

Type OSG32
CATHODE-RAY OSCILLOGRAPH

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Type OSG32 h-f CATHODE-RAY OSCILLOGRAPH

Description

The type OSG32 cathode-ray oscillograph is designed chiefly for use in radio, telephone, and telegraph laboratories. It is used for examining amplifiers, transmitters, and receivers, and is especially suitable for examining curves, modulation, and frequency, and for examining linearity and amplification. The wide frequency range and the high input impedance of the built-in Y amplifier are some of the most outstanding features of the oscillograph.

The oscillograph incorporates a 9 cm cathode-ray tube, a high voltage eliminator with regulating devices for the operating voltages of the cathode-ray tube, an arrangement for intensity modulation, anode voltage eliminator, sweep generator with synchronizing device, Y amplifier with calibrating device for vertical deflection of the light spot and X amplifier for horizontal deflection.

The screen of the cathode-ray tube is located above the center of the front panel and is provided with a graticule. The Y Switch (to the left) and the X Switch (to the right) are located below the screen. The ladder switch for the calibrating device of the Y amplifier is placed to the left of the screen, and below that (to the left of the Y Switch) is a fine adjustment knob for the amplifier.

The ladder switch (marked "Sweep Coarse") for the sweep generator is located to the right of the screen, and below that (to the right of the X Switch) is a control marked "X Amplifier Synchronization" for controlling the synchronizing device of the sweep generator or the amplification of the X amplifier.

The knob "Intensity" is for adjusting the intensity of the beam, and the knob "Focus" is for adjusting the focus of the light spot. The knobs "Sweep Fine" and "Sweep Amplitude" are

for fine adjustment of the frequency of the sweep generator, and the amplitude of the sweep. At the bottom are two knobs marked "Y Shift" and "X Shift" for vertical and horizontal displacement of the image, and finally the power switch marked "Off On".

Input binding posts and jacks are located on the side panels of the oscillograph. The input binding posts "YA" and "X" for the Y amplifier are placed on the left-hand panel nearest to the front panel, and the jacks Y_1 Y_2 Y_1' Y_2' for direct input to the Y plates are located nearest to the back panel. On the right-hand side panel nearest to the front panel are the input binding posts "XA" and a grounded binding post for the X amplifier and for the synchronizing device of the sweep generator, and nearest to the back panel are the jacks "TM X" "X Sweep" and a grounded jack for time marking (intensity modulation) and for direct input to the X plate or output of the sweep voltage. All switches, binding posts, and jacks are clearly marked with designations stating their function.

The cathode-ray tube

The cathode-ray tube is of the high-vacuum type (Philips type DN9/3 or DG9/3) and designed for vertical (Y) and horizontal (X) electrostatic deflection.

The Y deflection plates are connected directly to the Y Switch, that has four positions. In the two positions to the right (marked "Amplifier") the Y plates are connected to the output tubes of the Y amplifier, while in the two positions to the left the Y plates are connected to the jacks Y_1 and Y_2 for direct input to the Y plates. The jacks Y_1' and Y_2' are connected to the jacks Y_1 and Y_2 through 0.1 μ f condensers.

In two positions of the Y Switch (those marked S_1) one of the deflection plates (Y_2) is (besides being connected to the amplifier or the jack Y_2) also connected to the 0.25 megohm synchronizing potentiometer of the sweep generator through a condenser (0.1 μ f) and a resistor.

The impedance between the jack Y_1 and the chassis are 2 megohms in parallel with about 25 pf, no matter whether the Y Switch is in position "Direct S_1 " or " S_e ". Between the jack Y_2 and the chassis the impedance with the switch in position "Direct S_1 " is 0.5 megohm in parallel with about 25 pf, and for position

"Direct S_e " it is 2 megohms in parallel with about 25 pf. The jacks are disconnected in the switch positions "Amplifier S_1 and S_e ". The sensitivity at direct input is about 6 volts r-m-s per cm, and the frequency limit upwards is at approximately 30 megacycles. The jacks Y_1 and Y_2 are sensitive to both d-c and a-c voltages.

In order to obtain a sharp image, voltages being symmetrical referred to chassis must be passed to the Y plates.

The X deflection plates are designed for unsymmetrical supply of voltage, and one plate is permanently grounded. The other X plate is connected to the X Switch by means of which it can be connected to the sweep generator, to the X amplifier, or to the jacks for direct input (X Sweep and X'). The jack "X Sweep" is connected directly to the free X plate and to the sweep generator when it is connected. When the X switch is set to direct input, the jack X' is connected to the free X plate through a 2 μ f condenser. The lowest jack is in direct connection with the chassis of the oscillograph. When the X Switch is in position "Direct" the input impedance is 2 megohms in parallel with about 60 pf at the jack "X Sweep".

At direct input the sensitivity is about 7 volts r-m-s per cm.

Operating voltages of the cathode-ray tube. Time marking

The anode voltage and the d-c voltages required for adjustment of the intensity and the focus of the light spot as well as the placing of the image on the screen are fed from a high voltage eliminator that supplies 800 volts d-c. Through the jack TM the voltage that determines the intensity of the beam can be changed by impressing an a-c voltage or pulse that modulates the intensity and can be employed for time marking of the image. As the focusing of the cathode-ray tube depends on the intensity (owing to the construction of the tube) short pulses should be used for the time marking.

At lower frequencies the input on the TM jack is about 2000 pf. The maximum peak voltage is about 30 volts.

The anode voltage eliminator

The anode voltage eliminator supplies all the voltages required for the amplifiers and the sweep generator. It operates from the power line like the high voltage eliminator (50 cycles a-c).

By means of a built-in voltage selector it can be set to 110-127-150-200-220-240 volts line voltage. The total consumption amounts to 100 VA.

Sweep generator and synchronizing device

The sweep generator and the synchronizing device supply a sawtooth voltage for deflecting the light spot in horizontal direction and is used when a movement proportional to the time is required (e.g. when examining a-c voltage curves). When the sweep generator is connected to the X deflection plate, the beam moves from left to right at constant speed and then snaps back to its initial position and repeats the movement.

The speed and amplitude (length) of the movement is adjusted by means of the knobs "Sweep Coarse", "Sweep Fine", and "Sweep Amplitude". The coarse adjustment is made in steps of about 3:1. By means of these knobs the sweep frequency can be adjusted to any value from approx. 3 to 150,000 sweeps per second.

By means of the built-in synchronizing device the sweep frequency can be synchronized with an externally applied a-c voltage (Y Switch in positions S_e) or with the frequency which (in case of examinations) is fed to the Y plates (Y Switch in positions S_i). In both cases the synchronization is controlled by means of the knob "X Amplifier Synchronization".

At external synchronization the Y Switch must be in one of the positions marked " S_e ". The synchronizing voltage is fed between the binding post XA (or X'A - see section "The X amplifier" on page 8 for further details) and the grounded binding post on the right-hand panel.

At internal synchronization the Y Switch must be in one of the positions " S_i ".

Note: When the sweep generator is not in use the X amplifier can be employed only when the Y Switch is in one of the positions " S_e ".

The Y amplifier

The Y amplifier is a two-stage amplifier with symmetrical output and is characterized by great amplification (about 1200 times) that gives high input sensitivity (about 10 mm height of image for 5 millivolts r-m-s at full amplification). The special features of the amplifier are the frequency response, which is straight within ± 1 db from 10 cycles to 1.5 megacycles, and the amplifier control which is accomplished by an attenuator ("Y Amplifier Attenuation Ratio") and a fine adjustment ("Y Amplifier Fine Control"). The frequency response will not be affected when the knobs in question are being operated. The input binding post YA is coupled to the first amplifier tube through a condenser so the amplifier is not sensitive to superimposed d-c voltages. The lower binding post is grounded. The amplifier will stand about 400 volts peak voltage across the input terminals. The input impedance is 1 megohm in parallel with about 20 μ f. The knob "Y Amplifier Attenuation Ratio" has 6 positions. The four positions provide for controlling the amplification in steps in the ratios 1:10:100:1000. In the two remaining positions the adjusting device feeds a calibrating voltage of 20 or 50 millivolts to the input tube from the power line. The setting of the attenuator does not affect the input impedance and the frequency response.

The fine adjustment is made by varying the cathode resistance of the first amplifier tube. By this means the fine adjustment will not affect the frequency response, but the method involves the disadvantage that the image fluctuates while the fine adjustment is being operated. Only when the switch "Attenuation Ratio" is in position 1:1 the fine control affects the input impedance, varying it between 1 megohm and approx. 1.8 megohms.

The X amplifier

The X amplifier is a one-stage l-f amplifier with unsymmetrical output. The frequency range is 10 to 200,000 cycles. The frequency response is straight within ± 1 db from 10 cycles to 70,000 cycles when the input potentiometer is turned fully on. The amplification will then amount to about 45 times, which gives a sensitivity of about 10 mm width of image for 180 mV r-m-s at full amplification. The amplification is controlled by means of the potentiometer "X Amplifier Synchronization".

The input impedance is 0.25 megohm in parallel with 25 μ f. The input binding posts are designated XA and X'A. They are mutually connected to a 0.1 μ f condenser, and consequently the X'A binding post is not sensitive to d-c voltage. The lowest binding post is grounded. The maximum input voltage is about 300 volts.

Frequency curves

The appended chart shows the frequency response and the phase shift of the Y amplifier and the X amplifier. The curves of the X amplifier are somewhat dependent on the amplifier control. The curves shown for maximum amplification and $\frac{1}{2}$ amplification indicate the extreme limits. At low amplification the same curves are achieved as at maximum amplification.

The curves showing the frequency response and phase shift of the Y amplifier are not affected by the controls owing to the capacitively compensated attenuator employed here.

It should be noted that non-sinusoidal voltage curves will be distorted if the fundamental or harmonics of essential magnitude are outside the straight part of the phase shift curves. As will be seen the straight part of the phase shift curves is essentially shorter than the straight part of the frequency response curves.

OPERATION

Connecting the oscillograph and adjusting "Intensity" and "Focus"

Set the arm of the voltage selector to the appropriate line voltage. The voltage selector is located behind the left-hand side panel and in general it is set to 220 volts when the instrument leaves the factory.

Turn on the power switch and set the knob "Intensity" to an appropriate position and "Focus" to optimal focus. As a stationary spot may damage the screen this setting should not be made unless a voltage is applied to at least one of the deflecting plate pairs (e.g. the sweep generator to the X axis - "X Switch" in position "Sweep", the "Sweep Amplitude" knob in position 5-10). A few examples of the employment of the other elements of the oscillograph are stated below.

Plotting voltage curves with time base

Connect the sweep generator to the X plate by setting the X Switch to position "Sweep". Connect the voltage to be examined to the input terminal YA and the grounded binding post of the Y amplifier. If a stationary image is desired, set the Y Switch to position "Amplifier S₁". Adjust the amplification so that the height of image on the screen will be appropriate. (When the "Y Amplifier Fine Control" is operated the image will fluctuate. This nuisance, which means nothing in practice, is normal to the oscillograph and is due to the coupling employed, as mentioned before). Set the controls of the sweep generator ("Sweep Coarse", "Sweep Fine", and "Sweep Amplitude") by experimenting. When the synchronizing potentiometer is turned sufficiently on, various stationary images can be had, which correspond to various settings of the sweep generator. In general examinations of wave form are easy to make when 2 or 3 images are produced on the screen, corresponding to the sweep frequency being $1/2$ or $1/3$ of the frequency of the voltage under measurement. If you want to determine the magnitude of the voltage, adjust the amplifier by setting the knob "Y Amplifier Attenuation Ratio" to position "20 mV" or "50 mV", and set the knob "Y Amplifier Fine Control" to e.g. a position that corresponds to 20 divisions on the screen. In position 1 (maximum amplification) an input voltage of 1 and 2.5 mV, respectively, is then required per division of the height of image. As the amplification is ad-

justed in steps of 10 the a-c voltage under measurement can easily be determined by reading the graticule.

As the pulse for synchronization is drawn from one of the Y deflection plates the setting of the synchronizing potentiometer becomes dependent on the height of image. If you want to synchronize the sweep generator with an external voltage set the Y Switch to position "Amplifier S_e ", and then use the input binding posts XA (X'A) and the grounded binding post on the right-hand panel as input terminals for the synchronizing voltage. The voltage required is about 5 volts.

When applying a voltage to the input terminals of the Y amplifier, d-c voltages, if any, are filtered from the voltage under measurement.

If sufficient voltage is available the direct input jacks Y_1 and Y_2 or Y'_1 and Y'_2 can be used (Y Switch in position "Direct S_e "). The jacks Y_1 and Y_2 are directly connected to the Y plates, and consequently these jacks are sensitive to d-c voltages present in the voltage under measurement, whereas the Y'_1 and Y'_2 jacks are connected to the jacks Y_1 and Y_2 respectively through condensers of 0.1 μ f.

In general symmetrical input should be applied to the direct Y terminals, as this will give optimal focusing. If symmetrical voltages cannot be supplied, the jack Y'_1 should be connected to the grounded jack immediately above it by means of the short-circuiting strap inserted there, and the voltage should be fed to Y_2 (or Y'_2) and the chassis. If Y'_2 (or Y_2) are connected to the chassis instead, the internal synchronization does not operate. If the Y_1 jack is connected to chassis the possibility of Y shift is reduced.

If you want to synchronize with an external voltage set the Y Switch to position "Direct S_e ".

The X amplifier

is used e.g. when measuring the modulation percentage, at frequency comparisons, and at amplifier examinations. The amplifier is connected by turning the X Switch to position "Amplifier". At the same time make sure that the Y Switch is in one of the positions S_1 , as otherwise the input terminals XA and X'A of the X amplifier are blocked.

Measurements of modulation percentage may e.g. be made by supplying the modulated h-f oscillation through the Y amplifier (if the frequency is within the frequency range of the amplifier) or directly to the Y plates. The modulating voltage is fed to the X plates through the X amplifier. The oscillograph will now display a trapezium from which the modulation percentage can be measured directly. The measurement will be most accurate when the modulation frequency is chosen so low that phase shift in the amplifier is avoided. The phase shift manifests itself in that the inclined sides of the trapezium take the form of elliptical figures.

Frequency comparisons can be made by letting the oscillograph produce Lissajous figures. These figures appear when supplying a-c voltages (with frequencies in simple ratios to each other) to the deflecting plate pairs. The ratio between the frequencies can be determined by means of the Lissajous figures.

Of amplifier examinations may be mentioned: direct plotting of the characteristic of amplifiers. The amplifier is fed from a suitable generator - e.g. a RADIOMETER type HO12 or HO31 Beat-Frequency Oscillator - which is simultaneously connected to the X deflection plate of the oscillograph - either directly or through the X amplifier. The output of the amplifier under test is passed to the Y deflection plates, either direct or through the Y amplifier. The oscillograph will then produce an oblique, more or less curved line, representing the characteristic of the amplifier. In order to make sure that irregularities, if any, are not due to the oscillograph amplifiers, a voltage may be fed to the oscillograph amplifiers from the same Beat-Frequency Oscillator. It will then be seen that according as the frequency varies the curve displayed will be changed from an oblique line to an ellipse owing to the differing phase shifts of the two amplifiers. At 1000 cycles the phase shift is 0 in both oscillograph amplifiers.

Direct input on the X plate

is employed in cases similar to those mentioned above, when ample voltage is available. The voltage is fed to the jacks X' (or X Sweep) and the ground jack. The setting of the Y Switch is of no importance.

Intensity modulation. Time marking

The time marking device may in certain cases be employed as a third co-ordinate when more complicated examinations are going to be made. If an a-c voltage (preferably a short negative pulse) is fed to the TM jack the image will become dotted. A peak voltage of about 25 volts is required for extinguishing the beam.

Output of sweep frequency

When the sweep generator is connected to the X plate the sweep frequency may be drawn at the jack "X Sweep". This may e.g. be employed for controlling a frequency modulator when the oscillograph is to be used for plotting of curves where the abscissa is to be the frequency (e.g. for plotting filter curves).

Tubes

The instrument is supplied complete with the following tubes:

cathode-ray tube	1	type	DN9/3	(Philips)
high voltage eliminator	1	"	1876	"
anode voltage eliminator	1	"	EZ4	"
Y amplifier	(1	"	EF42	"
	2	"	EBL1	"
X amplifier and sweep generator	(1	"	EC50	"
	1	"	EF6	"

All tubes can be replaced by other tubes of the same type right away. If the axis of the cathode-ray tube is not horizontal, loosen the base and turn the tube into position. The tube must press against the graticule to avoid parallax. As the length of the tubes may vary, the housing on which the base is mounted is shiftable.

Protection against d-c connection

The oscillograph is provided with a 3-amp fuse for the power transformer. The fuse is fixed by means of a couple of clamps on the voltage switch. The oscillograph consumes about 0.45 amp at 220 volts a-c.



