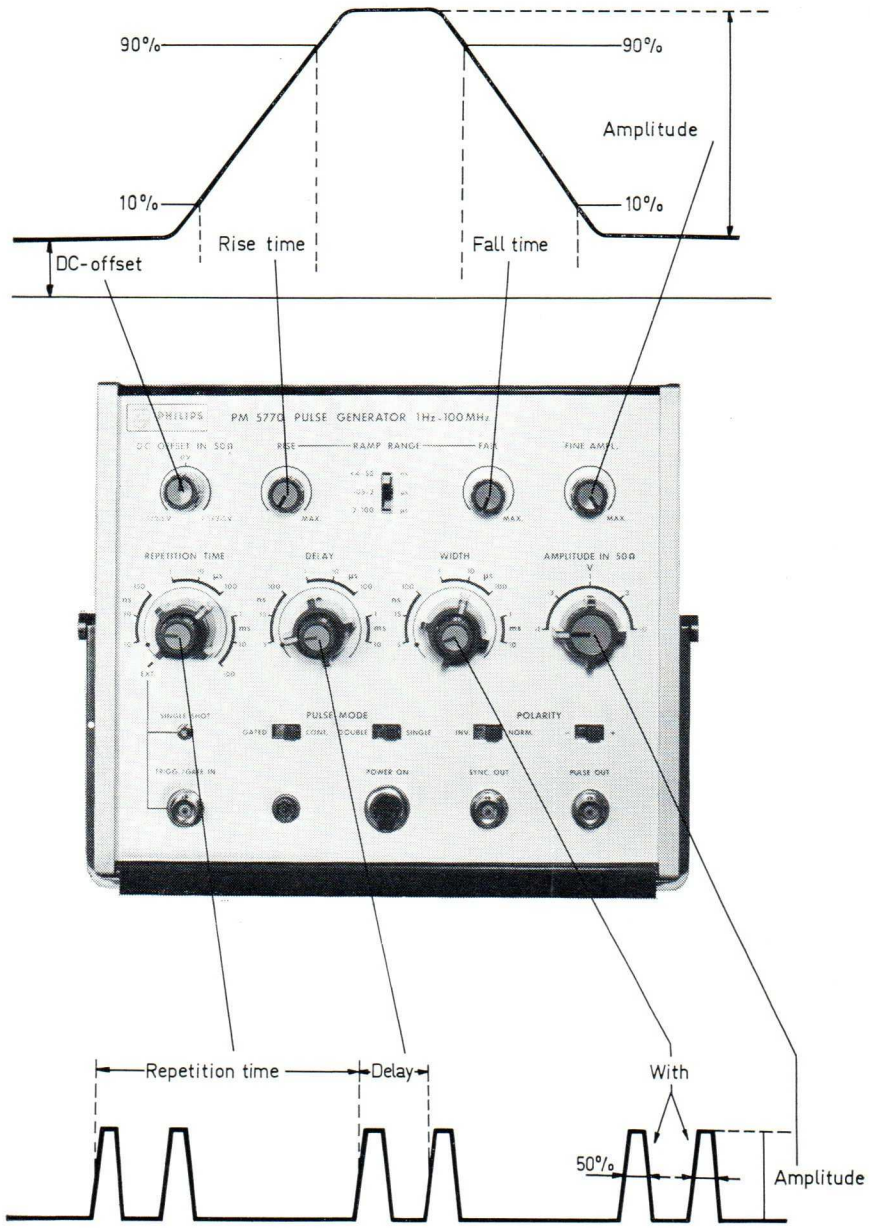
The photo fig. 3 was taken at an exhibition of integrated circuits. It shows a demonstration system made by Mullard, consisting of E^2CL circuits connected as various types of counters. In the situation shown, they were wired to form a divide-by-eight circuit, which performed well up to 40 MHz clock frequency. The PM 5770 was used as a clock generator and delivered a negative pulse with 0.7 V amplitude to the input of the circuit. Both the input and the output waveforms were monitored on a Philips' sampling oscilloscope PM 3419.

Testing TTL-gate

The photo, page 3, shows an investigation of a TTL-gate (Philips FJH III or Texas SN 7420). The measurements were made in accordance with a test circuit that is prescribed by the manufacturer of the integrated circuits. The pulse generator was set to 3 V amplitude, repetition time 1000 ns, pulse width 500 ns. Rise- and



1. Functional block diagram with abreviated specifications of the PM 5770



2. Ergonomic arrangement of the controls