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T&M news

from the
Test and Measuring Department

Volume 2 Number 3 1974

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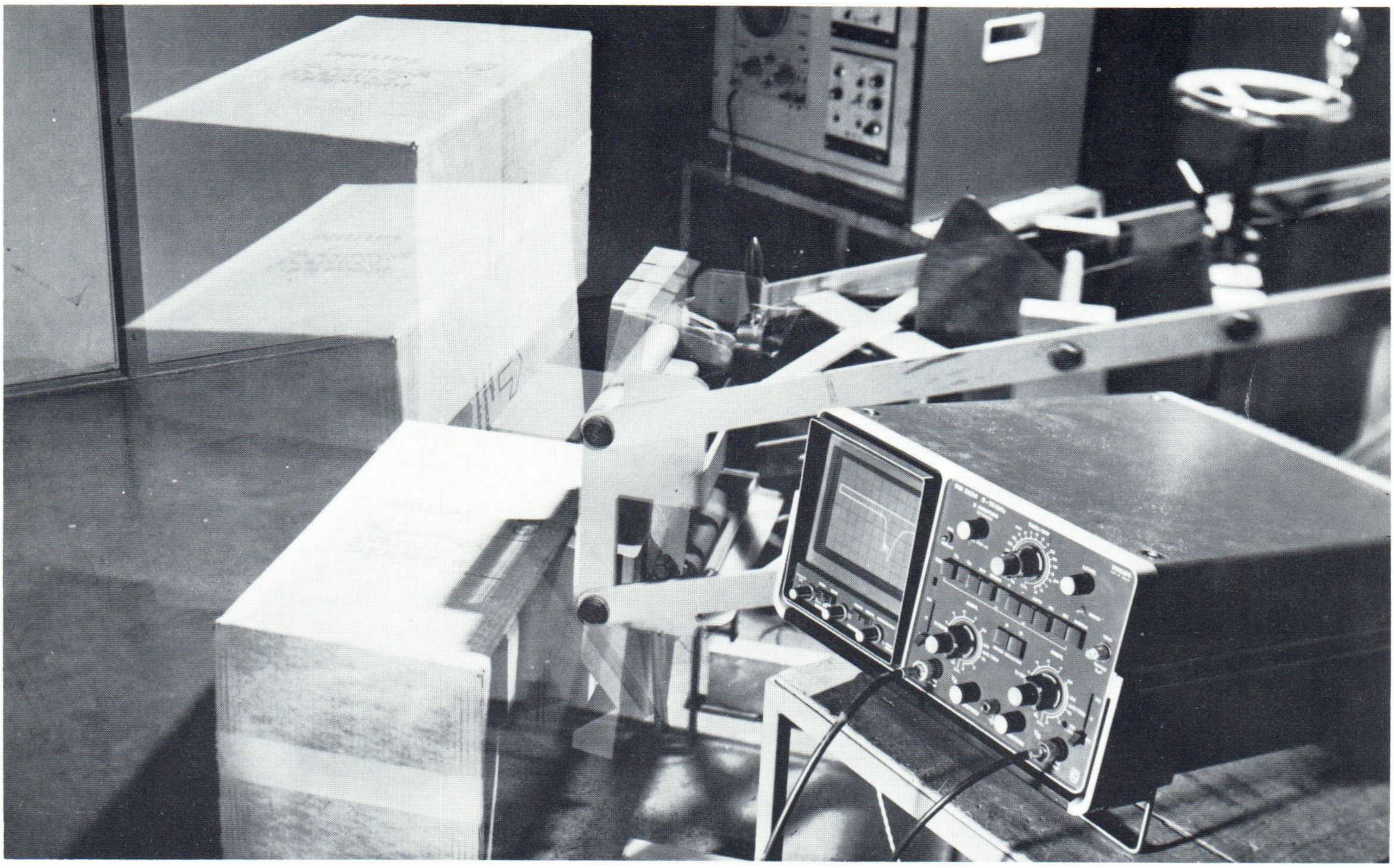
Testing TV remote control system
NTSC pattern generator

PHILIPS



10 MHz dual-beam storage oscilloscope

The new PM 3234 combines two techniques which have already proved their worth in earlier instruments: halftone storage with variable persistence and true dual-beam operation.

Thanks to these two features and the bright display (8.5 kV mesh-type CRT), the PM 3234 gives clear, uninterrupted, error-free displays, and is hence ideal for the study of two single-shot phenomena (this may be regarded as the main field of application of this instrument) and further of other low-frequency or low-intensity signals.
The 2 mV sensitivity is maintained over the entire bandwidth of 10 MHz. The large (8 x 10 divisions) screen is fully covered by both beams. Full triggering facilities (Auto, AC, DC and Single-shot) are available, and there are delay lines in both vertical channels.

This oscilloscope is compact, lightweight and easy to maintain. It can be powered by a 24 DC battery as well as by the mains. All these features combine to give an advanced, versatile instrument which can be used to advantage for a very wide range of applications (mainly for the study of switching and other low-repetition rate phenomena in electronics, and for the study of mechanical or medical effects etc. with the aid of transducers).

Photo: Acceleration measurement during drop-testing with the aid of the PM 3234.

continued on page two

T&M news

Published bimonthly by

N.V. Philips' Gloeilampenfabrieken Eindhoven, The Netherlands

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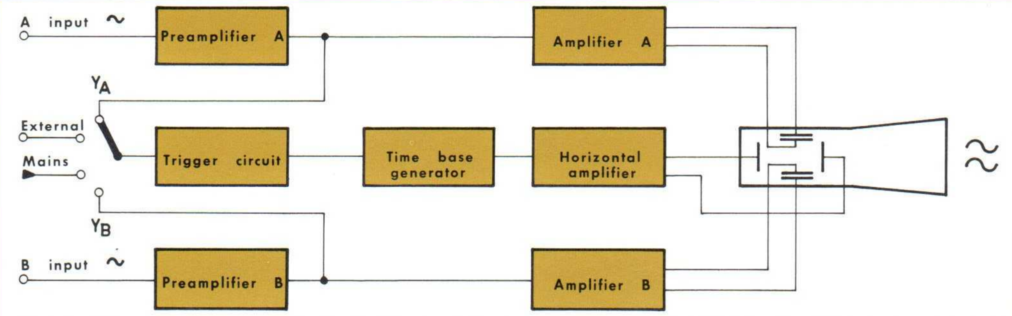

Fig. 1. shows the "dual-beam" circuit of the PM 3234. The beams are generated in one gun and independently deflected in the Y-direction. Note that no electronic chopper is employed, so that always two continuous, uninterrupted traces are written.
(See data sheet of sister instruments PM 3232 and '33 and also Test and Measuring Notes 1972/6 for full details).

10 MHz dual-beam storage oscilloscope PM 3234

(continued from front page)

The main field of application of any storage scope is the study of single-shot phenomena, and the PM 3234 is no exception. For example, a single-shot transducer signal which could hardly be seen at all with a conventional display can be held for more than 15 minutes on the screen of the PM 3234, thus permitting detailed analysis of the phenomenon. Additional application is the "building up" of low-intensity signals which are too faint to be seen in a normal display with the aid of the storage facilities in the tube's memory.

Combination of half-tone storage with true dual-beam operation gives this instrument its unique capabilities, since single-shot phenomena in particular generally have to be displayed in pairs for the purposes of comparison.

This true-dual-beam CRT makes use of a single electron gun which generates two separate beams; common X plates are used, but there are independent Y plates for the two beams; see fig. 1. The two traces on the screen are thus both uninterrupted, unlike the case with the chopped or "alternate" display of dual-trace instruments; especially with single-shot events, this uninterruted display gives incomparably better presentation of all details of the signal, as may be seen by comparison of fig. 2 and 3.

Although the half-tone storage principle is not new, we thought that the reader might like to refresh his memory about this interesting tube. Details are therefore given in the following article.

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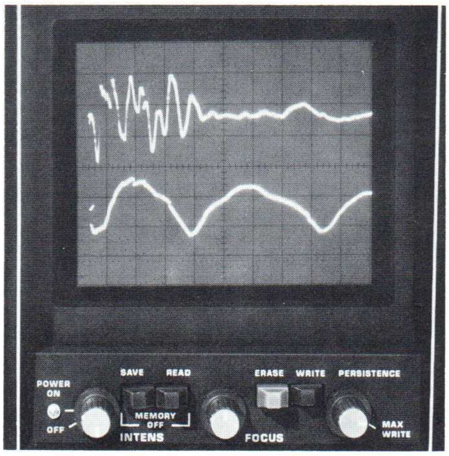


Fig. 2. This oscillogram shows a single-shot phenomenon accurately displayed on the PM 3234.

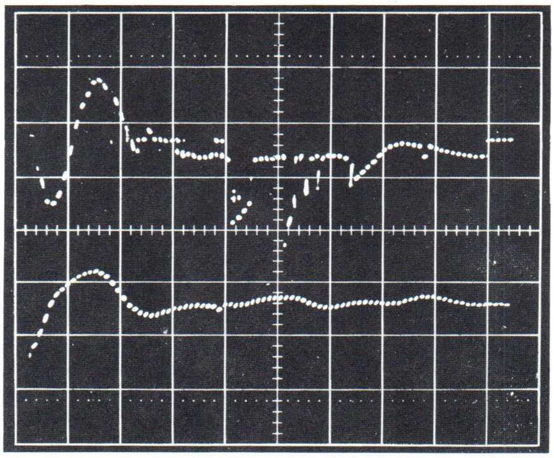


Fig. 3. This oscillogram was taken on a dual-trace instrument recording a single-shot signal similar to that of fig. 2. The ambiguity that the chopped display mode has introduced is all too obvious.

Brief technical specifications

CRT

Type
Philips L 14 - 130 GH rectangular dual beam post-accelerator half-tone storage tube.
Accelerating potential: 8.5 kV
Persistence
Normal: Natural persistence of P 31 phosphor (10 μs . . . 1 ms)
Variable: Continuously variable from < 0.3 sec. to > 1.5 min.
Storage time
In maximum persistence mode: > 1.5 min.
In "read" mode: > 3 min.
In "save" mode: > 15 min.
Writing speed
Normal: > 100 div./ms
Max. write: > 1 div./μs
Erase
Push-button operated, erasure takes approx. 600 ms

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.
Bandwidth
DC: 0 Hz . . . 10 MHz (—3 dB)
AC: 2 Hz . . . 10 MHz (—3 dB)
Risetime
35 ns
Deflection coefficients
2 mV/div. . . . 10 V/div.
Uncalibrated, continuous control between steps.
Input impedance
1 MΩ//20 pF

Horizontal amplifier (X via Y_A)

Bandwidth
DC: 0 Hz . . . 1 MHz (—3 dB)
AC: 2 Hz . . . 1 MHz (—3 dB)
Deflection coefficients
2 mV/div. . . . 10 V/div.
Uncalibrated continuous control between steps

Time axis

Time coefficients
0.5 s/div. . . . 0.2 μs/div.
Uncalibrated continuous control between steps.

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, provided a bright zero line at all sweep speeds at no signal conditions and stable triggering at an adjustable trigger level, the level automatically being limited to the peak-peak amplitude of the signal. A single shot facility is included.
Trigger source
Internal Y_A
Y_B
Mains frequency
External

Trigger bandwidth
DC . . . 10 MHz

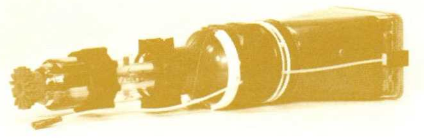
Supply voltages

Power AC
90 . . . 140 V or 180 . . . 265 V; 46 . . . 440 Hz
Power DC
22 . . . 30 V

Dimensions and weight

Length: 50 cm incl. front cover
Width: 32.6 cm incl. handle
Height: 18.5 cm incl. feet
Weight: 11.8 kgs

Dual-beam storage CRT



Storage principle

The PM 3234 storage oscilloscope contains a storage-mesh the storage time of which can be varied so that it can be used like a normal CRT, but with variable persistence of the displayed signal.

The storage of information takes place by writing the signal information from the normal electron (writing) gun into a storage layer of high quality, non-conductive material, so forming a positive charge pattern by secondary emission of electrons. This charge pattern on the storage surface remains for a considerable length of time, even when the writing gun is switched off. It is made visible on the phosphor viewing screen by a second electron beam the electrons of which are allowed to strike the phosphor via the positively charged positions on the storage layer.

The basis for storage of information on the non-conductive material is the secondary emission ratio curve, as shown in fig. 1. This curve shows the ratio between the number of electrons leaving the storage-layer surface and the number of electrons arriving (secondary emission ratio) plotted as a function of the surface potential. At a potential of about V_a volt the number of electrons leaving the surface is equal to the number arriving. This point is called the first cross-over (secondary emission ratio = 1).

If the surface is bombarded with electrons of higher energy, the surface potential rises, because more electrons are leaving than arriving.

If the surface is bombarded with electrons with energies lower than at V_a volts, the surface potential decreases, because fewer electrons are leaving than arriving. A practical value of V_a for a suitable type of non-conducting material is between +15 and +45 V.

Storage tube construction & operation

As shown in fig. 2, the PM 3234 storage CRT contains two systems: the 'Writing' system and the 'Flood' system. Construction and operation of the writing part are identical with that of the tone dual-beam CRT and will not be dealt with here.

The flood system consists of a pair of flood guns operated in parallel, both having a cathode c, a control grid g_1 and an accelerator grid g_2. Common to both flood guns are the flood-beam collimator g_7, the collector mesh g_8, the storage mesh g_9 (carrying the storage layer), and the phosphor viewing screen g_{10}.

The flood guns are physically located just outside the horizontal deflection plates. The cathode potential is —50 V. A cloud of electrons is emitted by each flood gun cathode. These clouds are combined, shaped, and accelerated by the two control grids g_1 and g_2 and by the collimator g_7 (which is formed by a coating on the inside of the tube). The positive voltage on the collimator is adjusted so that the flood-gun electron cloud just fills the CRT viewing screen. The cloud is further accelerated towards the storage mesh and viewing screen by the collector mesh g_8. After passing through the collector mesh, the flood electrons are further controlled by the potentials on the storage mesh and storage-layer surface.

Shown in fig. 3 are the storage and collector meshes, both with approximately 40 μm apertures. The cathode-side of the storage mesh is coated with a non-conductive material on which the storage of information takes place, fig. 4a.

The capacitive coupling that exists between the storage mesh and the storage-layer surface is essential for the operation of the store and erase functions. The storage mesh is normally at a potential of approximately +1 V with respect to the flood gun cathodes. The potential at the storage-layer surface is controlled by Write and Erase routines fed to the storage mesh and varies between 0 V and negative.

Fig. 4b shows that when the storage-layer surface is at 0 V, the majority of flood electrons pass through the holes of the mesh and reach the viewing screen. The remaining electrons are repelled by the storage-layer surface and picked up by the collector mesh. When the storage-layer surface is made negative (fig. 4c), the number of electrons passing the storage mesh is reduced considerably. At a certain value (the cut-off level), no electrons are passed.

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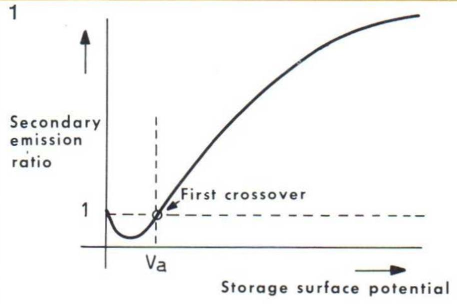

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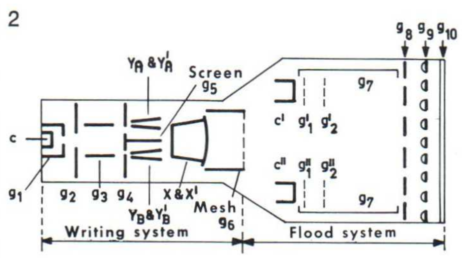

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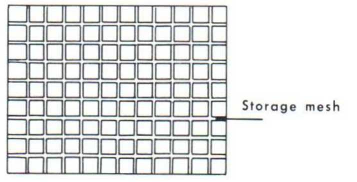
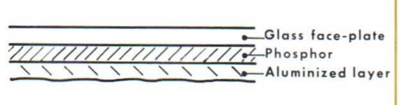
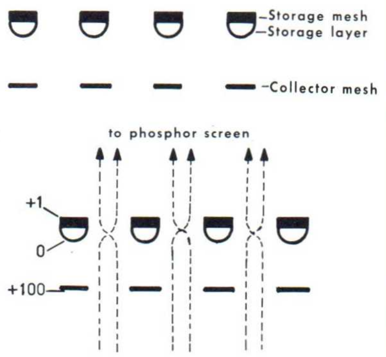


4a



4b



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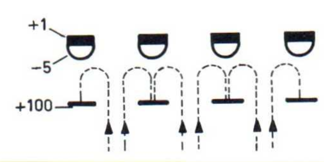

Fig. 1. Secondary emission ratio

Fig. 2. Simplified CRT construction

Fig. 3. Mesh construction used for collector and storage grids

Fig. 4a. Detail of storage system construction

Fig. 4b. Storage system at full brightness

Fig. 4c. Storage system at cut-off

The post-accelerator voltage (approximately 6 kV) is connected to the phosphor viewing screen. As soon as flood electrons are allowed to pass the storage mesh they are accelerated by this potential and strike the phosphor, thereby causing it to emit light.

The storage mesh g_9 (fig. 2) can be compared with the control grid of a triode. Just as the triode grid potential controls anode current, so the flood storage mesh potential controls the current of flood electrons to the screen and thus the intensity of the trace. An operator control for varying the brightness during storage will be discussed later.

Writing and storage

Let us assume that the storage-layer surface has been prepared by an Erase routine (to be discussed later) such that it is below the cut-off level: no flood electrons can reach the screen. When we now activate the writing cathode and let the electron beam move over the storage-layer surface, the high potential difference (—1500 V) existing between the cathode and this surface will cause the electrons to arrive at the surface with energy much in excess of first crossover. The surface will be charged in a positive direction wherever the electrons strike. The highest potential that can be reached is 0 V (flood gun cathode potential), any value above this would attract flood electrons, so reducing the surface to its original 0 V potential. We have seen in fig. 4b that those areas of the storage-layer surface that are charged to near zero volts, allow the post-accelerator field to 'reach through' and capture flood-gun electrons. Thus, the pattern of charge on the storage-layer surface is made visible on the screen.

The potential of the flood gun accelerators g'_2 and g''_2 is controlled by the upper of the pulser circuit shown in fig. 5. Depending on the operator mode selected, the accelerator grids are either continuously at cathode potential (Normal mode), continuously at +50 V (variable persistence mode) or pulsed positively at variable width (variable storage mode); see fig. 6. The storage brightness has a linear relationship with the pulse width selected. When the mode control is set to minimum brightness, the pulse will be almost cut off, and storage time will be maximum.

Erasure

Erasure of stored information can be done in two ways: by the Manual-Erase function or, in the variable persistence mode, by the Auto-Erase function.

Manual Erase

In the manual-erase mode the potential at the storage mesh is varied in accordance with the curve of fig. 7a. The corresponding curve for the storage-layer surface potential is shown in fig. 7b.

When the ERASE button is pressed (and held) t_1, the storage mesh is changed to the same potential as the collector mesh (+100 V). The storage layer surface follows to almost the same potential by capacitive coupling. Since this surface is then being bombarded by electrons with energies much higher than that at first crossover the entire surface potential becomes strongly positive and all information in the storage layer is overruled.

The surface potential cannot increase much beyond +100 V because the collector mesh would then repel the emitted electrons back to the storage surface, tending to decrease its potential.

When the ERASE button is released, t_2, the storage mesh returns to +1 V and the storage-layer surface follows to the same potential by capacitive coupling but then decays to zero volts by the action of the flood-gun electrons.

After 200 milliseconds, t_3, the storage mesh is automatically raised to +11 V. It is held there for 400 milliseconds. The storage-layer surface follows to +10 V by capacitive coupling but immediately starts decaying towards zero volts by capturing flood-gun electrons. At the end of the 400 milliseconds, t_4, the storage mesh is brought back to +1 V. This reduces the storage-layer surface from zero volts to —10 V. The erasure cycle is now complete, and the system is ready for the input of new information.

Auto Erase

In the auto-erase mode, recovery of the storage-layer surface potential to below cut-off level is accomplished after a number of automatic cycles of pulsed erasure. This is done by connecting a 2 kHz square-wave signal from the pulser circuit of fig. 5 to the storage mesh g_9. This signal, and the corresponding potential at the storage layer surface, are shown in figs. 8a and 8b. As in the manual-erase cycle,

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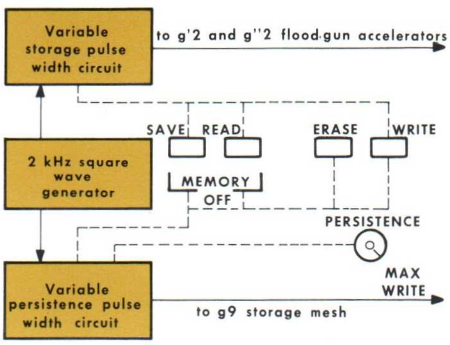


Fig. 5. Persistence and storage basic pulser circuit

Fig. 6. Flood gun accelerators potential during storage mode

Fig. 7a. Storage-mesh potential during erase cycle

Fig. 7b. Storage-layer surface potential during erase cycle

Fig. 8a. Storage-mesh potential during variable persistence mode

Fig. 8b. Corresponding storage-layer surface potential containing information

Fig. 8c. Same as 8b but persistence adjustment shorter (bigger pulse width)

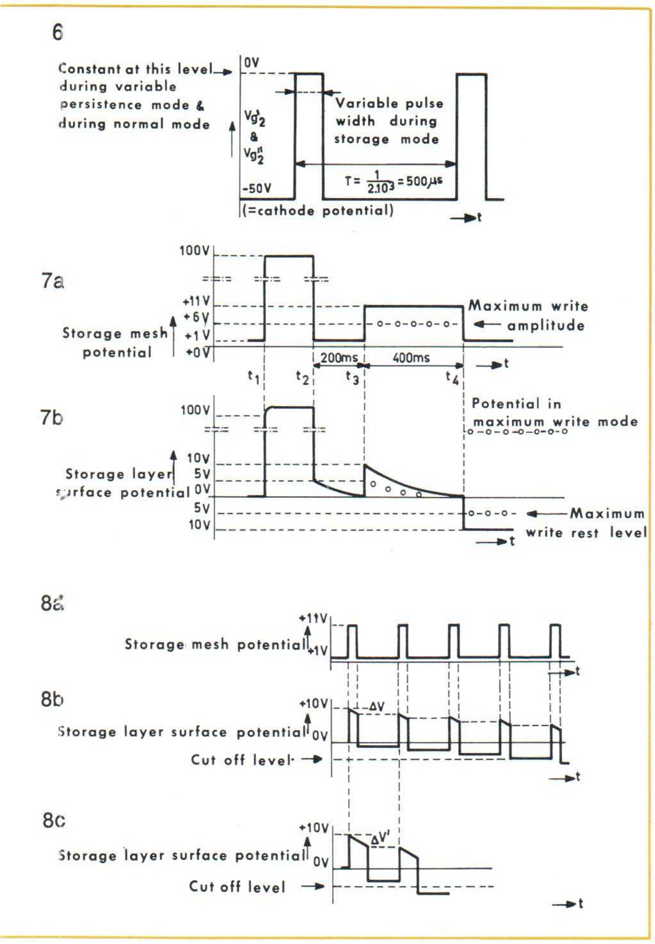
the storage-layer surface potential follows the voltage changes on the mesh. However, during each pulse the surface is moved in a positive direction and attracts and captures flood-gun electrons, tending to lower the potential by an amount ΔV. If this procedure is repeated many times the rest potential at the storage-layer surface will eventually pass the cut-off level and the stored trace will be erased.

When the pulse width is increased as shown in fig. 8c the drop in surface potential is increased too ($\Delta V'$) and fewer cycles of the square-wave are needed to complete the erasure.

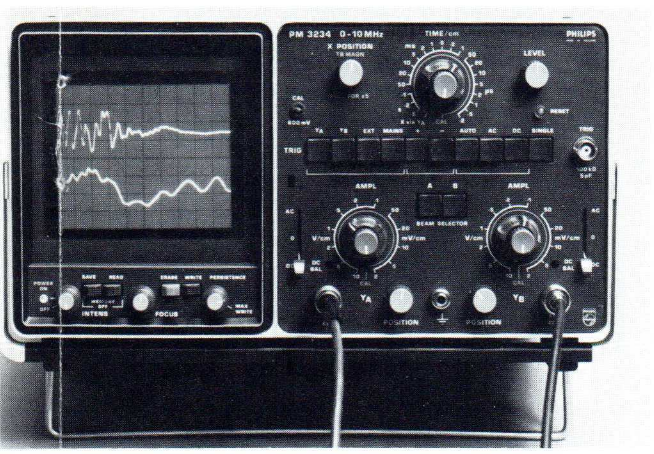
Varying the pulse width is accomplished by means of the variable persistence control (PERSIST.) of the PM 3234. Persistence can be adjusted between 0.3 sec and 10 minutes.

Maximum write mode

The secondary emission of electrons from the storage-layer surface caused by the bombarding flood-gun electrons, must charge the surface from its erased potential of —10 V to the storage threshold (cut-off level) of about —5 V before flood electrons can be captured by the post-accelerator (fig. 7b). Thus, the writing speed of the CRT can be enhanced by erasing the



surface to just below this writing threshold. By switching the instrument to the "Max. Write" mode, the amplitude of the erase pulse, shown in fig. 7a during t_3 - t_4, is reduced by approximately half. This results in a rest level after erasure of around —5 V. As the storage surface potential is raised to near the threshold potential, a part of the electron cloud is permitted to pass on to the screen, resulting in a light green background illumination. Although the contrast ratio is reduced, the writing speed for fast single-shot signals is increased between 10 and 20 times.



Monochrome pattern generator PM 5504

Although colour TV has been introduced in many countries during the past 10 years, most people still watch black- and white television; and this situation may be expected to last for many years to come. It would thus seem to be justified to include a monochrome-only test-pattern generator in a range of TV test-pattern generators. In line with this philosophy, Philips is launching a new monochrome test-pattern generator - the PM 5504 - as successor to the PM 5510. This new instrument may be regarded as a monochrome only version of the PM 5509 (PAL) and PM 5512 (NTSC) colour/monochrome test-pattern generators. It has been especially designed for checking and alignment of black/white TV receivers, monitors and video equipment in the service field.

Normally operating on the CCIR TV system G, it can easily be modified by a few internal changes for use with several other TV system with the exception of the French 819-line system.

TV bands I, III, IV and V and the video IF band are fully covered. Five widely used channels within these bands can be selected by means of push-buttons, after internal pre-setting of the corresponding electronic fine tuning adjustments. Range and frequency are indicated by two meters.

The PM 5504 offers the following 5 special test-patterns for checking the performance of a set.

A 6 x 8 row checkerboard
For checking e.g. the focus adjustment, horizontal and vertical deflection and synchronisation, the bandwidth can also be checked by observing the black/white vertical transitions.

Circle
For checking the overall linearity and geometry.

Cross-hatch
For centering and pincushion correction in 110° picture tubes.

100% white
For beam-current adjustment and brightness check.

Combined test-pattern
Definition lines in 8 sets ranging from 500 kHz to 5 MHz, for checking the resolution of a TV set or video recorder. The bottom part of this pattern consist of an 8-step linear staircase, for checking the linearity of a video amplifier.

The RF output voltage is more than 10 mV and can be attenuated by 60 dB for testing the sensitivity of a TV set. A BNC connector supplies a push-button-selected video signal of 1 V_{pp}. The same connector can be used as a video input by depressing a push-button, permitting the PM 5504 to be used as a video modulator. This facility comes in very handy for the testing video cameras.

As in the PM 5509, the sound carrier can be switched off when not required or can be (FM) modulated:

a. by an internal signal of 1 kHz
b. by the signal from a record player or tape recorder.

Finally, pulses at line or frame frequency are available for triggering of an oscilloscope.

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Testing TV remote control system with the aid of the PM 5164 sweep generator

Utrasonic remote control units, now coming into use for control of various functions of a TV set (volume, contrast, luminance, etc.) consist of a transmitter and a receiver. The transmitter gives instructions by radiating pulse-modulated ultrasonic signals. The heart of both transmitter and receiver is a transducer which is able to convert electrical signals of around 40 kHz into ultrasonic signals and *vice versa.*
After a description of the transducer, this article describes a measuring set-up for testing the most important parameters of this device.

The transducer
The transducer is made of piezoelectric ceramic material. The microstructure of such a material is considered to be based on an array of elementary electric dipoles. Unless measures are taken, the dipoles show no preference for any particular direction, but are oriented at random. When mechanical stress is applied under these conditions, charge displacements take place but the over-all charge shift of the randomly oriented dipoles is zero so that the material will not exhibit any piezoelectric effect (see fig. 1a).
To obtain this piezoelectric activity, the dipoles must be oriented; this is done at the manufacturing stage by exposing the ceramic to a strong external electric field at a high temperature (near the Curie point).
At this temperature the dipoles vanish, but are spontaneously recreated when the temperature is lowered. Under the influence of the strong polarizing field, they assume a position corresponding to the direction of the field, with the result that the ceramic body shows an elongation in the direction of the field (see fig. 1b).

After removal of the polarizing field and cooling of the product the dipoles cannot easily return to their original positions; the ceramic material has thus acquired a certain remanent polarization.
The ceramic body has become permanently piezoelectric and can convert mechanical into electrical energy and *vice versa.*

For example when a force of a few kgf, which can easily be achieved manually, is applied to a cylinder of piezoelectric material with a length of 20 mm and a cross-section of 1 cm^2, a voltage of about 100 V can be generated. At a pressure of 500 kg/cm^3, the voltage can even increase to 20 kV.

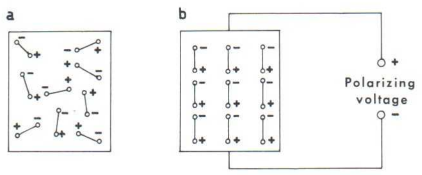

Fig. 1. Dipoles in piezoelectric ceramic a) before and b) after polarization

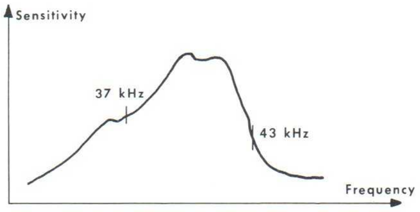

Fig. 3. Sensitivity-bandwidth characteristic

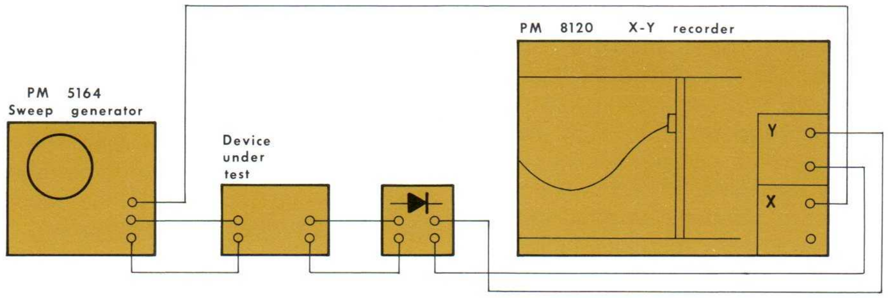

Fig. 2. Block diagram for measurement of the sensitivity-bandwidth characteristic of the transducer

Applications of the transducer
The material described is used in a range of applications such as:
ignitions of gas lighters
electric bells
earphones
small vibratory motors
optical scanners and choppers
gramophone pick-up cartridges
microphones
accelerometers
delay lines for colour TV
low-frequency filters

Sensitivity-bandwidth characteristic of the transducer
One of the most essential parameters of the piezoelectric transducer in a remote-control system is the sensitivity-bandwidth characteristic.
This curve can be directly plotted on an X-Y recorder with the aid of the set-up shown in the block diagram of fig. 2. A sweep generator (PM 5164) supplies a signal to a transmitter, which radiates its acoustic energy via a hole into an acoustically "dead" space in which the transducer under test is placed. In the photograph, the