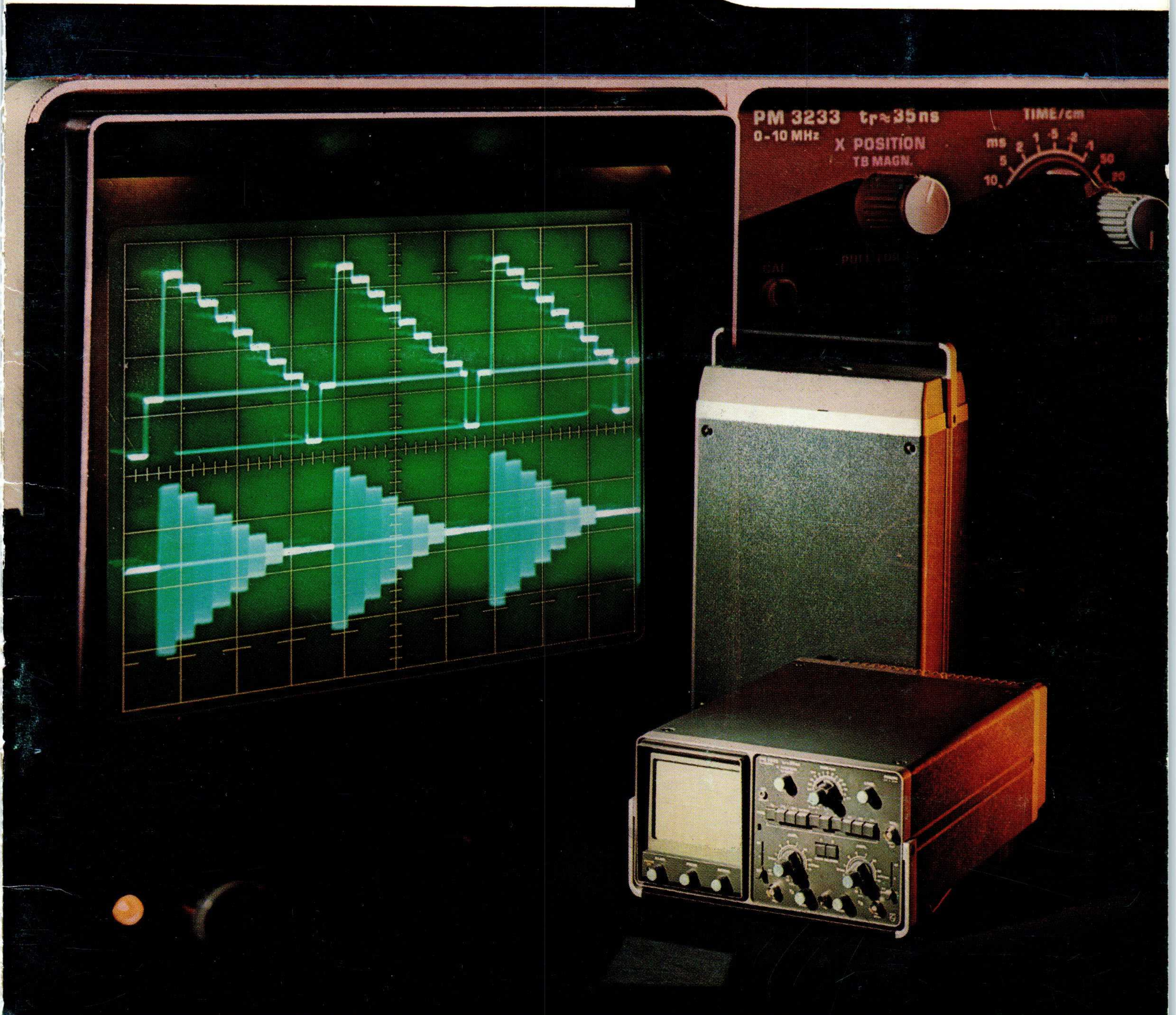
Splitbeam

PHILIPS

test and measuring notes



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PHILIPS

test and measuring notes

Introduction

The periodical Test and Measuring Notes provides information about the application and design of Philips electronic test and measuring instruments. 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 equipment which will best meet their particular measuring needs.

In this issue page

General information

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

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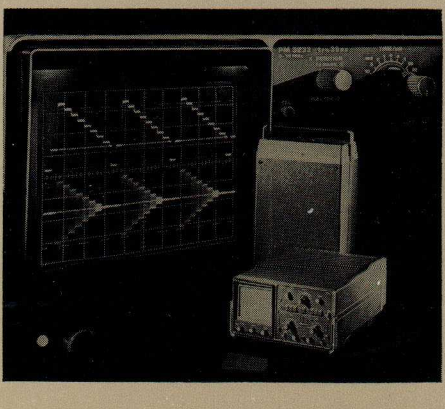
Front cover

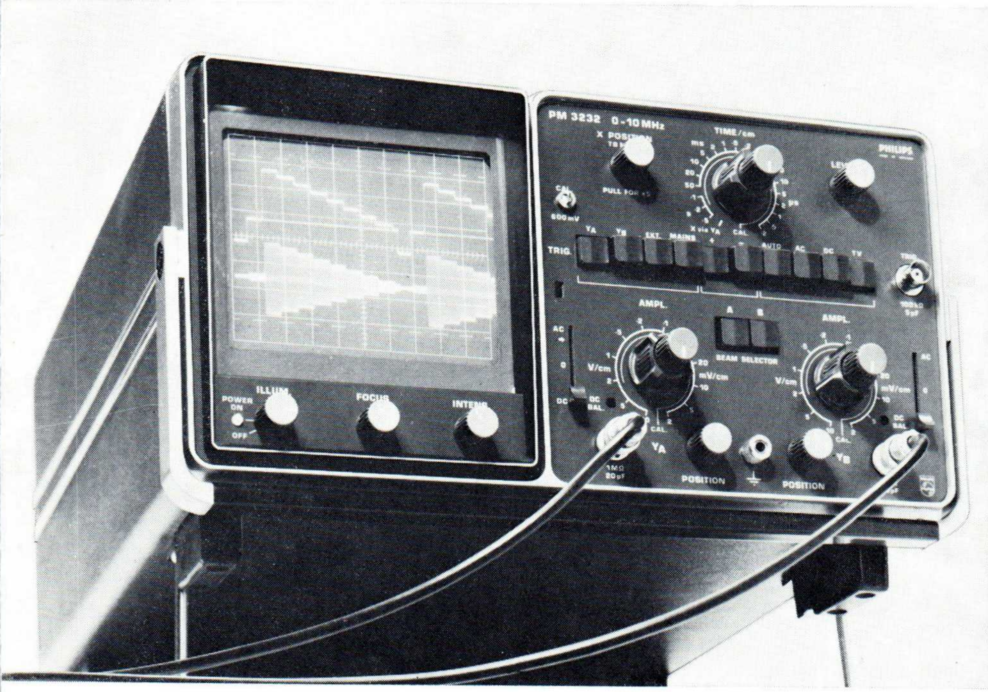
The PM 3232 new generation general purpose oscilloscope.
The compact design of this dual beam instrument enables maximum screen size with ease of operation through push-button controls



What is new in the PM 3232

by H. Toorens

In this article a new 10 MHz dual-beam oscilloscope, using a newly developed Philips rectangular dual beam, 10 kV mesh type PDA tube, is described.
The instrument features a.o. 8 x 10 cm, display-area, 2 mV/cm sensitivity, automatic level-detecting and DC triggering including auto-free-run. It can be powered from a wide range of AC voltages and external DC supply.



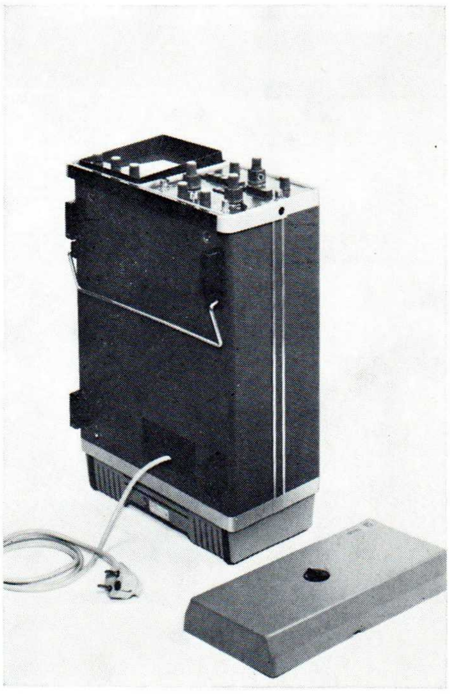
A 10 MHz osciloscope having two inputs may not seem to be spectacular.
One can find many types of them on the market each with various properties. Instruments like these are used throughout the entire field of applied electronics, from medical/biological research to manufacture and service of electronic datamachines and their peripherals.
Because of the variety of applications for oscilloscopes in this class, one can not easily identify who is actually the user. Included are the highly-skilled electronic engineer, who knows and realises what an oscilloscope does or for instance the biological scientist who only wants to get a graphical presentation of his experiment. The latter possibly having little knowledge of electronics.
But, whoever might use the instrument, they have one thing in common: they need a tool, a simple to operate, and reliable instrument which allows them to face their problem, without introducing new problems of operation. They want to be able to use it anywhere, in the airconditioned lab. or in the industrial environment of a steelmill and they want to take it from one place to another, easily.

The target

An oscilloscope with a specification which places it into many applications, including radio and TV design and development, industrial service and service of data machines, telecommunication and education.
An oscilloscope, to be easy to operate and "fool-proof" to a high degree.
It should be ergonomically designed and resistant against severe environmental circumstances. And, because an oscilloscope is an instrument to show things, it must have a large screen, with a brightness of traces which clearly shows even the most difficult waveforms.

The PM 3232

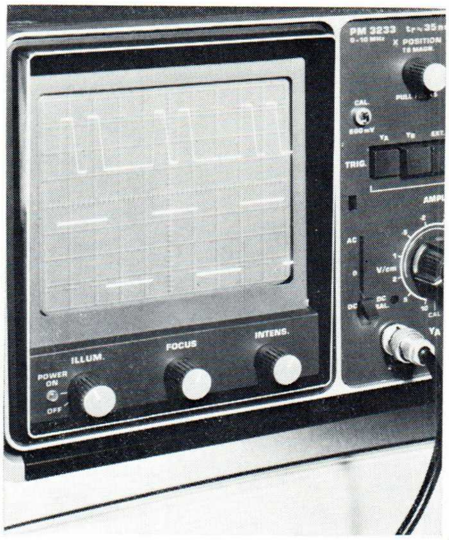
The PM 3232 fulfils all of the abovementioned requirements. Its modern styled cabinet provides a firm construction with good accessibility to all circuits and components. The total construction stands 4000 bumps of 10 g in three directions, perpendicular to each other. Testing also comprises vibration between 10 Hz and 150 Hz over an amplitude of 0.7 mm. with a maximum acceleration of 5 g in accordance with IEC 68 specifications. Furthermore, the PM 3232 can be used in a wide range of ambient temperatures; viz. —10... +55 °C. The obvious result of all this care is an excellent reliability. Its front panel lay-out and shape of controls, are ergonomically designed, so that operators' time and error are restricted to the minimum. But let us have a look at the most important part of any oscilloscope:



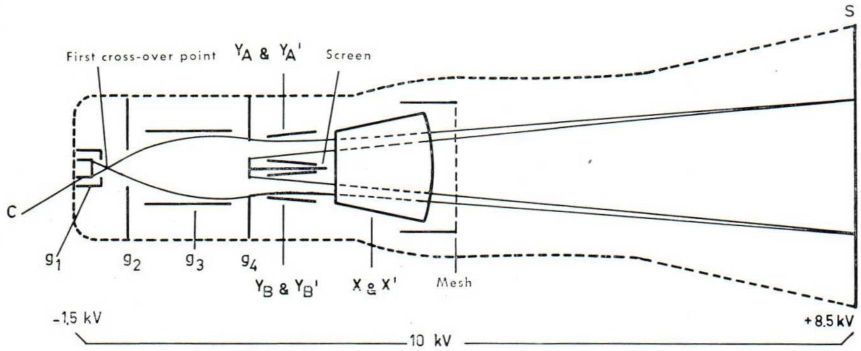
The display system

The heart of an oscilloscope is formed by the cathode-ray-tube on the screen of which all relevant information, like amplitude, time, and shape of a waveform are presented. As many applications of oscilloscopes require a means of comparison between two waveforms, this screen should be as large as possible.

The PM 3232 features a display area of 80 cm^2 (8 cm vertical and 10 cm horizontal) on a rectangular, post deflection accelerator dual-beam tube. The two beams, which can be deflected independantly from each other, produce two bright traces. This brightness, which is the result of a relatively high screen-current for each individual beam and the high total accelerating potential of 10 kV allows the user to see fast signals even at low repetition rates. Metal backing of the phosphor layer avoids burning, when high intensity is used. A simplified drawing of this newly developed Philips CRT is given hereunder in fig. 1.



1. Simplified diagram of the CRT



Electrons are emitted from the cathode (c) and accelerated by the first accelerator (g_2). The Wehnelt cylinder (g_1) acts as first grid and defines the beam current and thus, the intensity. Passing the first accelerator (g_2), the beam has a divergent shape. By means of the convergent lens, formed by g_2, g_3, g_4, a sharp focussed projection of the first crossover point is produced on the screen (s) forming the spot. However, the second accelerator electrode (g_4) has two holes, instead of one.

The result is that the beam is split into two parts, thus producing two spots on the screen, instead of one as in a conventional CRT. So, behind the second accelerator, there are two beams.

These two beams are deflected individually, one with the balanced pair of deflection plates Y_A and Y_A', the other with Y_B and Y_B'. Horizontal deflection is the same for each beam, by X and X', so that both spots are always accurately traced, ensuring optimum time correlation of the two traces. After being deflected, the electron beams pass through a mesh, and are then accelerated by the post-deflection accelerating potential of 8.5 kV. This mesh acts as an electrostatic screen between the high post-accelerating voltage and the deflection plates. If this were not the case, the deflection sensitivity of the tube would have been considerably lower.

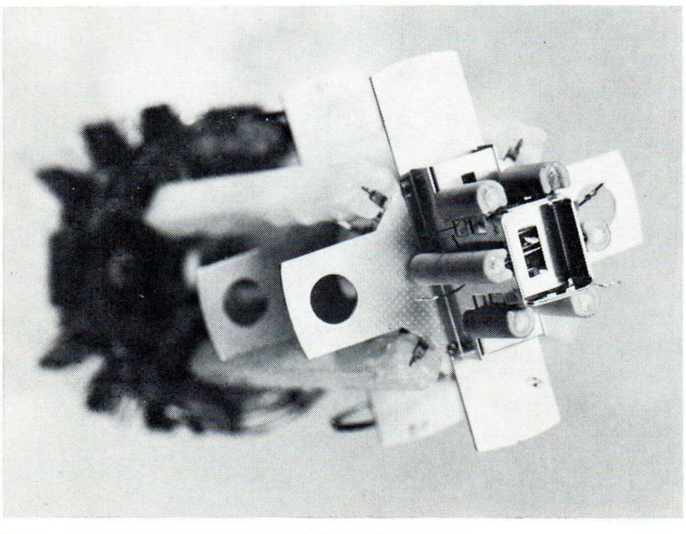


Photo shows assembly of vertical deflection plates

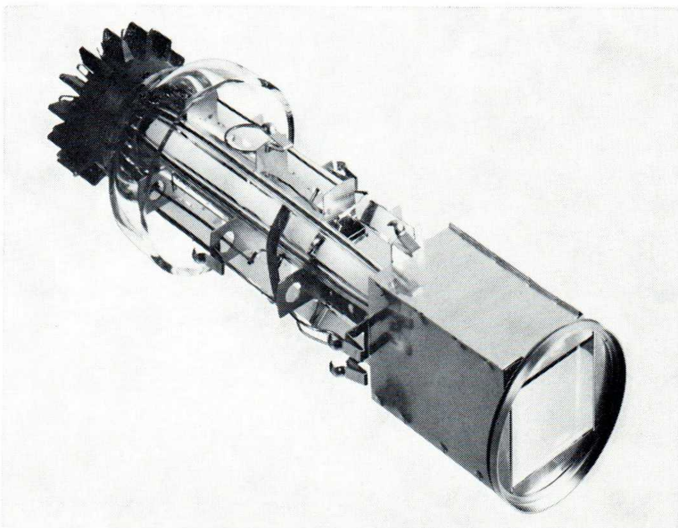


Photo shows complete gun of PM 3232 cathode ray tube

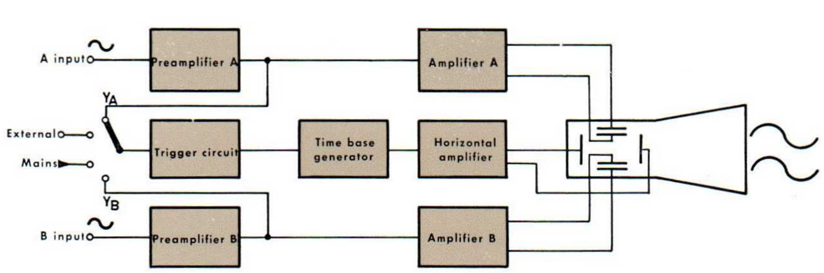
Why dual beam

The display of two waveforms simultaneously on one screen, can be done with two beams, which are individually deflected by two separate amplifiers. It can also be achieved by using a conventional single beam CRT, which displays parts of the two signals in a time-shared mode.

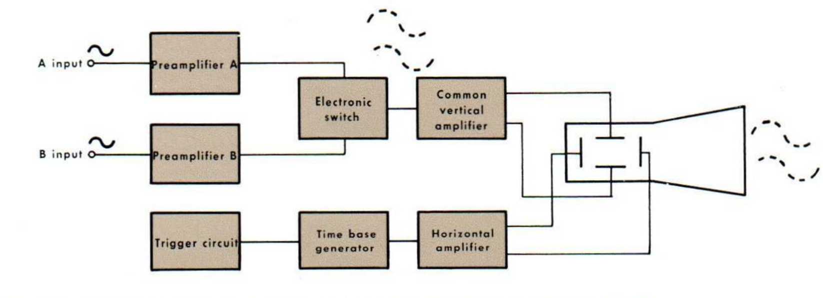
The different set-up is illustrated in the following (simplified) fig. 2 and fig. 3 on the page 3.

The dual-beam method requires a more complex CRT construction and an extra amplifier, but it brings some significant advantages over the simpler-to-construct time-sharing system.

The basic difference is that a dual-beam oscilloscope always produces two uninterrupted waveforms at the same time, while in the time shared system, the single spot is always moving from one trace to the other.



2. The "dual-beam" circuit as used in the PM 3232. Two beams are generated in one gun and independantly deflected in the Y direction



3. The conventional time-sharing method having common X and Y plates and employing an electronic switching arrangement. Note that the two traces are written in parts so that discontinuities may be visible. Furthermore, this technique gives rise to ambiguity in triggering conditions and can produce display errors.

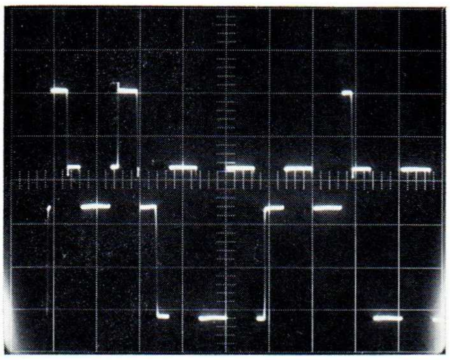


Fig. 4 illustrates one possible cause of error when a dual trace scope is in the chopped mode. Fundamentally this technique only shows half the waveform, the rest is interpolated. Although the display is not complete, note that the phase is correct.

Time-shared oscilloscopes offer two display-modes, known as "chopped" and "alternate". In the "chopped" mode switching occurs at a fixed switching rate. The higher the frequency, the better the resolution of the displays, but the switching frequency is limited by the bandwidth of the amplifier. In practice, this switching frequency is in the order of 50 times lower than the frequency limit of the oscilloscope.

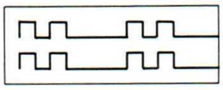
A time-shared oscilloscope is preferable used in this chopped mode but on the other hand, discontinuities are visible when the input signal interferes with the chopper frequency. Also single shot phenomena or signals with low repetition rates cannot be displayed at relatively high sweep-speeds without visible interruptions (see fig. 4).

In the "alternate" mode, a time-shared oscilloscope displays one complete trace per sweep, because the electronic switch is operated at the end of each saw-tooth. The displaying sequence thus is for example A-B-A-B etc.

It will be clear that this method cannot be used for low-repetitive signals or single-shot phenomena, as only one trace is seen at the same time. And it may even show misleading results!

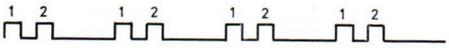
Imagine that this signal is connected to **both** inputs of a time-shared oscilloscope operating in the alternate mode.

It should be displayed as follows:



But it can go wrong! For example:

(a) is the signal to both inputs

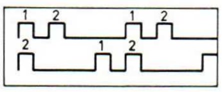


(b) is the signal to trigger the time base

(c) is the time base signal

(d) shows that odd sweeps start with pulse 1 whilst even sweeps begin with pulse 2.

The result looks like this:



The more complex a pulse pattern is, the more chance that the display is not true. As has been mentioned before, a dual-beam oscilloscope always produces two uninterrupted waveforms **at the same time,** and therefore avoids the errors as mentioned above. Therfore, it is easier to work with and gives rise to less errors. Furthermore, it brings more advantage of the high accelerating potential as used in the PM 3232, because the maximum light output is not divided over two traces as it is in the time-shared system.

Significant electrical properties

The input sensitivity of the PM 3232 is high viz. 2 mV/cm. This not only makes display of weak signals possible, it also allows the user to employ passive attenuator probes, so that the parallel capacitance loading the circuit-under-test is reduced. Even when a 100 : 1 probe is used, like the PM 9358, (input capacitance of only 2 pF) a useful sensitivity at the probe tip is achieved.

The time base generator which has a wide range of sweep speeds (0.5 s/cm up to 200 ns/cm) can be triggered by Y_A, Y_B, Ext or Mains frequency. This trigger source selection makes the instrument really versatile. Triggering, by the way, is easy with the PM 3232. The trigger circuit can be DC coupled, a **must** when measuring

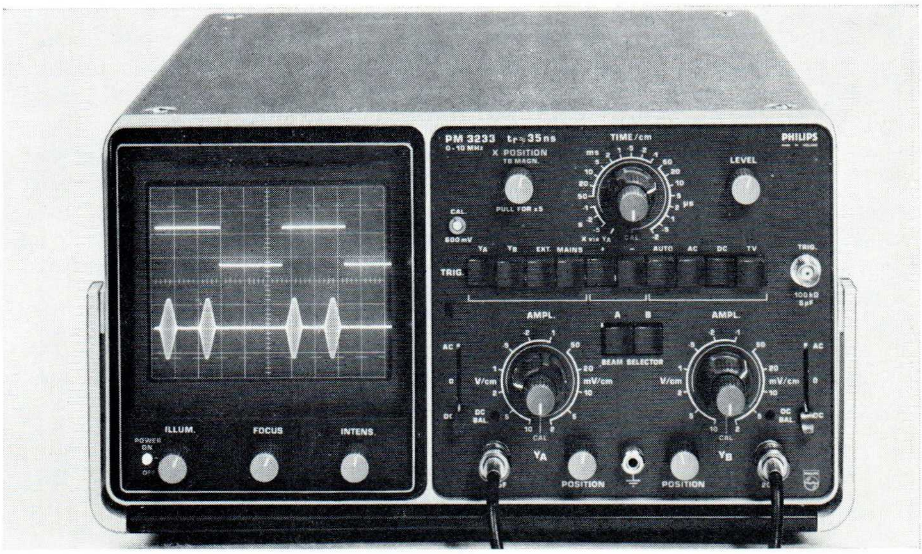
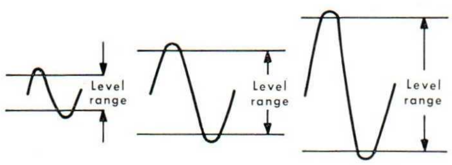


Photo shows the clear front-panel lay-out of the PM 3233, the delay line version of the PM 3232

digital waveforms where duty-cycles are most variable. There is also a refined Automatic trigger mode.

This Auto-mode ensures that a bright line is displayed under no-signal conditions for quick zero-referance. When a signal is applied the time base is triggered, automatically, on a level which is variable between the extremes of the waveform.



This feature implies that nearly all signals can be displayed without even touching the level control!

There is no "trigger-stability" control on the PM 3232. It triggers stable beyond 10 MHz.

Displaying video waveforms is also an automatic function. Pressing the button „TV" is all to be done to have the time-base triggered by the televisions synchronisation pulses. Selection of "Frame" and "Line" triggering is done automatically while setting the time-base speed.

Conclusion

The PM 3232 is a general purpose oscilloscope, in which much attention is paid to the display system including the cathode-ray-tube. Many measurements can be made using the very convenient automatic trigger mode. DC trigger coupling ensures stable displays, even when repetition rates and/or duty cycles of the signals to be measured are variable.

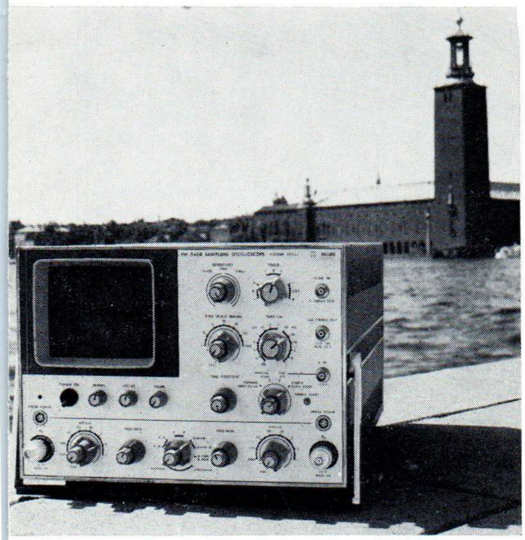
The photographs with this article will show the very clear, functional design with which every operator will feel familiar in a few seconds.

Thanks to the use of building-blocks, plug-in semiconductors and wiring, service-down-time is restricted to a minimum, increasing the eficiency and usefulness of the new PM 3232 dual-beam oscilloscope.

Some applications of the output signals of the PM 3400 sampling oscilloscope

by W. Spapens

The output signal of a sampling scope can be used to drive an X-Y recorder; accurate DC measurements can be made at any desired point on the trace; and signals can be measured up to 70 dB below the noise level.



Introduction

Electronic sampling techniques are becoming more and more important nowadays, because:

a. they allow high-frequency recurrent signals to be brought into the frequency range where they can be conveniently processed by analog or digital methods.

b. the increasing use of digital signal processing leads to a requirement for the signal to be sampled before being processed.

One device which is often used for applications of the first type is the sampling oscilloscope, which has been on the market for a good many years now but has recently been improved in a number of respects thanks to improvements in semiconductor techniques, so that it may now be regarded as a general-purpose measuring instrument.

While sampling oscilloscopes cannot display high-frequency single-shot phenomena, they do have a lot of advantages over real-time oscilloscopes. Benefits such as wide bandwidth, high sensitivity, broad dynamic range, the availability of the signal after sampling and accurate X-Y measurement facilities up to high bandwidths and many other points, are now quite common for sampling oscilloscopes.

The horizontal scan of a sampling oscilloscope

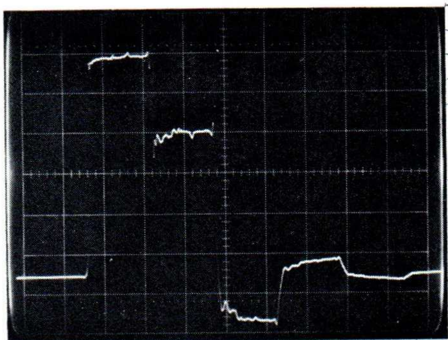
It is characteristic of sampling oscilloscopes that the equivalent time scale, that is the number of ns/cm of μs/cm, and the movement of the spot over the screen, are completely independent of each other.

The display can be written at any speed and even backwards from right to left. One can, therefore, sweep the display at a speed which can be conveniently followed by an Y-T or X-Y recorder, thus allowing permanent recording to be made. An additional advantage of using a recorder is that it acts as a low-pass filter which effectively reduces noise and jitter. This freedom of scanning the signal facilitates closer investigation of the signal than is possible by simple observation of the oscilloscope screen.

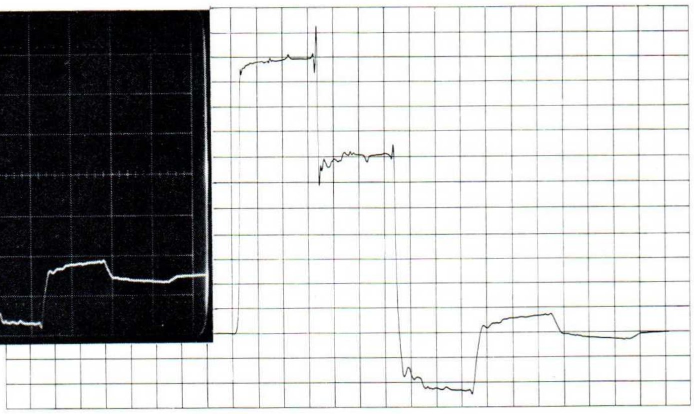
In this article we will deal with some applications based on this principle, viz:

1. *the recording of signals*
2. *the accurate measurement of signals*
3. *measurements on signals completely submerged in noise.*

For readers who are not familiar with the operation of a sequential sampling oscilloscope, a brief description of the operating principles of the PM 3400 is given in an appendix.



1. Oscillogram of a fast-rise-time signal with reflections. Amplitude 200 mV/div, Time 20ns/div



2. The signal of fig. 1 recorded on an X-Y recorder. Amplitude 100 mV/cm, Time 10 ns/cm

Recording signals with an X-Y recorder

One of the limitations of an oscilloscope is the relatively small size of the screen (generally 8x10 cm). If the trace is 0.3 mm thick this thus gives a resolution of about 270x330 lines. A photographic record of the trace on the screen will be subject to the same limitations as regards resolution, while the making of extra copies of Polaroid prints (the usual medium used in oscilloscope cameras) is by no means an easy matter, and is relatively expensive.

If we connect one of the vertical outputs and the X output of the PM 3400 to an X-Y recorder, we can get a recording of the signal on the screen of the CRT. A Polaroid photo and an X-Y recording of the same signal are shown in fig. 1 and 2 respectively. On the recording, 2 cm correspond to 1 cm on the screen, while the line width is about the same in the two cases.

The resolution of the X-Y recording will thus be about twice as good as that of the Polaroid oscillogram. Moreover, the X-Y recording has the advantage that it can be made on graph paper, thus making amplitude and time measurements much faster and more accurate. Finally, the X-Y recordings can be reproduced with normal copying equipment; this gives excellent, very cheap prints, which can be very important when a large number of copies of the recording are needed e.g. as educational material in schools and universities.