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*09-98/MS

GB OPERATING INSTRUCTIONS

Dual Trace Storage Oscilloscope

OS-3020 D, 20 MHz, Best.-Nr.: 13 12 02
OS-3060 D, 60 MHz, Best.-Nr.: 13 12 10

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F NOTICE D´EMPLOI

Oscilloscope à mémoire à deux voies

OS-3020 D, 20 MHz, Best.-Nr.: 13 12 02
OS-3060 D, 60 MHz, Best.-Nr.: 13 12 10

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D BEDIENUNGSANLEITUNG

Zweikanalspeicheroszilloskop

OS-3020 D, 20 MHz, Best.-Nr.: 13 12 02
OS-3060 D, 60 MHz, Best.-Nr.: 13 12 10

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NL GEBRUIKSAANWIJZING

Tweekanaaloscilloscoop

OS-3020 D, 20 MHz, Best.-Nr.: 13 12 02
OS-3060 D, 60 MHz, Best.-Nr.: 13 12 10

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CE

(GB) Dual Trace Storage Oscilloscope OS-3020 D/OS-3060 D

Proper use of the storage oscilloscope includes:

Measurement and display of various DC measuring signals up to 20 MHz using the OS-3020 D or up to 60 MHz using the OS-3060 D with a maximum input voltage of 250 V DC or peak alternating voltage (Vp = Vrms x 1.41; 1.41 = square root of 2). Storage and display of changes in signal waveforms up to a maximum sampling rate of 20 Ms/s.

Warning! Please read carefully

Please read these operating instructions carefully. Any damage caused by failure to follow these instructions will not be covered by guarantee. We accept no responsibility for any subsequent damage which may arise as a result.

Contents

Introduction

1.1 Physical description and technical data (specifications)

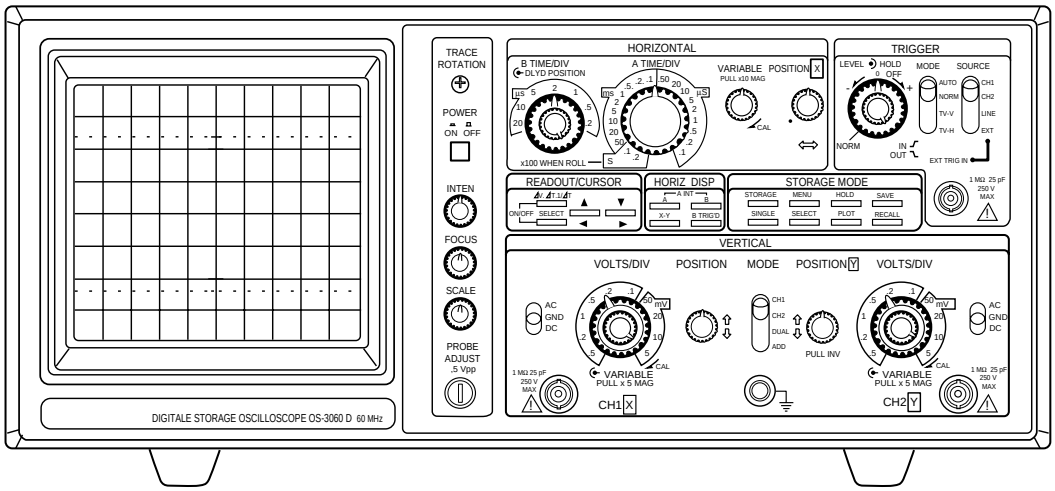


Fig. 1. Front view of OS-3060 D (the OS-3020 D is almost identical)

OS-3020 D	OS-3060 D

Display section

1)) Design:	6" rectangular CRT display with graticule, 8 x 10 div (1 div = 1 cm), marker for determining rise time, 2 mm graduation on central axes (X and Y).	
2) Anode voltage approx. 1.9 kV (relative to cathode)		approx. 10 kV (relative to cathode)
3) Phosphor coating	p 31 (standard)	
4) Focusing	Yes	
5) Trace rotation	Yes	
6) Graticule illumination	Adjustable	
7) Intensity adjustment	Yes	

Z-axis input = intensity modulation

1) Input signal:	Intensity of electron beam is reduced by applying a positive voltage. Significant modulation is perceptible beyond a certain voltage level.	
	Beyond 5 Vpp (pp = peak to peak)	
2) Bandwidth	0(DC) to 2 MHz (-3dB)	0 (DC) to 3,5 MHz (-3dB)
3) Coupling	DC	
4) Input resistance	20 KΩ to 30 KΩ	
5) Max. input voltage	30 V (DC or V AC peak)	

OS-3020 D	OS-3060 D

Vertical sweep

1) Bandwidth (-3 dB)		
DC coupled	DC up to 20 MHz normal DC up to 7 MHz expanded	DC up to 60 MHz normal DC up to 10 MHz expanded
AC coupled	10 Hz to 20 MHz normal 10 Hz to 7 MHz expanded	10 Hz to 60 MHz normal 10 Hz to 10 MHz expanded
2) Operating modes	CH 1, CH 2, ADD and DUAL (CHOP: position of TIME/DIV switch 0.2 s to approx. 5 ms ALT: TIME/DIV switch 2 ms to approx. 0.2 µs)	ALT: TIME/DIV switch 2 ms to 0.1 µs
3) Deflection factor	5 mV/div to 5 V/div, X5 expansion in 10 calibrated steps: 1 mV/div to 1 V/div in 10 calibrated steps	
4) Accuracy	normal: ±3% expanded: ±5%	
5) Input impedance	approx. 1 MΩ in parallel with 25 pF ±3 pF	
6) Input voltage:	250 V max. (DC and V AC peak) directly or, when using a probe, referred to the latter's specification	
7) Input coupling	AC-DC-GND	
8) Rise time	17.5 ns or less (50 ns or less with X5 expansion)	5.8 ns or less (35 ns or less with X5 expansion)
9) CH 1 output	20 mV/div into 50 Ω: 0 to 10 MHz -3 dB (at rear of unit)	
10) Inversion	Only in case of CH 2 (channel 2)	
11) Signal delay	Adjustable	

Horizontal sweep

1) Display options:	A, A int, B, B trig. D, X-Y	
2) Time base A	0.2 µs/div to 0.2 s/div in 19 calibrated steps	0.1 µs/div to 0.2 s/div in 20 calibrated steps
Hold-off time	Adjustable by means of hold-off potentiometer	
3) Time base B	0.2 µs/div to 20 µs/div in 7 calibrated steps	0.1 µs/div to 19 µs/div in 7 calibrated steps
Sweep delay	1 to 10 div	
Jitter	better than 1:20,000	
4) Sweep expansion **Caution:**	10 times => up to 20 ns/div) 20 ns/div is not calibrated	10 times => up to 10 ns/div) 10 ns/div is not calibrated
5) Accuracy	±3% (10 ºC to 35 ºC), possible additional error with magnification is ±2%	

Triggering system

1) Operating modes	auto, normal, TV-V, TV-H	
2) Source	Channels 1, 2, line and ext.	
3) Coupling	AC	
4) Slope	+ or -	
5) Sensitivity and frequency	20 Hz – 2 MHz 2 Hz – 20 MHz	20 Hz – 2 MHz 2 Hz – 60 MHz

OS-3020 D		OS-3060 D	
AUTO, NORM	INT 0,5 div 1,5 div EXT 0,2 Vpp 0,8 Vpp	0,5 div 0,2 mV	1,5 div 0,8 mV
TV-V, TV-H	1 div or 1 Vpp		
6) External trigger Input impedance Max. input voltage	1 MΩ II approx. 30 pF 250 V (DC or AC peak)		

X-Y function

1) X input: =	channel 1, up to accuracy and bandwidth Accuracy: ±5%, DC bandwidth up to 500 kHz (-3 dB)	
Y-input:	channel (= CH) 2	
2) Phase displacement	3 or less (for DC up to 50 kHz)	

Screen overlays

1) Readouts:	Direct reading of amplitude: ΔV Direct reading of period: ΔT Direct reading of frequency: 1/ΔT	
2) Usable switches/ controls	Vertical axis (CH1 and CH2) Horizontal axis	V/DIV, not calibrated, expanded Time/DIV, not calibrated, expanded
3) Usable cursor area starting from co-ordinate intersection	Vertical ±3 div, horizontal ±4 div	
4) Resolution	1/25 div	

Digital storage data

1) Display memory	1 Kb per channel (= 1000 bytes = 100 "words")	
2) Recording memory	2 x 1 Kb per channel	
3) Memory for special functions	5 µs/div - 0.2 s/div; 2 Kb 0.2 µs/div - 2 ms/div: 1 Kb	5 µs/div - 0.2 s/div: 2 Kb 0.1 µs/div - 2 µs/div: 1 Kb
4) Max. sampling rate	10 MS (10^6 samples = megasamples = MS)/second	
5) Vertical resolution	25 "pixels"/div	
6) Horizontal resolution	100 "pixels"/div	

Digital bandwidth

1) Single shot	5 MHz (4 samples/sweep)	
2) Repetitive with periodic signal waveform	20 MHz or 7 MHz on Y input with X5 expansion	60 MHz or 7 MHz on Y input with X5 expansion
3) Memory functions	NORM MODE : data of signal are with each trigger pulse AVG mode : averaging, 4 passes per sample up to 256 passes per sample ROLL MODE : data are continuously acquired and stored HOLD MODE : data are "frozen" in case of NORM, AVG and ROLL functions (still image) SINGLE MODE : the signal waveform is frozen after storage (still image), display functions	

OS-3020 D		OS-3060 D
	SMOOTH: the stored signal is displayed either by individual pixels (dots) or continuously (without interruption) INTER-POLATION: the stored signal is either displayed by pixels (dots), linearly or as a "reconstituted"/approximated sine-wave	
4) Data security	Up to 2 stored signals can be saved/stored and retrieved/reproduced at any time	
5) Pre-trigger: Plotter:	Display of signals before the trigger event The stored signal can be printed out on an HP-GL plotter via the RS-232 interface	
5) Write speed at output	1/10th of TIME/DIV setting	
6) X-Y function	Sensitivity X-axis = CH1: 1 mV - 5 mV/div ±5% Y-axis = CH2: 1 mV - 5 mV/div ±5% Phase error 3 or less in the DC range up to 50 kHz	
7) Spot velocity	Single: 0,2 µs/div to 20s/div (= x 100) Repetitive: 0,2µs/div to 2 µs/div „ROLL"-Funktion: 0,5µs/div to 20 s/div ALT: 0,5 µs/div to 1 ms/div CHOP: 1 ms/div to 20 s/div	0,1 µs/div to 20s/div 0,1 µs/div to 2 µs/div 0,5 µs/div to 20 s/div 0,5 µs/div to 0,5 ms/div 0,5 ms/div to 20 s/div
8) Probe setting	approx. 1 kHz, 0.5 V pp (±3%) square-wave pulse, mark-to-space ratio: 50%	
9) Power supply	Voltage range 100 V(90 to 110) AC 120 V(108 to 132)AC 220 V(198 to 242)AC 240 V(216 to 250)AC	Fuse 2A/250 V 2A/250 V 1A/250 V 1A/250 V
10) Mains frequency		50/60 Hz
11) Power consumption		approx. 65 W
12) Mass		approx. 8 kg
13) Dimensions L x W x H		430 x 320 x 140 mm

Environmental conditions

1) Operating temperature range	0 ºC (min.) to +40 ºC (max.)
2) Storage temperature range	-20 ºC to +70 ºC
3) Atmospheric humidity	35% min., 85% max. (RH)

1.2 Safety instructions

Warning!

1.2.1 Selecting the mains input voltage

The input voltage can be adapted to suit all the usual line voltages encountered in Europe by means of a built-in voltage selector switch. Before using the oscilloscope, make certain that the correct mains voltage has been selected and that the appropriate mains fuse has been fitted.

Setting the voltage selector switch incorrectly or fitting the wrong fuse can destroy the measuring appliance.

To set the voltage, make sure that the appliance has been disconnected from all voltage sources and measuring circuits. Having isolated it from the mains supply, prise out the fuse holder "cover" with the voltage markings and check that the mains fuse is of the correct type and appropriate current rating and then replace the

fuse holder "cover" so that the arrow mark matches the actual mains voltage.

1.2.2 Safety rules when installing and handling

Observe the following rules when setting up the appliance:

1. Do not operate it in extremely cold or hot locations, in a vehicle in summertime or in the vicinity of a fan heater.

2. Never switch on the appliance immediately after it has been moved from a cold into a warm room. The condensation created may destroy your appliance. Leave the appliance switched off until it has reached ambient temperature.

3. Avoid the following unsuitable environmental conditions:

- Dampness or excessively high atmospheric humidity
- Dust and flammable gases, vapours or solvents
- Severe vibration
- Strong magnetic fields such as those in the vicinity of machinery or loudspeakers.

4. Never block the ventilation slots or openings in the housing because this can cause heat accumulation and/or damage.

5. Never operate the appliance near hot soldering bits.

6. Never lay the oscilloscope with its controls side facing down because this can damage the adjusting knobs.

1.2.3 General safety instructions

1. Oscilloscopes OS-3020 D and OS-3060 D were manufactured and tested in accordance with DIN 57411 Part 1/VDE 0411 Part 1, Protective measures for electronic equipment, and left our factory in a perfectly safe condition.
To keep them in this condition and to ensure their safe operation, the user must observe the safety instructions and warnings contained in these operating instructions.

2. The appliance is a Class I instrument. It is equipped with a VDE tested power cord with a protective conductor and must therefore only be connected to and powered by a 230 V AC mains supply with protective earthing.

3. Make sure that there is no break in the (yellow/green) protective conductor in the power cord, in the appliance or in the mains supply because this would create a risk of fatal injury.

4. Measuring appliances must be kept away from children!

5. On commercial premises, the accident prevention regulations of the Association of Industrial Professional Associations with respect to electrical systems and operating equipment must be observed.

6. In schools, training centres and DIY workshops, the operation of measuring appliances must be supervised by responsible, trained personnel.

7. Opening covers or removing parts can lead to live parts being exposed, unless this can be performed manually. Connection points can also be live. Before being balanced, serviced or repaired or having any parts or componentry replaced, if the appliance must be opened, it must first be isolated from any sources of voltage or voltage circuits. If, subsequently, it is absolutely necessary to balance, service or repair the open appliance while live, this must be carried out by a qualified technician familiar with the risks involved and the relevant regulations (VDE 0100).

8. Capacitors inside the appliance may still be charged even after the appliance has been isolated from all sources of voltage and voltage circuits.

9. Make sure that only fuses of the specified type and specified current rating are used as a replacement. The use of rewired fuses or shorting out the fuse holder is not permissible.

To replace the fuse safely, isolate the appliance from all voltage sources (pull out the mains plug!) and voltage circuits. After isolating the appliance, use a suitable screwdriver to prise out the fuse holder together with the faulty fuse fitted, remove the faulty fuse and replace it by a fuse of the same type.

When inserting the replacement fuse into the fuse holder, make sure that the arrow mark corresponds to selecting the correct mains input voltage.

10. Exercise special care when dealing with voltages in excess of 25 V alternating current (AC) or 35 V direct current (DC). Even at voltages as low as these, it is still possible to suffer a life-threatening electric shock if contact is made with conducting parts.

11. Before each measurement, check your measuring appliance (oscilloscope) and measuring leads (probes, BNC cable) and the power cord for damage.

12. To avoid any possibility of electric shock, ensure that you do not come into contact, even indirectly, with the probe tip(s) and/or alligator clips in the case of exposed BNC wiring or the connections being measured (measuring points).

13. When safe operation is obviously no longer possible, the appliance must be taken out of use and secured from being accidentally switched on.
It can be assumed that safe operation is no longer possible when:

- there is visible damage to the appliance,
- the appliance is no longer working,
- the appliance has been stored for an extended period in unsuitable conditions,
- it has been exposed to adverse transport conditions.

2. Operating Instructions for Oscilloscope OS-3020 D/OS-3060 D

2.1 Description of controls

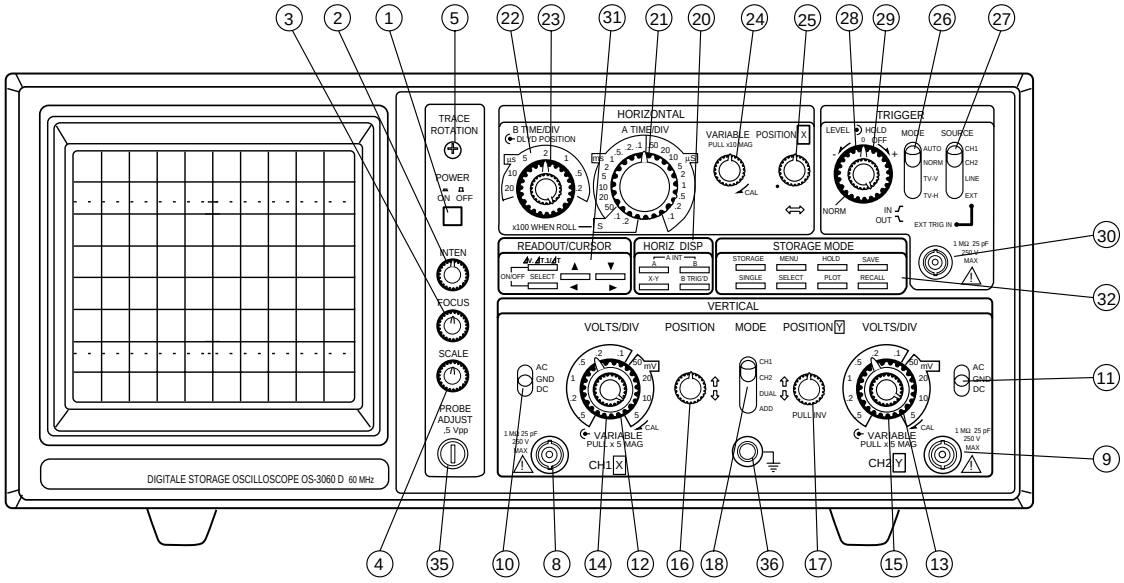


Fig. 2, Front view

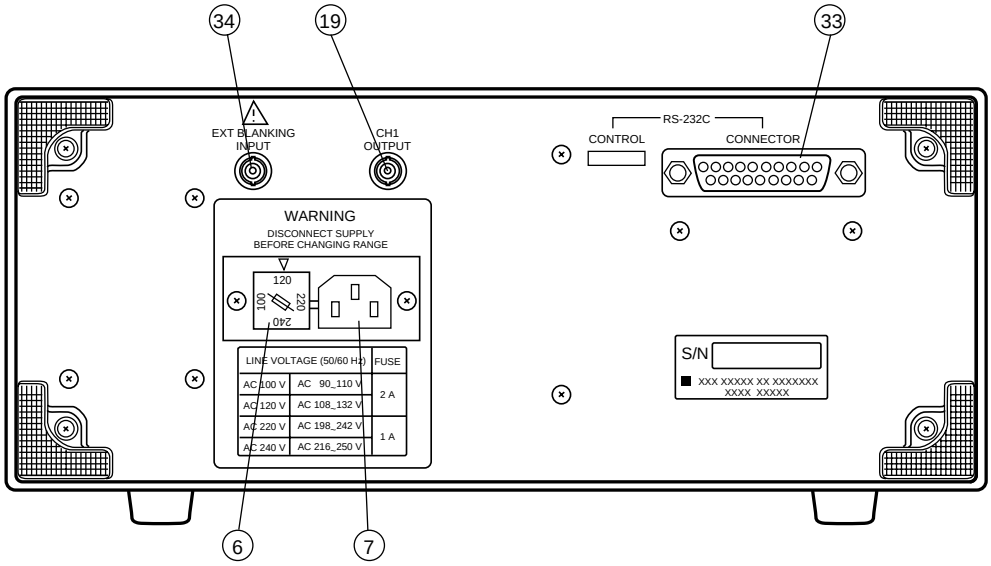


Fig. 3, Rear view

2.1.1 CRT settings and power switch

(1) Power switch ON/OFF

(2) Inten(sity) control:
Used to adjust the brightness

(3) Focus control:
Adjusts the "trace focus"

(4) Graticule illumination:
Adjusts the variable background illumination

(5) Rotation control:
Used to adjust the trace system to the horizontal and vertical lines on the screen graticule

(6) Voltage selector switch:
Allows correct setting of appropriate mains voltage

(7) Mains socket:
Used to connect the supplied power cord (cord with protective conductor for non-heating appliances)

2.1.2 Vertical amplifier section

(8) CH-1 or X-socket:
Used to connect a measuring signal for channel 1 or for the X-axis in the case of X-Y mode

(9) CH-2 or Y-socket:
Used to drive channel 2 or the Y-axis in the case of X-Y mode

(10) CH 1 AC/GND/DC
Switch for type of coupling for the input signal to the vertical amplifier of channel 1.

In the AC position, a capacitor that "blocks" the DC component of the measuring signal is connected between the input of the amplifier and the socket.

In the GND position, the amplifier input is connected to the frame earth

In the DC position, the measuring signal is fed directly to the signal amplifier input.

(11) CH 2 AC/GND/DC:
Switch for type of coupling for channel 2

(12) CH 1 volts/div:
Used to match the level of the measuring signal to the input of the amplifier of channel 1

(13) CH 2 VOLTS/DIV:
Used to match the level of the measuring signal to the input of the amplifier of channel 2

(14) and (15) Variable
PULL X 5 MAG:
When these knobs are pulled out, the vertical sweep can be steplessly adjusted between the latched-in levels of switches (13) and (14) up to a ratio of 1:5 (not calibrated). When these knobs are not used, make sure that they are turned to the right as far as the stop, latched and pushed in.

(16) CH 1 POSITION:
This potentiometer is used to adjust the position of the channel 1 trace upwards or downwards

(17) CH 2 POSITION:
Position adjustment for channel 2

(17a) PULL CH 2 INV:
If (17a) is pulled out, channel 2 is inverted, i.e. rotated through 180º

(18) V mode:
Used to modify the display mode.

Position CH1 means that only channel 1 is displayed on the screen.

Position CH2 means that only channel 2 is displayed on the screen.

The DUAL position means that both channels are displayed alternately.

CHOP for the range from 0.2 s/div to approx. 5 ms/div in the case of the OS-3020 D and OS-3060 D.

ALT for the range from approx. 2 ms/div to approx. 0.2 µs/div (OS-3060 D: 0.1 µs/div).

The ADD position means that both channels are algebraically summed (CH1+CH2).

(19) CH 1 OUTPUT:
This BNC socket is located at the rear of the unit: the attenuated signal from channel 1 is available here for further analysis.

2.1.3 Sweep and trigger section

(20) HORIZONTAL DISPLAY:
Used to set the type of sweep: A, B, B trig D etc.

A: Trace is displayed with no delay.

A int:Trace is displayed with no delay. A portion of the trace (signal) is shown "amplified" by time base B. The position of this portion on the screen can be altered by means of the "Delay Time Pos control" knob.

B: The trace is displayed depending on the setting of the B Time/Div switch (speed), the A Time/Div switch (time delay) and the Delay Time Pos pot (knob).

B TRIG'D: The time-delayed trace is triggered by the "first" trigger pulse.

OS-3060 D X-Y: pressing this button takes you into X-Y mode.

(21) TIME/DIV A:
Used to set the time-base sweep (horizontal deflection) from 0.2 s to 0.2 µs/div in the case of the OS-3020 D in 19 calibrated steps; turning the switch to the right as far as the stop is equivalent to X-Y mode.

(21) TIME/DIV A:
Used to adjust the time-base sweep from 0.2 s to 0.1 µs/div on the OS-3060 D

(22) TIME/DIV B:
Used to adjust the time-base sweep of the "delayed" B time base

(23) DLY'D POSITION
This knob is used to determine the point at which deflection of the non-delayed trace starts.
= Horizontal adjustment of the delayed signal portion.

(24) VARIABLE:
Infinitely-variable fine adjustment of the time-base sweep between the latched-in positions of switch (22).

(24a) PULL X 10 MAG:
Sweep expansion by a factor of up to 10 (not calibrated). To calibrate, turn the pot to the right as far as the stop until it latches in.

(25) POSITION <=>:
Used to change the trace position from right to left and vice versa

(26) TRIGGER MODE:
Used to set the triggering mode:

AUTO position
In this position, automatic triggering is active, a trace is always visible on the screen even when there is no input signal. Triggering takes place automatically beyond a frequency of approximately 25 Hz.

NORM position
Manual triggering mode must be selected (pressed) if the incoming signal has a frequency of 25 Hz or less. If no signal is present, no trace is visible.

TV-V position
This position and the next position (TV-H) are used for easier triggering by TV and video signals. TV-V below approx. 0.1 ms and TV-H above approx. 0.1 ms.

(27) TRIGGER SOURCE:
Used to set the trigger source

CH1 position
The trigger signal of channel 1 is used in this switch position.

CH2 position
The trigger signal of channel 2 is used in this switch position.

LINE position
The trigger signal derived from the mains frequency is used in this switch position.

EXT position
If you select this switch position, the signals that are fed into the EXT TRIG IN socket are used as a trigger signal.

(28) HOLDOFF:
Certain complex signals can be triggered by adjusting this knob. The HOLDOFF time is increased by turning the knob to the right. The NORM position (turned left as far as the stop) is used for "simple" signals.

(29) TRIGGER LEVEL:
This pot can be used to select the triggering point relative to the signal amplitude. Turning it to the right moves the triggering point towards the positive peak signal amplitude, turning it to the left moves the triggering point towards the negative peak signal amplitude.

(29a) Trigger SLOPE switch:
Pulling out or pushing in the trigger level control selects the positive-going edge of the signal

Pulled => negative
Pushed => positive

(30) EXT TRIG IN:
BNC socket used to connect an external trigger signal

2.1.4 (31) READOUT:
Cursor control panel for screen overlays

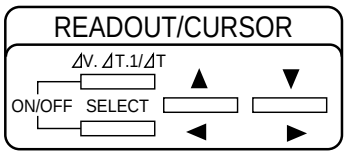


Fig. 4 Cursor Control Panel

(a) Select — Use this button to select which cursor line is to be moved (note the arrows at the start of each line)

(b) ΔV, ΔT, 1/ΔT — Use this button to select the type of display:
ΔV stands for delta V (volt = voltage), primarily for amplitude measurements

ΔT stands for delta T (time = period)

1/ΔT is the reciprocal of the period --> frequency

Note

The frequency is only indicated in "MHz, kHz or Hz" in storage mode: when not in storage mode, the number of DIVs is indicated.

(c) ON/OFF — If the "ΔV, ΔT, 1/ΔT" and "SELECT" buttons are pressed simultaneously, the screen overlays are switched on or off.

(d) >,< — These buttons are used to move the cursor lines

2.1.5 (32) Storage mode operator panel

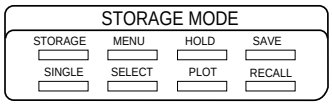


Fig. 5

(a) storage — Pressing this button "switches on" storage mode; a LED under the button cap is lit/flashes/flickers to confirm storage mode. Pressing the button again switches off storage mode and the LED goes out.

(b) MENU — This button is used to select the various storage modes:
PROBEx1, x10 - SMTH (Smooth) ON, OFF - AVG (Average) 4, 16, 64, 256 and NORM - ROLL ON, OFF.

- ITPL (interpolation) OFF, LIN, SIN-AMAG (= ALT MAG) ON, OFF

- G-NG (Go-NoGo) XH, OH - NORM. After each button press, a LED under the button cap is lit.

(c) HOLD — When this button is pressed, the sampling process is paused/stopped and the last signal waveform displayed is frozen. When the button is pressed again, a LED under the button cap is lit. Pressing this button again restarts the sampling process and the LED goes out.

(d) SAVE — This button is used to store the instantaneously displayed signal waveform in the "recording" memory as soon as the Hold button is pressed. A LED under the button cap is briefly lit.

(e) RECALL — This button is used to reproduce the recorded signal. Two memory contents can be retrieved. After this button is pressed, a LED under the button cap is lit. The previously set input sensitivity in V/div, the horizontal deflection in Time/div and the signals in memory A (=1) or B (=2), S A or S B are displayed in the lower third of the screen overlay.

(f) PLOT — This button initiates transfer of the signal from the screen to an X-Y plotter. The Hold button must be pressed beforehand to achieve this.

(g) SELECT — This button can be used to select/set/change the operating modes under MENU.

(h) SINGLE — The red LED under the button cap is lit to show that a trace is displayed as soon as the trigger signal is obtained. After triggering, the LED goes out. When the sampling process has been completed, a new signal waveform is shown on the screen. The SINGLE sequence is terminated, the screen signal is paused (HOLD) and the LED under Hold goes out.

2.1.6 General

(33) DIP switch and RS-232 interface:

DIP switch — The DIP switch is used to adapt the interface to any plotter or computer that is connected to the oscilloscope.

RS-232 connection — The connecting cable between the oscilloscope and the plotter/computer is connected to this 'D' sub-miniature socket.

(34) EXT BLANKING INPUT:
If a positive signal is applied to this BNC socket at the rear of the unit, this darkens the trace; a negative signal makes the trace brighter (unblanking/blanking/modulation).

(35) CAL:
On this pin there is a rectangular-pulse signal that is used exclusively to calibrate a test probe (0.5 Vpp/1 kHz)

(36) Earth connection:
This earth connection provides a ground reference for separate earth conductors.

2.2 Basic settings

2.2.1 Default settings of switches and knobs (controls)

a) Before switching on the appliance, all the switches and knobs must be set to their basic positions:

b) Connect the power cord to the mains socket (7). It is crucial to make sure that the cord is properly plugged in and that the voltage selector switch has been correctly set (jumper plug: note the direction of arrow and the chart alongside it).

POWER switch	(1)	:	OFF (not depressed)
INTEN	(2)	:	set to left-hand stop
FOCUS	(3)	:	set to middle position
AC/GND/DC switch	(10)+(11)	:	set toAC
VOLTS/DIV switch	(12)+(13)	:	set to 20 mV position
POSITION	16)+(17)	:	middle position, depressed
VARIABLE	(14)+(15)	:	set to right-hand stop, depressed
vertical mode switch	(18)	:	set to CH 1 position
TIME/DIV switch	(20)	:	set to 0,5 ms
VARIABLE knob	(24)	:	set to right-hand stop, depressed
Horizontal POSITION	(25)	:	set to middle position
Trigger MODE switch	(26)	:	set to AUTO
Trigger SOURCE switch	(27)	:	set to CH 1
Trigger LEVEL	(29)	:	set to middle position
HOLDOFF knob	(28)	:	set to NORM position = left-hand stop

Then connect the earthing-type plug to a socket-outlet with an earthing contact and protective earthing.

Warning!

There must be no break in the protective conductor/earth connection inside the appliance, in the power cord or in the socket-outlet because any discontinuity in the protective conductor would create a risk of fatal injury.

c) Actuate the power ON/OFF switch (1). After roughly 30 s, slowly turn the INTEN knob (2) to the right until the trace becomes visible on the screen. Then set the desired brightness level.

NOTE:

Do not leave the brightness set to maximum for any length of time in the absence of a signal. Above all, note that no spot is visible on the screen (= no horizontal sweep) immediately after powering-up. Otherwise the electron beam or spot will burn the CRT's internal coating, thus damaging it.

d) Use the FOCUS knob (3) to adjust the trace focus.

e) Then use the CH-1 POSITION knob (16) to move the trace so that it coincides with the horizontal centre line.

f) If the trace does not coincide exactly with the centre line, adjust it by using a suitable screwdriver to operate the ROTATION control (5).

g) Use the POSITION knob (25) to align the trace horizontally and centrally.

h) Set any probe that has a selectable attenuation ratio to 1:10, connect it to the channel 1 input (CH-1) and connect the probe tip to the CAL output (35). A rectangular-pulse signal, having an amplitude of 0.5 Vpp divided by 10 (=Volt peak/peak=ss), should then appear on the screen.

i) If the edges of the rectangular-pulse signal are over or under modulated, the probe must be matched to the input capacitance of the oscilloscope. See figure on the next page.

j) Set the V-MODE switch (18) to channel 2 (CH 2) and repeat steps h) and i) for the other probe.

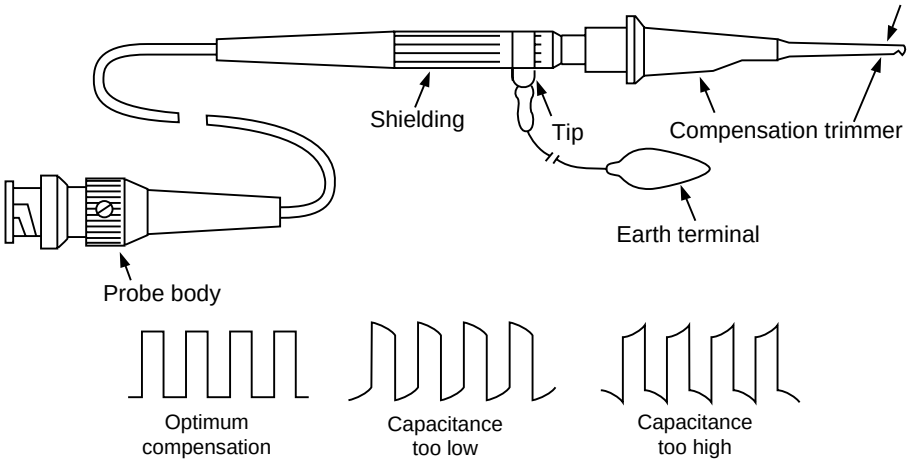


Fig. 6. Probe compensation

2.2.2 Cable connections (signal leads)

Three types of signal leads can be connected to the oscilloscope:

- a single measurement ribbon cable, insulated conductor
- a coaxial cable
- or a probe.

A single lead may be sufficient for higher signal levels of low impedance, such as those of TTL circuits. This type of signal feed, however, is not used very often in case of low-level signals because of the unacceptable distortion it introduces. Unacceptable distortion is caused because the single lead is not screened.

If signal sources having BNC outputs are to be connected to the oscilloscope, a coaxial cable should be used for such connections as a rule. These cables are screened, i.e. the inner conductor that carries the signal is screened against spurious external signals by braided copper wires or braided tinned copper wires. This "screen" is connected to the frame earth of the power source or the oscilloscope.

If signals are to be measured on components or subassemblies of circuits, probes are used for this purpose. These are available in various designs. Some probes have a switch that can be used to change over to 1:10 attenuation (= calibration setting). Roughly 1/10th of the amplitude of the available measuring signal is displayed in this switch position.

Example:
Indicated values = 5 mV pp, probe set to 1:10 position ==> actual value = 50 mV pp.

Warning!

Do not exceed the maximum input values.

If the source resistance or the line capacitance are not known in the case of direct connection between the device under test and the oscilloscope, especially at relatively high frequencies, use a 1:10 low-capacitance probe.

One method of minimising the measuring error at high frequencies in the case of coaxial cables is to use a terminating resistor. The impedance of this resistor which is connected directly to the oscilloscope must match the impedance of the signal source or the lead.

Example:
Output resistance of a frequency generator = 50 Ω. Line resistance of coaxial cable used = 50 Ω. Resistance value of terminating resistor = 50 Ω.

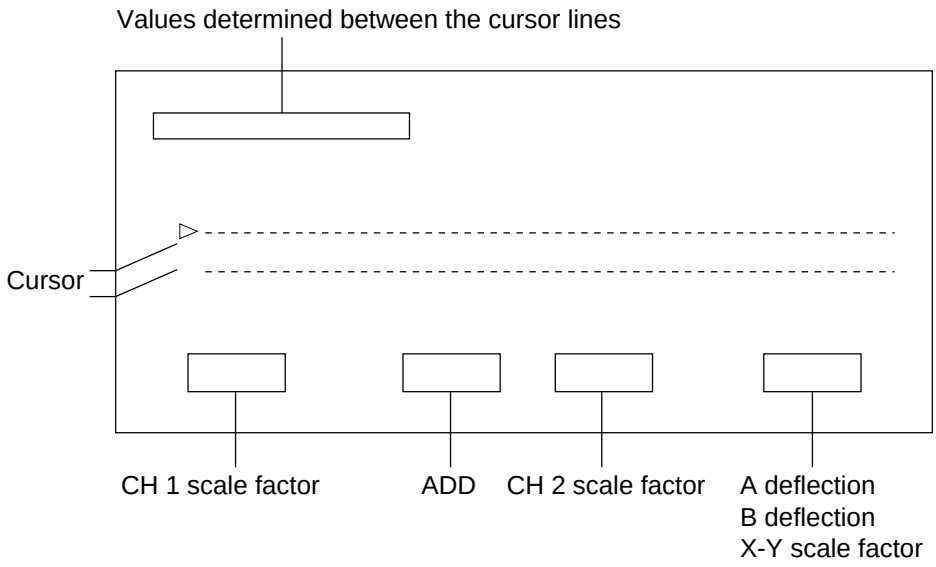
In order to minimise the ripple voltage when taking measurements, always connect the frame earth of the circuit under test ("-" or housing) to the frame earth of the oscilloscope (via a screened cable with the BNC socket of the relevant input CH 1 or CH 2).

Warning!

The frame terminals of the oscilloscope, the BNC sockets (8), (9), (19), (30), (34) and the earth connection (36) are connected directly to the protective conductor of the mains input socket or the connected power cord. Make certain that the circuit in/on which you are making measurements is electrically isolated from the mains by a transformer. Never connect the (BNC) inputs/outputs directly to the mains supply, chassis that are live or circuits that are operated without transformers (input electrically isolated from output). Danger - risk of fatal injury.

2.2.3 Screen overlays, explanation

(1) "Real-time display"



(a) Channel 1 and 2 scale-factor indication

V / DIV
P1 0X > 1 0 m V

Indication for probe	Blank field denotes calibrated switch position
P 10X : 1:10	> = non calibrated switch position
P 1X : 1:1	* = expanded 5 times

In vertical mode, "ADD" (18) the plus sign "+" is shown between the two scale-factor details.

(b) Display for the deflection factor of A, B and X-Y

Time/div
> 0. 5 m s

"Blank": X1 calibrated
*: X10 expanded

>: not calibrated

1.) In X-Y mode, "X-Y" is displayed: the "values" for the Time/div setting of A or B disappear

2.) In delayed mode, the B time is displayed.

c) "Measurements" using the cursor lines

"Measured" value
d V + 3 0 . 0 V

Δ (=delta) V: CH1, CH2, ADD, DUAL

Δ T: time difference between the two cursor lines

1/ΔT: reciprocal of ΔT

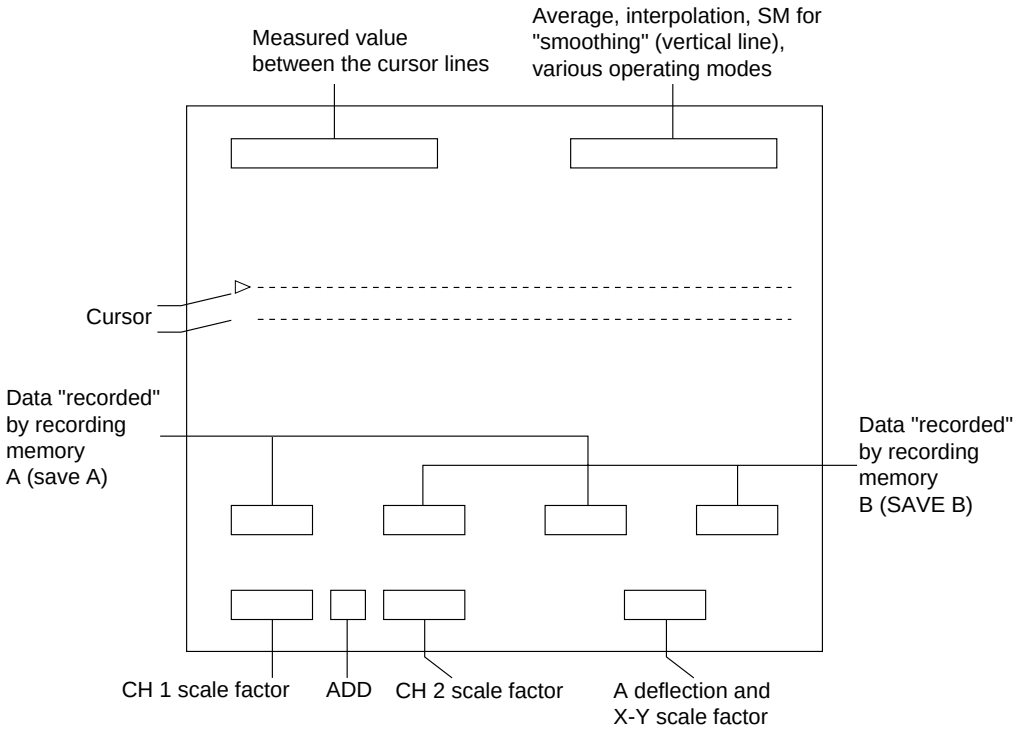
ΔV: +, -, mV, V, div

ΔT: +, -, µs, ms, s, div

1/ΔT: MHz, KHz, Hz...

"div" is displayed in the following cases:
- the measured value of the previously set channel is not calibrated
- in the case of time-delayed B sweep
- In X-Y mode
- In non calibrated "A mode"

(2) Display for storage mode



(a) Channel 1 and channel 2 scale factor indication, see (1)(a)

(b) Display for the deflection factor of A, B and X-Y, see also (1)(b)

Time / Div

> 0. 5 m s

„Blank“ : X1, calibrated (not expanded) In X-Y mode, the usual*
: No interpolation _____ details dissappear ans “X-Y” appears instead
: Sinus (sin) interpolation X 10 expansion
: Linear (Lin) interpolation-

(c) Measurements using the cursor lines, see (1)(c)

2.2.4 Single-trace mode

Single-trace mode using the single time base and internal triggering is a frequently used operating mode. Use this mode if you only want to observe one signal.

Because this oscilloscope is a dual-trace unit, there are two particular ways of obtaining single-trace operation.

a) If you want to read off the frequency on a frequency counter at the same time as observing the signal, select channel 1 (CH 1) as the signal feed. The signal applied to channel 1 can be picked off on a BNC socket at the rear of the oscilloscope for further use, but at reduced amplitude.

b) Channel 2 (CH 2) offers the facility to invert the signal by means of the POSITION knob (17), i.e. the signal is rotated through 180°.

Basic settings for single trace mode

1. Set up the oscilloscope for single trace mode as described below. Make sure that the trigger SOURCE switch (27) and the channel that is used actually match (signal feed in channel 1 => switch (27) set to CH 1)

Power switch	(1)	: set to ON
AC/GND/DC switch	(10) or (11)	: set tof AC
Vertical POSITION	(16) or (17)	: middle position and depressed
VARIABLE	(14) or (15)	: right-hand stop and depressed
Vertical MODE switch	(18)	: set to CH 1 or CH 2
Trigger MODE switch	(26)	: set to AUTO
Trigger SOURCE switch	(24)	: set to CH 1 or CH 2
Trigger LEVEL	(29)	: set to middle position
HOLDOFF knob	(28)	: set to NORM position = left-hand stop

2. Use the POSITION knob (16) or (17) to bring the trace into the centre of the screen

3. Connect the signal lead carrying the signal to be fed in to the channel you previously selected. Set the VOLTS/DIV switch so that the signal amplitude takes up the entire height of the screen.

4) To stop the signal moving, adjust the trigger level knob (29) if necessary.

Warning!

Do not exceed the maximum input values. Never connect voltages in excess of 300 V DC or 212 V AC rms.

5. If the signal to be measured is too small, even with a 5 mV/div setting, to be triggered correctly, pull out the VARIABLE knob (14). This increases the range to 1:5, i.e. sets it to 1 mV/div. However, this reduces the bandwidth to 7 MHz and measurement results may be falsified by noise in the case of such small signals.

6. If there is only a dense frequency spectrum on the screen with a 0.2 µs/div setting, especially at high frequencies, pull out knob (21) in order to expand the range to 1:10, this expands 0.2 µs/div to 0.02 µs = 20 ns.

7. If the signal to be measured is a direct voltage or an extremely low-frequency alternating voltage, it is best to set the coupling type switch (10) or (11) to DC.

WARNING!

If the signal is an extremely low-level periodic signal, it is crucial to make sure that it is not a pulsating voltage, i.e. that it is not superimposed on an extremely high direct voltage such as the ripple voltage of a loaded source of direct voltage. It is crucial not to exceed the maximum permitted input values.

(Re. 7.) In addition, the trigger MODE switch (26) must be set to NORM if the measuring signal is less than 25 Hz. If necessary, trigger LEVEL (29) must be readjusted.

2.2.5 Dual trace mode

The oscilloscope is designed for dual-trace operation. The oscilloscope is generally operated in this mode. The basic settings are identical to those for single-trace mode but with the following exceptions:

1. Set the vertical MODE switch (18) to the DUAL position. In the case of frequencies equal to or greater than 0.2 ms, ALT mode is selected and in case of frequencies having a period of less than 0.5 ms, CHOP mode is selected without you having to operate any other switch.

2. If both the measuring signals are of the same frequency, set the trigger SOURCE switch (27) to the position for the channel that has a waveform that resembles a stepped shape such as a rectangular-pulse signal. In contrast, if the measuring signals are of different frequency, use the channel that has the lower frequency as the trigger source (SOURCE). Do not forget that when you disconnect the measuring signal from the channel that you are using as a trigger source, the display "runs away".

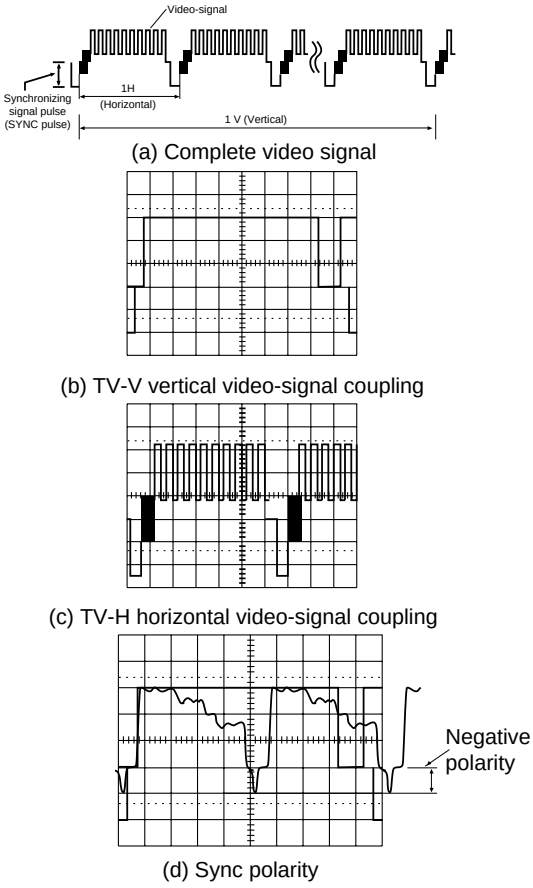


Fig. 7 Using the TV-V and TV-H trigger switch

2.2.6 Optional trigger settings

Choose the triggering mode (trigger MODE = (26)).

In the NORM manual mode, a trace is only "painted" on the screen if the input signal reaches a level that corresponds to that previously set using the LEVEL knob (26). In the AUTO position, automatic triggering is active, i.e. a trace is always visible on the screen even when no input signal is applied. The only disadvantage of auto-

matic triggering is that signals below 25 Hz and complex signals may not trigger the time base reliably enough. In this case, immediately switch to NORM mode in order to obtain a "stable" image again.

In the TV-V and TV-H switch positions, the trigger signals are routed via a filter in the trigger circuit (see also Figure 7). The polarity of the TV sync signals must be negative to obtain the best possible results.

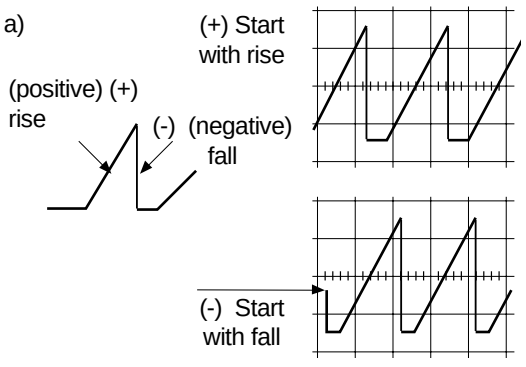
Choosing the point at which triggering starts

Use the SLOPE switch (26) located on the shaft of the LEVEL knob to decide the point at which triggering starts: on the positive-going or negative-going transition of the trigger signal, see also Figure 8-C.

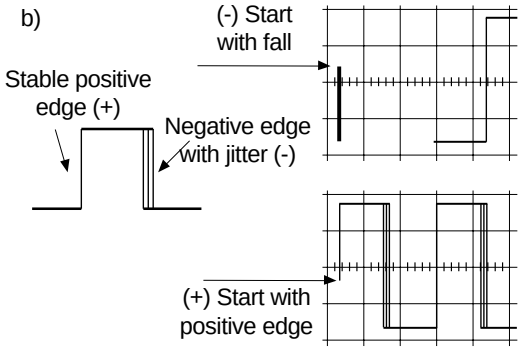
Setting the trigger LEVEL

Use the trigger LEVEL knob to stabilise the signal so that it can be observed more accurately. The effect of adjusting the trigger level is shown in Figure 8. The "-", "0" and "+" markers are referred to the zero crossing of the signal waveform or the negative and positive area. If the trigger signal rises or falls extremely steeply, as in the case of rectangular-pulse or digital signals, no clear reversal of the displayed trace will be apparent until the LEVEL knob has reached its most negative or most positive point by turning it to the left or right, at which point the display runs away (in the AUTO position) or disappears entirely (NORM position).

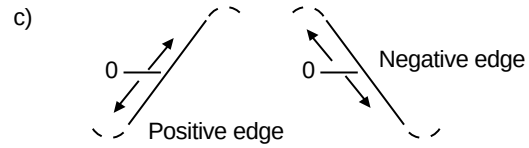
8-A Sawtooth pulse



8-B Square-wave pulse



8-C Trigger level (LEVEL)



2.2.7 Addition and subtraction of signals

In this operating mode of a dual-trace oscilloscope, the signals that are applied are "combined" with each other and displayed as a trace. Addition gives the algebraic sum of CH 1 and CH 2 and subtraction gives the algebraic difference of the two channels.

Set up the oscilloscope as follows in order to use these functions:

1. Perform the basic settings as described under heading 2.2.5.

2. Make sure that both the VOLTS/DIV switches are set to the same position and that both the VARIABLE knobs (14) and (15) are set to the right-hand stop (cal. = calibrated) and are pushed in. If the difference in the amplitude of the two applied signals is too large, adjust the two VOLTS/DIV controls so that both amplitudes take up the entire height of the screen.

3. Use the channel that has the higher amplitude as the trigger source.

4. Set the MODE switch (18) to the ADD position. The result is the algebraic sum of both the signals in CH 1 and CH 2.

Note:

If the two applied signals are in phase, they can both be added algebraically, e.g. 4.2 div + 1.2 div = 5.4 div. If the two applied signals are in phase opposition (180º), the two signals are subtracted from each other, e.g. 4.2 div - 1.2 div = 3 div.

For algebraic subtraction, follow the same procedure as that described for ADD and pull out the POSITION knob (17). In-phase signals are then displayed as a difference and signals in phase opposition are displayed as a sum.

2.2.8 X-Y mode

In this mode both channels are switched as the X and Y input, CH 1 for the X-axis and CH 2 for the Y-axis with both axes having a time base.

The MODE switch (18), the entire trigger section and all the knobs and sockets associated with it are inoperative in X-Y mode.

The basic settings for X-Y mode are as follows:

1. Turn the time-base switch (20) to the right as far as the stop.

Note:

Reduce the intensity (2), otherwise the spot in the centre of the screen (if no signals are present) will destroy the screen's phosphor coating.

2. Then connect the horizontal signal to channel 2 and the vertical signal to channel 1. You can readjust the brightness as soon as a display becomes visible.

3. Use the VOLTS/DIV knob for CH2 to adjust the height of the display and use the VOLTS/DIV knob for CH1 to adjust the display width. It may also be useful to use the expansion switches (14) and (15).

4. The position of the trace can be moved upwards and downwards by control (17) and to the left and right by control (22). The position knob (16) is inoperative in X-Y mode.

5. The signal for the Y-axis can be inverted by pulling out knob (17).

2.2.9 Delay mode = delayed sweep

Oscilloscopes OS-3020 and OS-3060 have two time bases, one for the "real-time display" of a signal (time base A) and one for delayed sweep (time base B). This makes it possible to delay/stretch/expand a selected portion of a signal or a pulse, e.g. a TTL signal, at the same time as displaying the original signal. Delayed sweep can be used both in single-trace and in dual-trace mode.

1. Set the Vertical mode switch (18) to the desired position.

2. Make sure that the B TRIG'D pushbutton in the HORIZONTAL DISPLAY panel (20) is pressed.

3. Press the A INT button in the HORIZONTAL DISPLAY panel (21). A portion of the signal is displayed "thicker".

Note:

If the portion of the signal displayed is very small (dot), the settings of the knobs for time base A and time base B are too different.

4. Adjust the knob for time base B until the selected portion of the signal is sufficiently large/wide to produce a "clean image". See also Figure 9b.

5. Adjust the DELAY'D knob (23) in order to place/position the "trace unblanking" over the selected portion of the signal.

6. Then press button B in the HORIZONTAL DISPLAY panel (20). The selected portion of the signal is then displayed over the entire width of the screen. See also Figure 9c.

7. The displayed signal form can be expanded more by a factor of 10 by pulling out the VARIABLE knob (24).

Triggering of time base B

If the ratio of the switch position of the knob for time base A to that for time base B exceeds 100:1, the B trace may be affected by jitter, i.e. it is unstable and triggering is not "clean".

To prevent this phenomenon, press the B TRIG'D button in the HORIZONTAL DISPLAY panel (20) and use the TRIGGER LEVEL knob (29) to readjust.

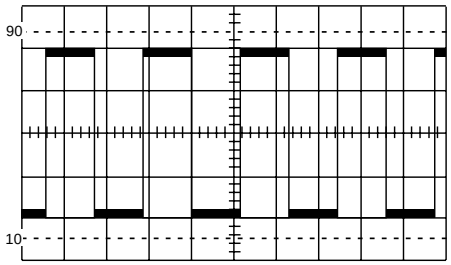


Fig. 9a, Display of time base A

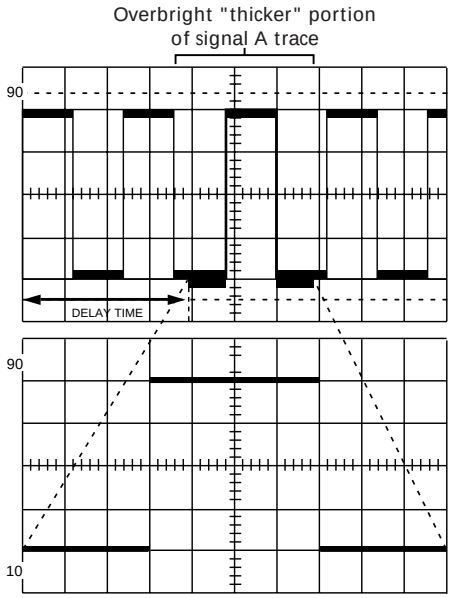


Fig. 9c Display of time base B

2.2.10 Storage mode

Storage mode functions as follows:

(1) "NORM" mode

a) Press the "STORAGE" button in the "STORAGE MODE" panel.

b) "NORM" appears at the top edge of the screen in the middle and the displayed signal that is to be stored is then shown in the "real-time" display.

c) All subsequent sweeps/displays are in slow motion. If the Time/div switch is set to 0.1 µs/div, roughly 2 to 3 s elapses until a new trace is painted and triggered.

d) If the Time/div switch is set to between 0.2 µs/div (in single-trace mode 5 µs/div) and 0.2 s/div (OS-3060 D: 0.1 µs/div to 0.2 s/div), successive signal waveforms can be continuously stored.

e) The "HOLD" button can be used to pause the display, i.e. the signal is frozen in NORM mode.

(2) EQUIV mode (equivalent)

If the Time/div switch for time base A is set to between 0.2 µs/div and 2 µs/div (OS-3060: between 0.1 µs/div and 2 µs/div), "EQUIV" (stands for Equivalent) appears instead of NORM at the top edge of the screen in the middle.

a) In this mode it is not possible to display the left-hand end of the signal waveform (rising or falling edge); the second cycle of the signal must therefore be used for measurement purposes.

b) Roughly 5 s elapse before a signal having a frequency of less than 1 kHz is stored.

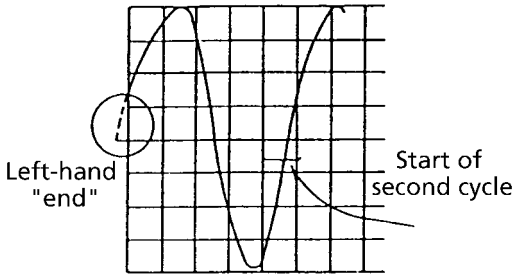


Fig. 10, EQUIV-MODE

(3) ROLL mode

The spot is slowly "painted" from left to right. This mode is especially suitable for signal waveforms having a frequency of less than roughly 100 Hz. Just press the "HOLD" button in order to pause Roll mode.

ROLL MODE display

The signal display "rolls" from the right-hand edge of the screen to the left. Sampling takes place from right to left, i.e. signal changes are first apparent at the right-hand edge of the screen. Note the following figure.

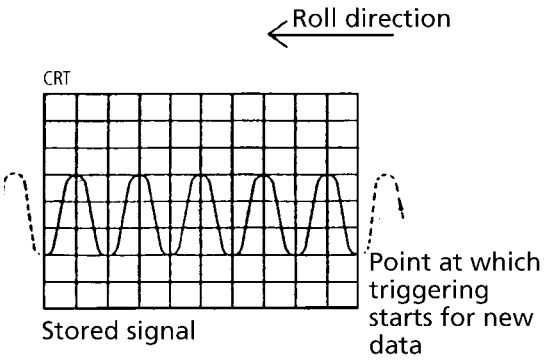


Fig. 11, “Roll” operating mode

Note

In ROLL operating mode, the trigger level and trigger source functions are inoperative. ROLL mode is not possible in the range from 2 ms/div to 0.2 µs/div or 0.1 µs/div in the case of the OS-3060 D.

(4) Single mode in NORM mode

Proceed as follows:

a) Set the Time/div switch to a switch position between 5 µs/div and 0.2 s/div. This selects NORM operating mode in storage mode.

b) Press the "SINGLE" button. The red LED under the button cap is briefly lit and this indicates that a trace is displayed as soon as the trigger signal occurs.

c) After triggering, the red LED under the cap of the SINGLE button goes out.

d) Once the sampling process has completed, a new signal waveform is shown on the screen. The SINGLE sequence is terminated, the on-screen signal is paused and the LED under the cap of the HOLD button is lit.

Note

If the trigger signal is not indicated in SGL mode, the red LED under the button cap remains lit until there is a trigger signal.

SINGLE mode does not work with the following functions: Average (AVG), ROLL, EQUIV or when the time base is expanded (MAG).

(5) HOLD (ALL) function

If you press the HOLD (ALL) button in ROLL, EQUIV or NORM mode, the sampling process stops and the measuring signal stored in memory in 1-second fractions is displayed as a "still image".

(6) Recording and reproduction of signals

The SAVE/RECALL function is ideal for comparing a specific signal waveform to other signals. To do this, the "paused" signal is placed in the "clipboard memory" until it is retrieved using the Recall key or it is cleared. "Save A" (SA) saves CH 1 = channel 1, SAVE B (SB) saves CH 2 = channel 2.

To record a signal, proceed as follows:

a) Use the HOLD button to stop the current sampling process.

b) Press the SAVE button in the STORAGE MODE panel. Once the signal has been stored in the recording memory, the LED under the cap of the SAVE button is briefly lit. The signal has then been recorded.

(7) Reproducing the recorded signal waveform (= RECALL)

If you want to check the signal immediately after storing it, proceed as follows:

a) Press the RECALL button once; the signal that was stored in recording memory A (SA) appears with the recorded VOLTS/DIV and TIME/DIV settings, regardless how the VERTICAL MODE switch is set.
If you press this button again, the recorded signal waveform from recording memory B appears. If the RECALL button is pressed a third time, both A and B appear on the screen, together with the stored settings.
If you press the RECALL button a fourth time, this clears the "clipboard memories" (A and B) and both the signal waveforms with their respective settings.

b) Reproduced signal waveforms cannot be moved upwards or downwards by using the Position knob (16 or 17).

(8) X-Y plotter output (RS-232) with PLOT button

A signal is only available on the plotter interface for printout if you first pressed the HOLD

button to freeze the signal waveform and then pressed the PLOT key to print the screen content. A more detailed description of this interface can be found in a later section.

(9) Magnified signal display (MAG)

In storage mode there are two ways of expanding a specific signal waveform or displaying it in expanded form. The first way is to pull out the VARIABLE knob (24), the other is to use the TIME/DIV switch in conjunction with the HOLD function.

a) Expansion using Variable switch (24)

The signal or signal spectrum can be expanded by a factor of 10 ("stretched") in storage mode by pulling out the VARIABLE knob (24).

Note

Signals that have been stored in the recording memory cannot be expanded.

If both channels (1 and 2) are operating, both channels (CH 1 and CH 2) are expanded by a factor of 10. When the knob is pushed in again, the non-expanded signal waveform appears again.eint erneut der ungedehnte Signalverlauf.

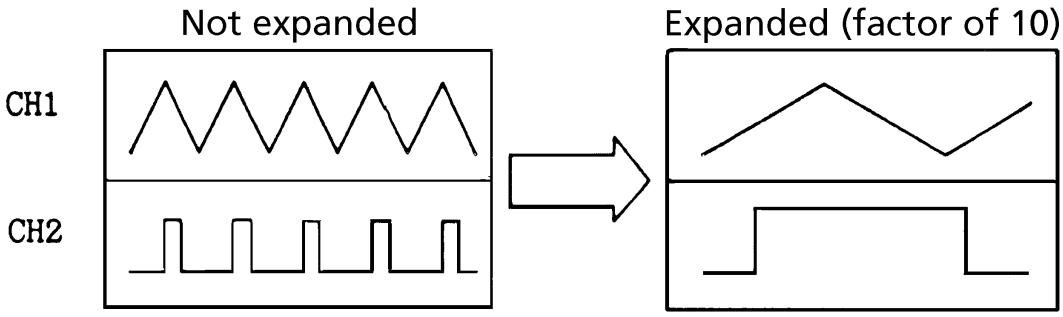


Fig. 12

b) Expansion using the HOLD button and the TIME/DIV switch

In storage mode, press the HOLD button to freeze the screen content that is to be expanded. Turn the TIME/DIV knob (21) clockwise (to the right) one switch position further. This displays the signal magnified by a factor of "2". Turning the switch another step to the right stretches the expanded signal again by a factor of "2". Each further turn of the switch to the right expands the waveform by a factor of "2.5", i.e. a total factor of "10" (2 x 2 x 2.5 = 10) => three switch positions.

Example:

You can read off the individual division factors by watching the dT screen overlay at the top edge of the screen.
Basic setting: 10.72 µs/div, one switch position (the first), subsequent switch position: 5.36 µs/div.

One switch position further (the second): 2.68 µs/div. Finally, the third switch position to the right: 1.072 µs/div --> 1/10th.

If you turn the TIME/DIV switch further or turn it in the wrong direction (to the left), no further sweep expansion takes place.

(10) Interpolation

If expanding a signal waveform distorts the way in which it displays, the signal can be "smoothed" or modified by interpolation (see also Figure 14).

The "INTERPOLATION" sub-function is selected by pressing the "MENU" button. Keep this button pressed until "ITPL OFF" appears at the top edge of the screen in the middle. Then use the "SELECT" button (underneath it) to set linear interpolation "ITPL LIN" or sine interpolation "ITPL SIN " or "interpolation off" ("ITPL OFF").

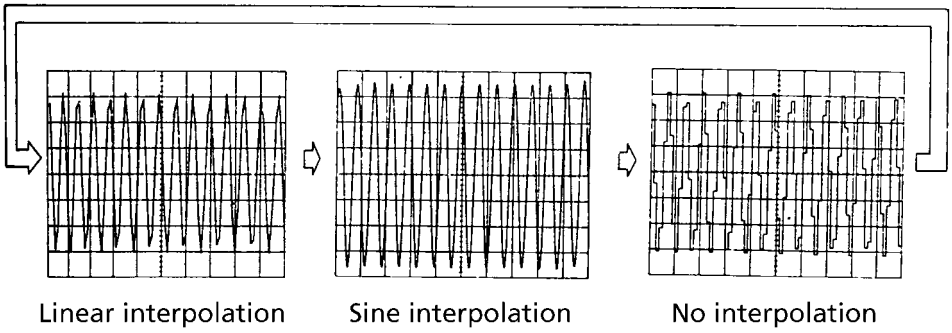


Fig. 13

(11) AMAG operating mode = ALT MAG

In this operating mode, both the "normal" stored signal waveform and the expanded signal waveform of the relevant channel that was previously set, e.g. CH 1, are displayed simultaneously or alternately = ALT.
To display CH 2, Vertical switch (18) must first be set to CH 2.

Note the following Table:

Switch position	Normal indication (not storage)	AMAG mode
CH 1	CH 1-signal	CH 1 signal + expanded CH 1 signal
CH 2	CH 2-signal	CH 2 signal + expanded CH 2 signal
DUAL	CH1- and CH2-Signal	CH1 and CH2 signal, both channels expanded
ADD	CH1- + CH2-Signal	The result of adding CH1 + CH2 at the same time as the "expanded" result.

Typical settings:

a) Set the Vertical switch to the CH 1 position

b) Press the HOLD button

c) Use the Menu button to select the AMAG OFF sub-function and use the SELECT button to switch it on (AMAG ON.

d) Expand once as described in 9a or 9b.

e) The expanded signal waveform is displayed roughly 3 div underneath the non-expanded signal.

(12) Go-NoGo mode

The Go-NoGo sub-function is useful for the assessment of signals. Each displayed "pixel" of the signal waveform is "extended" upwards and downwards by a specific amount. The following "lengths" can be set: +/-0.4 div, +/-0.8 div or +/-1.2 div. To select or set this sub-function, proceed as follows:

a) In storage mode, press the MENU button until "G-NG XH=>OH" appears at the top edge of the screen in the middle.

b) Press the RECALL button once.

c) "0.4 div" appears instead of "XH=>OH". This value can then be modified by pressing the SELECT button (under MENU).

d) Then set the desired "assessment area".

e) Finally, to run the function, press the RECALL button again.

f) The original signal waveform is then displayed together with an "envelope".

g) "XH" denotes that the relevant POSITION knob (depends on the channel, 16 or 17) can be used to move the original signal out of the envelope (the assessment area) to allow better signal comparison. "OH" denotes that the original signal cannot be moved out of the envelope. As soon as the edge of the envelope is reached, the Hold function is activated.

h) To reset this function or quit it, simply briefly press the HOLD button.

(13) Explanation for "MENU" button

The MENU button has been mentioned several times in connection with the sub-functions stated above. This button can be used to select any of the sub-functions below:

ITPL = Interpolation
SMTH = Smoothing
PROB = Probe
AVG = Average
ROLL = Roll function
AMAG = ALT MAG, alternate magnification
G-NG = Go-NoGo, used to set an envelope.

As soon as the MENU button is pressed in storage mode, the LED under the button cap is lit. The SELECT button located under the MENU button is a kind of "Help" button and is used to "set" a sub-function.

13.1 PROBE "probe setting"

Press the MENU button until PROB X1 appears. Use the "SELECT" button to select either "X1" or "X10".

P R O B X 1 0

13.2 SMOOTHING

Keep pressing the MENU button until "SMTH OFF" appears at the top of the screen.
The SELECT button switches the "smoothing filter" ON or OFF.

S M T H O F F

If smoothing is switched off, a series of dots are displayed in storage mode rather than continuous lines. However, if more than five "zero crossings" of a signal are displayed, it is advisable to switch smoothing on (SMTH ON.

13.3 AVERAGING (AVG)

Keep pressing the MENU button until "AVG NORM" appears at the top of the screen in the middle. Use the SELECT button to set the "number" of averaging calculations to be performed. For example, setting "4" means that a mean-value will be generated from 4 samples before the signal waveform is next displayed. The higher this setting, e.g. 256, the slower the display is refreshed. This makes it possible, for example, to acquire non-continuous periodic signals where there is no trigger.

A V G N O R M

NORM: no averaging
4 : 4 passes
16 : 16 passes
64 : 64 passes
256 : 256 passes

Note:

Averaging is not possible in "ROLL" mode

13.4 "ROLL" mode

Keep pressing the MENU button until ROLL OFF (or ROLL ON) appears.
Use the SELECT button to switch this operating mode ON or OFF.

R O L L O N

13.5 Interpolation (ITPL)

Keep pressing the MENU button until ITPL OFF appears at the top of the screen in the middle. Use the SELECT button to select sine interpolation (ITPL SIN), linear interpolation (ITPL LIN) or to switch interpolation off (ITPL OFF).

I T P L O F F

The INTERPOLATION function is used to "clean up" the display of horizontally expanded "reconstituted" signals. In the ITPL SIN position, "reconstituted" signals are similar to a sinusoidal function. However, if a rectangular-pulse signal is applied to the input and "reconstituted"/distorted in storage mode, and the ITPL SIN

position is then selected, it is possible that the input signal may no longer match the display. In this case (square-wave signals), linear interpolation (ITPL LIN) is ideal for display purposes.

13.6 AMAG = ALT MAG mode

Keep pressing the MENU button until "AMAG OFF" (or AMAG ON) appears at the top edge of the screen in the middle. In this mode the SELECT button can only be used to make a setting if the Hold key has previously been pressed.

A M A G O F F

13.7 Go-NoGo mode (signal assessment)

Keep pressing the MENU button until "G-NG => XH OH" appears at the top of the screen in the middle. With this function, the SELECT button can be used to toggle between XH= Comparison and OH = Hold.

G - N G => X H O H

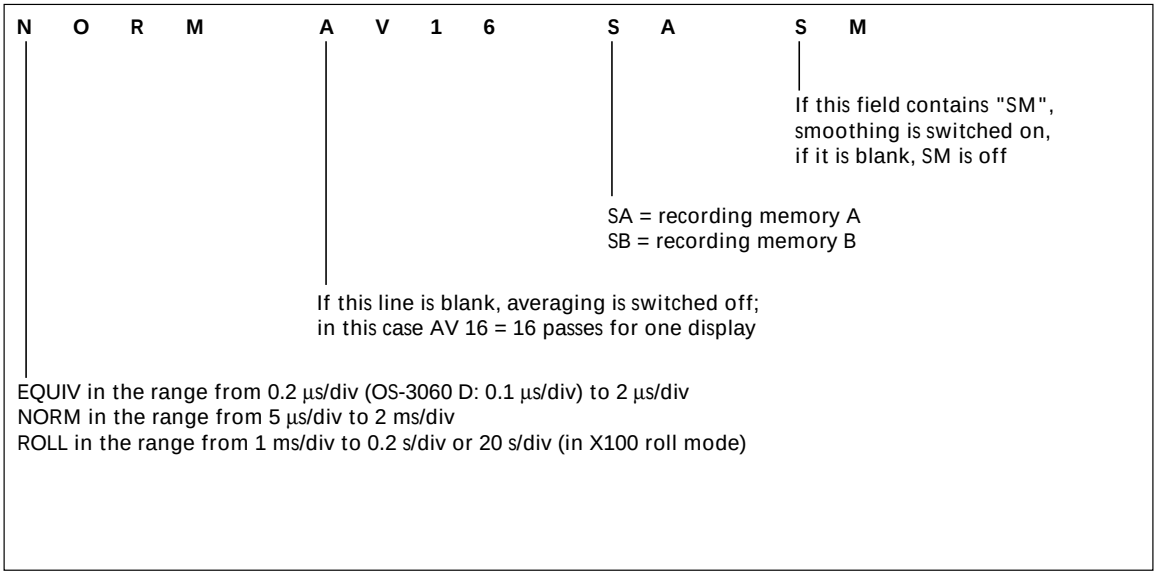
If one of these two functions (XH or OH) was selected, the basic value = 0.4 div must be set by pressing the RECALL button once. If a higher value is required, keep the SELECT button pressed until the desired value is reached.

G - N G 0 . 4 d i v

0.4 div: the assessment area covers ±0.4 div
0.8 div: the assessment area covers ±0.8 div
1.2 div: the assessment area covers ±1.2 div

13.8 Header text line at top edge of screen without MENU button

Assuming that all the necessary settings have been made and the MENU button is no longer required, keep this button pressed until the LED under the button cap goes out. The header text line at the top edge of the screen (right-hand half) might look as follows:



(14) X-Y mode

The procedure to make the settings for the X-Y function in storage mode is as follows:

a) Set the Vertical switch to the DUAL position

b) Press the HOLD button in order to pause sampling. Both input signals (X = CH1 and Y = CH2) continue to be displayed.

c) turn the Time/div switch to the right-hand stop in the case of the OS-3020 D or press the X-Y button in the "HORIZ DISP" panel on the OS-3060 D.

Note:

If the brightness is too high, reduce the intensity because otherwise this will damage the sensitive internal coating of the CRT screen and the signal could be permanently burnt into the coating.

2.3 Taking measurements using Oscilloscopes OS-3020 D and OS-3060 D

2.3.1 Amplitude measurements

A fundamental distinction is made between two types of voltage measurements when using an oscilloscope:

- Measurement of peak-to-peak voltage without any reference to polarity, and

- Measurement of the instantaneous values of a voltage referred to a basic reference (polarity related).

If you want to perform one of these two types of measurement, make certain that the VARIABLE knobs are pushed in and calibrated (right-hand stop, latched-in).

1. Peak-to-peak voltages

To measure such voltages, proceed as follows:

a) Set up the oscilloscope according to 2.2.1 (default settings of switches and knobs)

b) Set the TIME/DIV switch so that two to three cycles of the signal are visible on the screen with the VOLTS/DIV switch turned to the left-hand stop (5 V/div).

c) Use the Vertical position switch (25) to move a negative peak of the signal as close as possible to the vertical centre line (the line with the fine graduation marks = 0.2 DIV).

d) Move the signal onto a horizontal graticule line by using one of the Horizontal position switches (16) or (17) depending on the input to which the signal is applied.

e) You can then determine the peak-to-peak voltage:

Count the "boxes" between the negative and positive peak of the signal and multiply them by the VOLTS/DIV setting.

Example:
If you counted 4.2 divisions and the VOLTS/DIV switch is set to 1 V/DIV, the voltage is therefore 4.2 DIV x 1 V/div = 4.2 V pp.

f) If X5 expansion is switched on, you must divide the determined value by 5, if a 1:10 probe is connected, you must multiply the result by 10.

g) In the case of sine-wave signals below 100 Hz and rectangular-pulse signals below 1000 Hz, set the AC/DC/GND switch of the relevant channel to DC in order to prevent measuring errors.

Warning!

Make certain that a periodic quantity is not superimposed on a very high zero-frequency quantity. It is crucial not to exceed the maximum permissible input values.

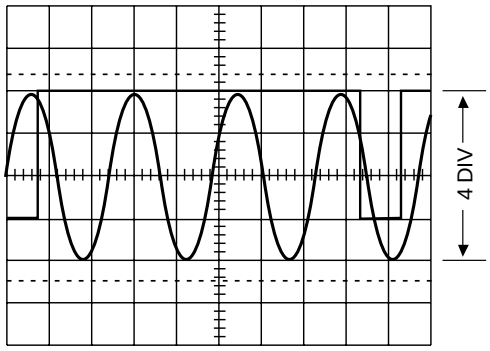


Fig. 14. Determination of peak-to-peak voltage

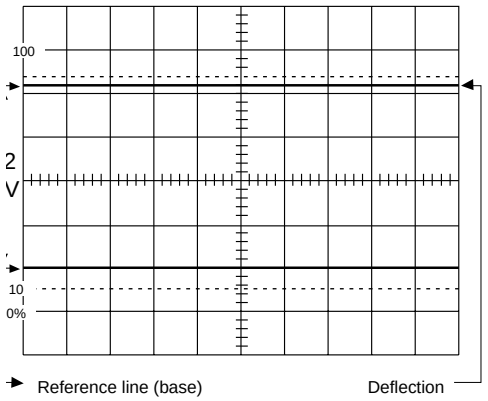


Fig. 15. Measurement of direct voltage

2. Measurement of direct voltage

To determine a direct voltage, proceed as follows:

a) Set up the oscilloscope according to 2.2.1.

b) Set the AC/GND/DC switch of the channel in which the signal is present to GND.

c) Use the appropriate Position switch (16) or (17) to move the trace to the centre of the screen graticule (= the horizontal centre scale line).

d) The POS switch must not be moved again until the measurement has been completed.

e) Then set the AC/GND/DC switch to DC, making absolutely sure that the maximum input values are not exceeded. All signals above the centre line are positive and all those below it are negative.

f) Determine the interval between the positive or negative line and the centre line by counting the scale marks or the "boxes" = DIVISIONS and multiply this number by the setting of the VOLTS/DIV switch.

Example: The interval is 2.8 DIVs (= 2 boxes and 4 scale marks x 0.2 cm). The VOLTS/DIV switch is set to 2 VOLTS/DIV. This gives 2.8 DIVs x 2 VOLTS/DIV = 5.6 V.

g) If X5 expansion has been set (by pulling out the VARIABLE knob), you must divide the determined value by 5, if a 1:10 probe is connected, you must multiply the determined value by 10.

2.3.2 Measurement of time, time intervals

To perform this type of measurement, proceed as follows:

1. Set up the oscilloscope according to 2.2.4.

2. Then set the TIME/DIV switch so that the signal image (a half-wave) is displayed on the screen as large as possible.

3. Use the Vertical and Horizontal position switches [POSITION (16) or (17) and (25)] to move the image so that the start of the time interval coincides with a vertical graticule line and its end is on the horizontal centre line of the graticule.

4. The time is then determined as follows:
Time = interval between start point and end point of half-wave in DIVs x setting of the TIME/DIV switch.

Example: The interval is 5.4 DIVs and the TIME/DIV switch is set to 5 µs/DIV. This gives 5.4 DIV x 5 µs/DIV = 27 µs. The time is 27 µs (microseconds = 10^{-6} seconds).

2.3.3 Measurement of period, pulse width etc.

This measurement is performed in a similar way to that described under heading 2.3.2.

The period of a square-wave pulse or any other waveform is the time taken to complete a full cycle (360º) (see also figure).

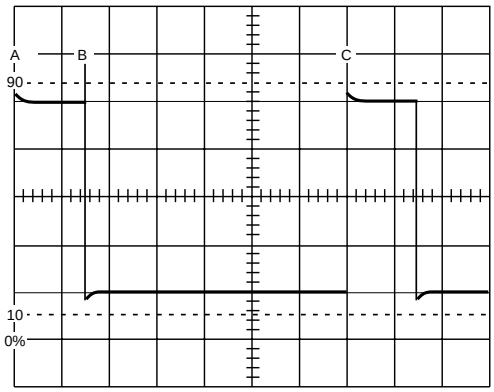


Fig. 16

In this figure, the time-base sweep is 10 ms/DIV; the measurement is made between A and C, thus giving a period of 70 ms.

The pulse width is the distance between A and B, i.e. roughly 1.5 div which is equivalent to 15 ms. The larger the waveform displayed, the more accurate the reading or measurement result. To achieve this, either select the next smallest time-base sweep (to the left) or pull out the VARIABLE knob (24), but in the calibrated position (right-hand stop). The X position knob (25) can then be used to position the signal more accurately.

Once the pulse width and the period are known, the mark-to-space ratio can be determined as follows:

$$= \frac{\text{Pulse width} \times 100}{\text{Period}} = \frac{15\text{ ms} \times 100}{70\text{ ms}} = 21{,}4\ \%$$

2.3.4 Frequency measurements

Wherever possible, a frequency counter should be used to obtain an accurate frequency indication. The counter can be connected to the channel 1 output at the rear of the oscilloscope. However, the oscilloscope can be used to determine a frequency if a counter is not available or in the case of modulated signals or noise where the counter does not respond.

The frequency is the reciprocal of the period = 1/dT. First determine the period as described in the previous chapter, then use a hand-held calculator to divide "1" by the period. If your calculator has a 1/x key, just enter the period and press the 1/x key to obtain the frequency. However, remember the powers of ten, these are listed in the Table below as a reminder.

Period in s	Reciprocal = Hz (= 1/s)
In ms = 10-3 s	= kHz
In µs = 10-6 s	= MHz

The accuracy of this measurement is limited by the accuracy of the time base.

2.3.5 Measurement of phase displacement

The phase displacement or phase angle between two signals can be determined either in dual-trace mode or in X-Y mode.

a) Dual trace mode

This method of measurement can be used to work on various signal waveforms up to a maximum frequency of 40 MHz.

To measure the phase angle, proceed as follows:

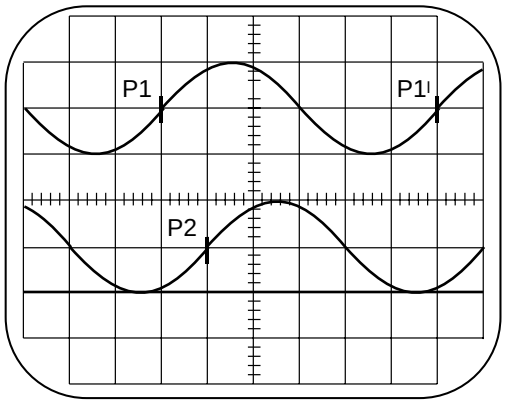
1. Set up the oscilloscope as described under heading 2.2.4 for dual-trace mode. Connect one signal to CH 1 and the other signal to CH 2.

Note:

To avoid measuring errors, use identical, accurately compensated probes or coaxial cables of identical length/type to ensure identical delay times.

2. You will then see two in-phase points on both curve traces on the screen. If the signals have a sine-wave shape, find a point that is as close as possible or, best of all, actually on the datum line (horizontal centre line). The slope of the curve trace is at its steepest at this point and here it is possible to determine a position on the X-axis with maximum accuracy.

3. In the figure below, these points of the two sine-wave signals are identified as P1 and P2. To obtain the phase difference, the displacement is measured as the distance P1-P2 which is then expressed as a ratio to distance P1-P1'.



Example of phase measurement

Fig. 17

4. The phase angle is expressed in angular degrees and must be determined from the measured distances. One period corresponds to exactly 360º. The phase angle phi is obtained as follows:

$$\text{Phi} = \frac{1\text{-}P2}{P1\text{-}P1'} \times 360° \text{ from the fig.} = \frac{1\ \text{DIV}}{6\ \text{DIV}} \times 360° = 60°$$

b) X-Y mode (Lissajous method)

This method is used exclusively in the case of sine curves. Measurements are possible up to 500 kHz max. which is the bandwidth of the horizontal amplifier.

Using this method, proceed as follows:

1. Set the TIME/DIV knob to the right-hand stop and do not forget to reduce the intensity (brightness).

2. Make sure that the POSITION knob for channel 2 (17) is pushed in, otherwise this would give a phase displacement of 180º.

3. Connect one measuring signal to the CH 1 or X input and the other measuring signal to the CH 2 or Y input.

4. Use the CH 2 POSITION knob (17) and the VOLTS/DIV knob (13) to adjust the vertical sweep so that the amplitude covers 6 DIVs and is above the 100% marker line (horizontal; the number "100" is on the left-hand edge of the graticule) and the bottom touches the 0% line.

5. Then set the CH 1 VOLTS/DIV knob (12) to obtain the largest possible image.

6. Use the X position knob (25) to set the horizontal sweep so that the image is centred.

7. Count the DIVs along the vertical centre line (dimension "A" in the figure on the next page).

8. The phase displacement (phase angle phi) between the two signals equals the arc sin of A divided by B --> PHI = sin-1 x A/B.

Example: In the figure, the counted DIVs = 2.0, divided by 6 DIV this gives 0.334, the arc sin of this gives a phase angle phi = 19.5.

9. The simple formula in para. 8 only applies up to a phase angle of 90º. For an angle > 90º (left-sloping ellipse), add 90º to the calculated angle. The figure below shows a few Lissajous patterns having various phase angles. Use these patterns for guidance when deciding whether or not to add 90º.

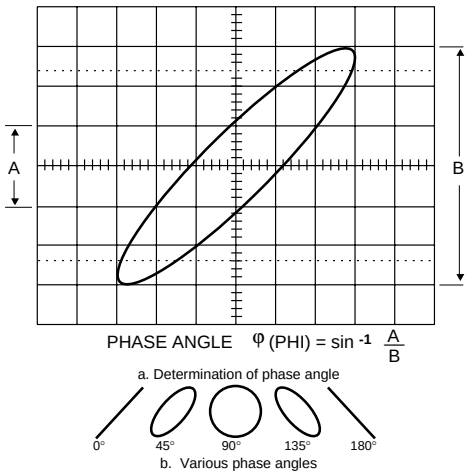


Fig. 18

2.3.6 Measurement of rise time

The rise time is the time which the amplifier needs in order to track the amplitude of an ideal square-wave step change from 10% to 90%. The fall time is the time the amplifier needs to track the amplitude from 90% to 10%.

To determine the rise time or fall time, proceed as follows:

1. Connect the measuring signal to CH 1 and set the AC/GND/DC switch to AC.

2. Set the time-base sweep (TIME/DIV) so that two cycles of the signal can be viewed on the screen. Make sure that the VARIABLE knob (24) is at the right-hand stop and pushed in.

3. Adjust the Volts/Div knob and the CH 1 POSITION knob so that the top of the signal touches the 100% marker line and the bottom touches the 0% line. If this adjustment cannot be obtained using only the VOLTS/DIV knob, turn the VARIABLE knob (14) to the left.

4. Use the X position knob (25) to adjust the rising edge of the signal so that it passes through the point where the 10% line intersects the vertical centre line (see figure on next page).

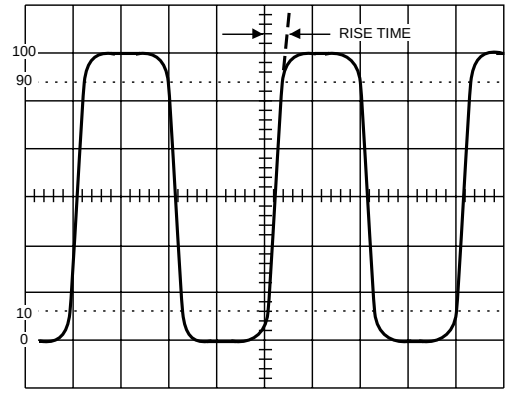
5. If the rising edge is very steep and a short rise time can be expected, the image can be expanded by a factor of 10 by pulling out the VARIABLE knob (24). Then repeat the procedure described under heading 4.

6. Count the DIVs between the 10% intersection and the point at which the rising edge intersects the 90% marker line.

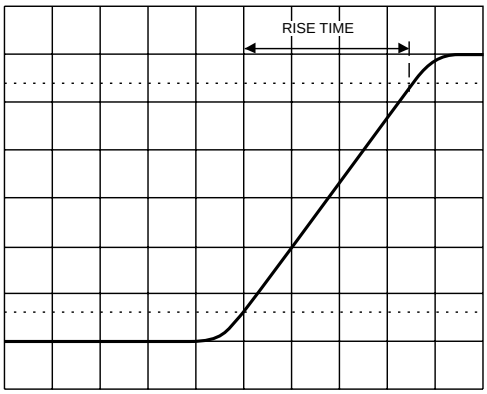
7. Multiply the number of DIVs by the setting of the TIME/DIV knob. If the PULL x 10 knob was pulled out to expand the signal, divide the result by 10.

Example: In the bottom figure (next page), the 3.6 DIVs read off multiplied by a TIME/DIV setting of 1 µs (= 100 ns) divided by 10 give a rise time of 360 ns.

8. To measure the fall time, adopt the same procedure as when determining the rise time, but with the difference that the falling edge of the signal passes through the point where the 10% line intersects the vertical centre line.



a. Display, not expanded



b. Expanded display

Fig. 19

2.4 Digital X-Y plotter output (interface)

All displayed signals and signal waveforms that can be viewed in storage mode can be printed out via the plotter output.

This chapter describes how to connect the plotter, what the data format is and the pin assignment of the interface.

2.4.1 Specification

a) Markers and cursor lines

All markers and cursor lines that are part of the screen content are printed out.

b) Signal data

All signal data (screen overlays) are also printed.

c) Screen grid, graticule and scales

The screen graticule and graduated horizontal and vertical centre line are also printed out (plotted).

d) Screen scale/adjustment

The DIP switch located alongside the interface can be used to modify the overall size of the screen content so that several images fit on a single A4 page. Chapter 4.4 describes how to set this DIP switch. Also note the following figures.

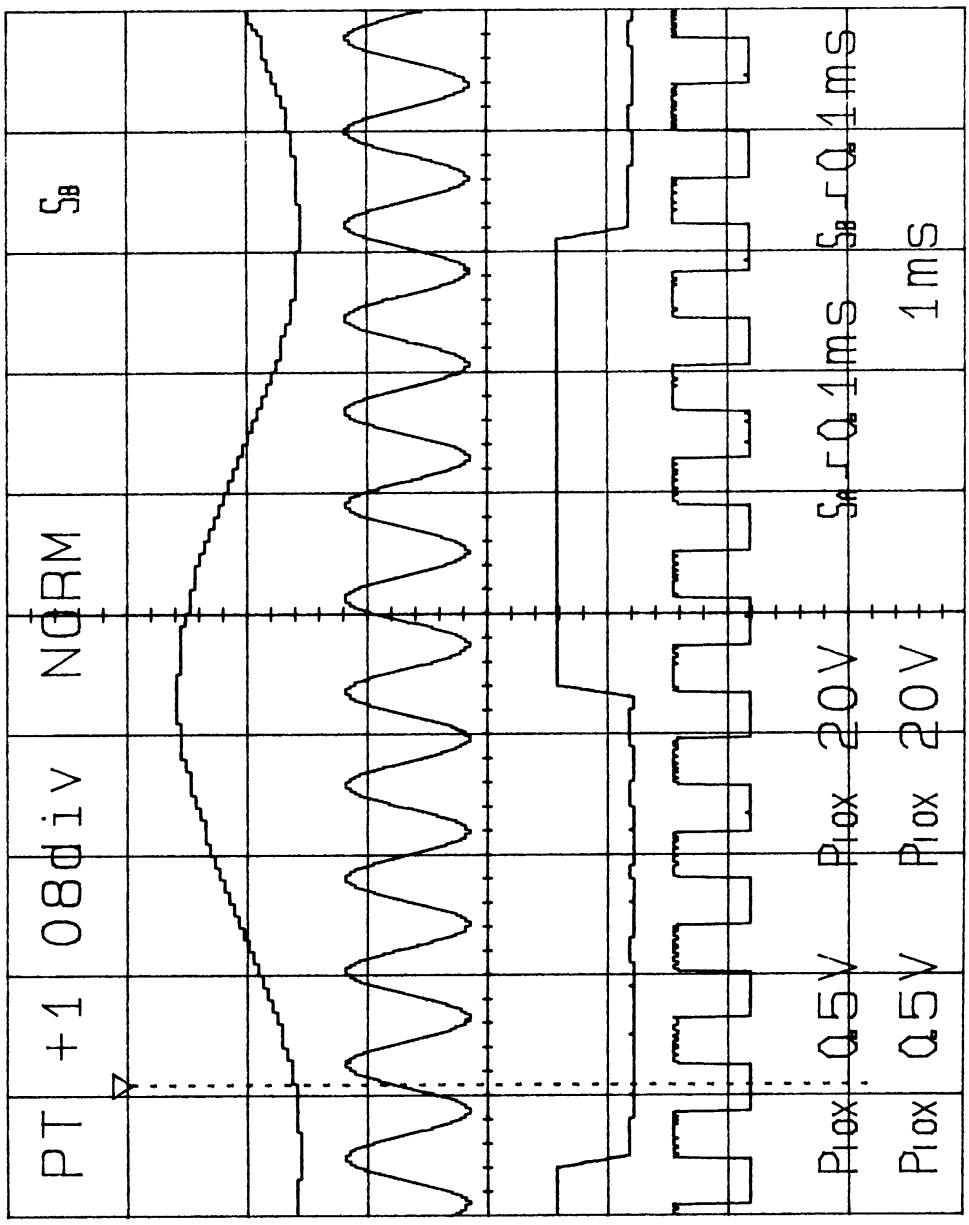


Fig. 20. Screen dump on one page

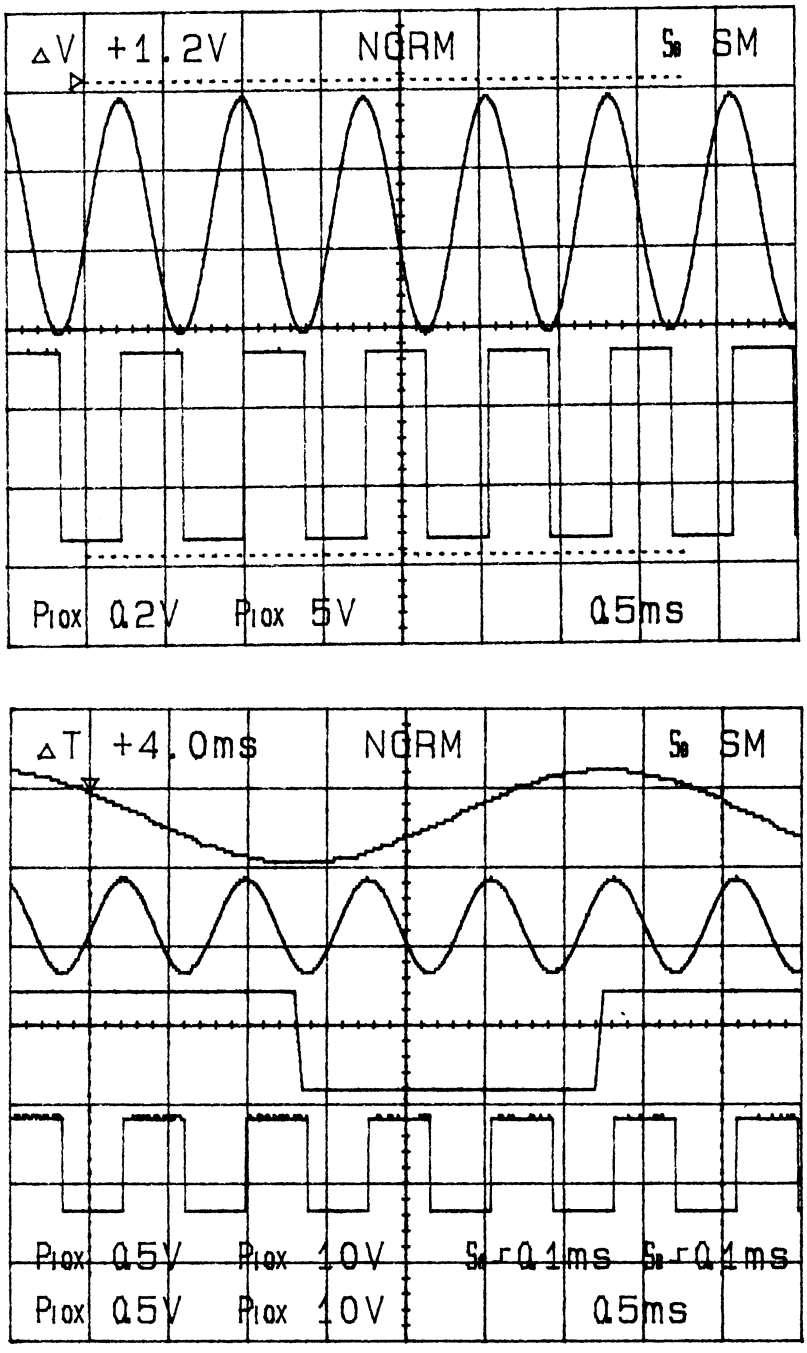


Fig. 21. Two screen dumps on one page (portrait)

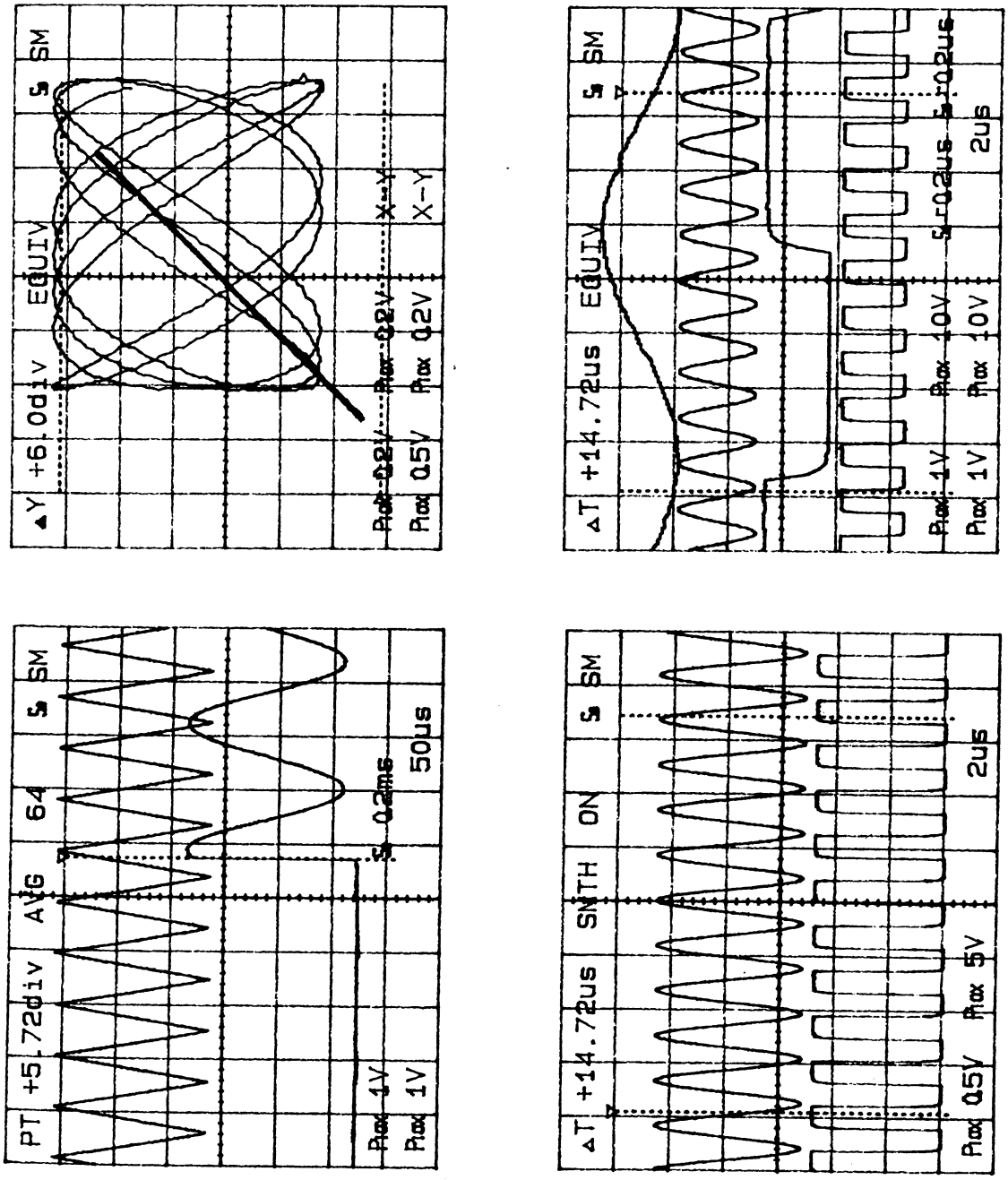


Fig. 22. Four screen dumps on one page

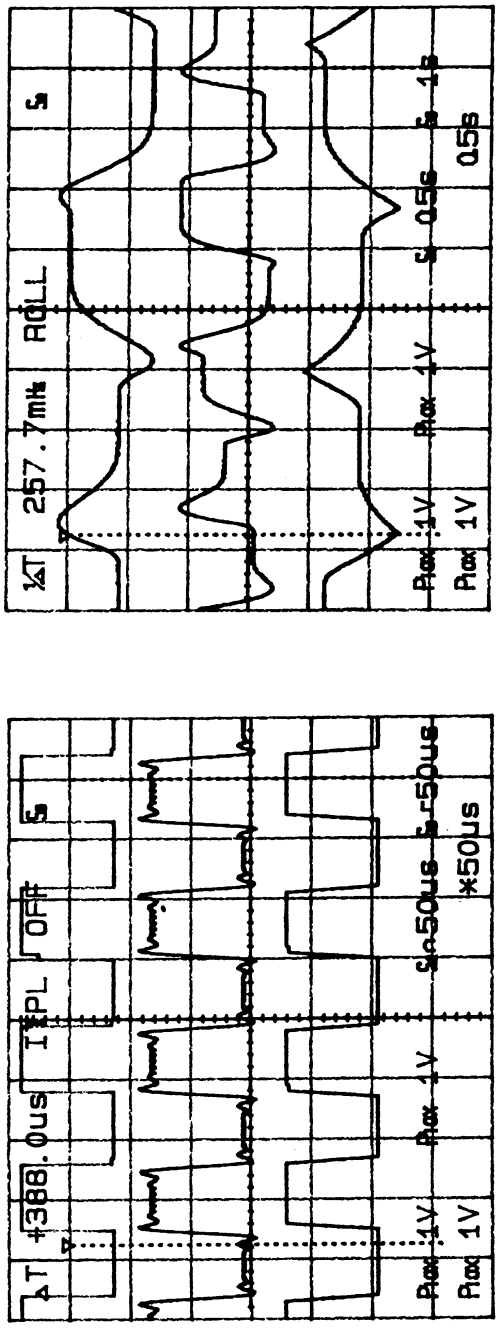
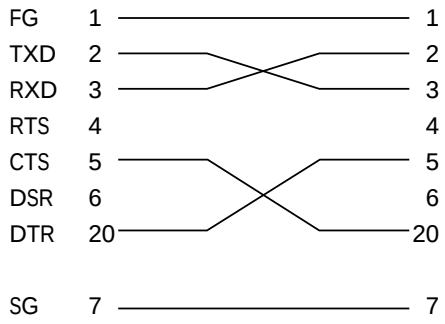


Fig. 23. Two screen dumps on one page (landscape version)

2.4.2 Interface connection, pin assignment

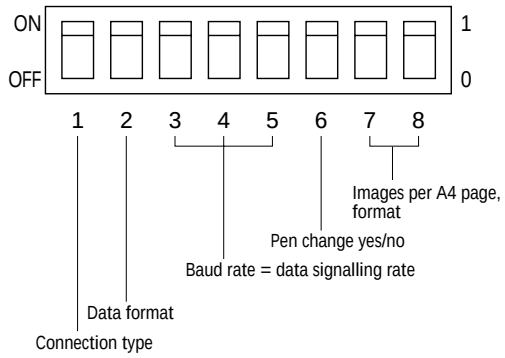
An RS-232 interface cable must be used to connect the plotter and the oscilloscope. The cable is connected to the oscilloscope on the 25-pin 'D' sub-miniature socket at the rear of the unit.

The following figure shows the connector/socket pin assignment.



2.4.3 Setting the DIP switch (alongside the interface)

This switch configuration is used to adapt the oscilloscope to the connected peripheral devices (printer, computer, etc.).



Example 1:

Connecting an HP-7475A plotter (baud rate: 9600)

Set the DIP switch as follows:

1	2	3	4	5	6	7	8
1	1	0	0	0	0	1	1

(on oscilloscope side)

9	8	7	6	5	4	3	2	1
S2	S1	Y	US	A3	B4	B3	B2	B1
0	0	0	0	0	1	0	1	0

(Plotterside)

Example 2:

Connecting a HITACHI 681-XA plotter (baud rate: 9600 bauds)

1	2	3	4	5	6	7	8
1	1	0	0	0	0	1	1

(Oscilloscope side)

1	2	3	4	5	6	7	8	9	0
0	1	1	0	1	1	0	1	0	0

(Plotterside)

A) Setting the number of images per hard copy page

DIP switches 7 and 8 are used to specify how many images are plotted on one page and in what format.

DIP switch No. 7 No. 8	Description	Size/format of image(s)
ON ON	One image is printed out on one A4 page	170 mm x 70 mm See also Figure 20
OFF ON	Two images per page (A4)	120,8 x 120,8 mm See also Figure 21
ON OFF	Four images per page (A4)	85 mm x 85 mm See also Figure 22
ON OFF	Two images per page (A4)	85 mm x 85 mm/afb See also Figure 23

B) DIP switch "6" is used to specify whether printout on the plotter uses one pen or whether different coloured pens are used.

DIP switch setting	
DIP switch No. 6	Pen change?
ON (up "1")	No
OFF (up "0")	Yes

f the DIP switch is set to OFF, six different-coloured pens are used for printout on the plotter. The table below shows which pen is used for a particular detail.

	Detail	Pen No.
Screen graticule and scales		1
Signal waveform	Channel 1	3
	Channel 2 Recording memory A (=SAVE A) Recording memory B (=SAVE B)	4 5 6
Cursor lines		2
Screen overlays/ legends	VOLTS/DIV channel 1 Channel 2 SAVE A SAVE B	3 4 5 6
Time-base sweep	SWEEP SAVE A SAVE B	1 5 6

C) Data signalling rate

DIP switches No. 3, 4 and 5 are used to specify the baud rate. The minimum value (slow) is 300 bauds, the maximum value (fast) is 9600 bauds.

DIP switch No.	3	4	5	Baud rate
	ON	ON	ON	300 BAUD
	OFF	ON	ON	600 BAUD
	ON	OFF	ON	1200 BAUD
	OFF	OFF	ON	2400 BAUD
	ON	ON	OFF	4800 BAUD
	OFF	ON	OFF	9600 BAUD
	ON	OFF	OFF	9600 BAUD
	OFF	OFF	OFF	9600 BAUD

D) Data format settings

DIP switch No. 2 can be used to set the following data formats:

DIP switch 2	Data format
ON	1 start-bit + 8 bit + 1 stop-bit
OFF	1 start-bit + 8 bit + 2 stop-bit

E) Setting the connection type, "send" only or "send" and "receive" = two-way communication

DIP switch 1 is used to specify whether communication between the oscilloscope and peripheral device (plotter or computer etc.) uses a one-way connection or a two-way connection = "send" and "receive".

DIP switch 1	Connection type
ON	One-way (plotter connection)
OFF	Both-way (connection to a PC)

Note:

Before switching on the oscilloscope and after connecting any peripheral device, always check that the DIP switch is correctly set in order to avoid unnecessary errors.

2.4.4 Setting up the oscilloscope (to start plotter)

Note:

Settings must only be made when the equipment, oscilloscope and peripheral devices are switched off.

If you want to print out (plot) a specific screen content in storage mode, press the HOLD button in the STORAGE MODE panel. Plotter output is then possible. Printout is initiated by pressing the PLOT button in the STORAGE MODE panel. During printout, the LED under the cap of the PLOT button is lit. Once printing has finished, the LED goes out again.

2.4.5 Troubleshooting if plotter does not work:

a) The connecting cable between the oscilloscope and plotter was not connected/plugged in or was connected/plugged in incorrectly.

b) The plotter may be switched off.

c) DIP switch No. 1 is incorrectly set.

d) You forgot to press the HOLD button in storage mode.

e) The baud rate and the data format do not match the plotter manufacturer's settings.

3. Maintenance and Care

Warning!

It is crucial to observe the safety instructions given under heading 1.2 when carrying out maintenance or repair.

Use a dry, lint-free, antistatic cleaning cloth to clean the oscilloscope.

Note

Never use any solvents that contain hydrocarbons, e.g. petroleum spirit or thinners to clean the housing. They release toxic vapours, create risk of explosion in the event of sparking and will damage the surface of the oscilloscope. In order to remove dust or dirt from the anti-glare filter or the surface of the CRT screen, use a suitable screwdriver for slotted screws to carefully remove the two pins in the bottom edge of the front cover (they are made of plastic), carefully swivel the cover forward from the top (see figure below). Use a mild glass cleaning solution to clean the anti-glare filter and the screen surface. Before reassembling, make sure that your fingers have not touched the surface of the screen or the anti-glare filter (finger marks) and that everything is dry.

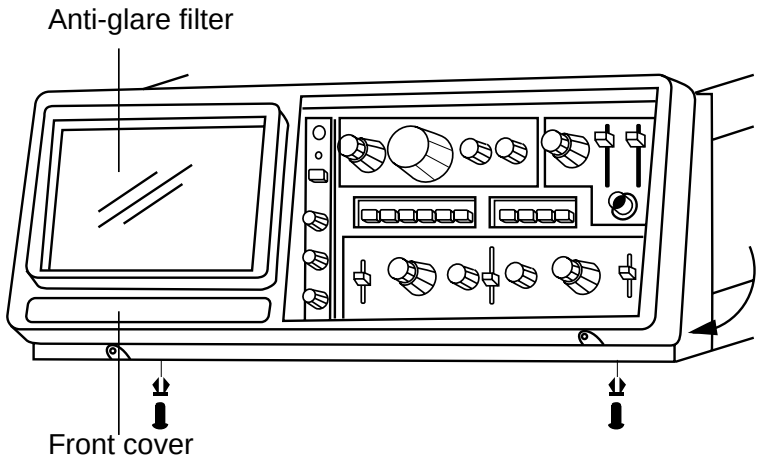


Fig. 24

Block Diagram

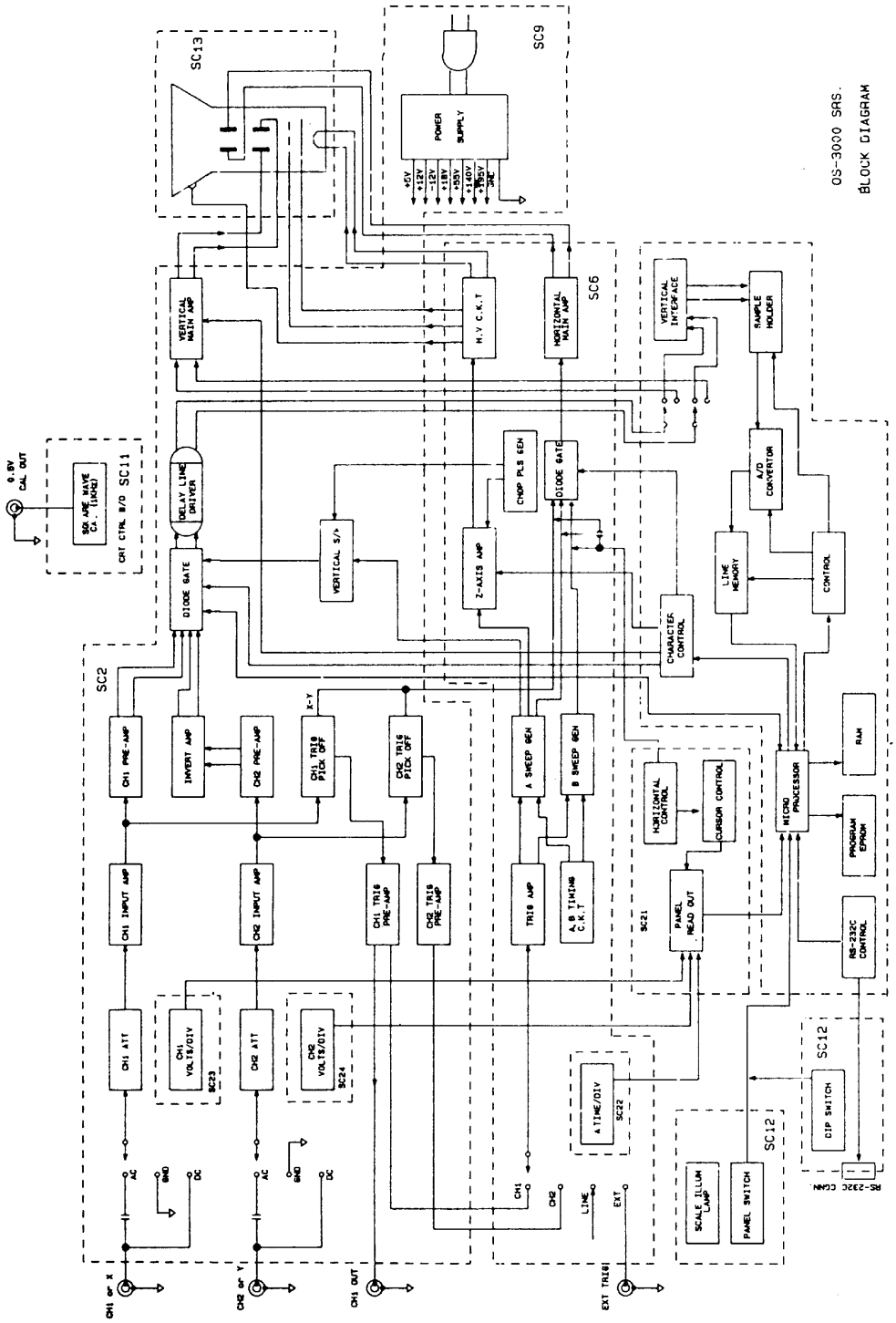


Fig. 13

Z U S A T Z I N F O R M A T I O N
ZUR
B E D I E N U N G S A N L E I T U N G

UPGRADE
Stand: 05/2000

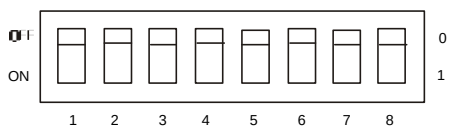
Zweikanalspeicheroszilloskop
OS-3020D / OS-3060 D
Best.-Nr. 13 12 02 und 13 12 10

Durch eine Umstellung in der Produktion ergeben sich folgende Änderungen am Produkt und in der beiliegenden Bedienungsanleitung

Sehr geehrter Kunde,

leider hat sich der Druckfehlerteufel eingeschlichen. Bei den ausgelieferten Geräten wurden die DIP-Schalter (neben der Schnittstelle) geändert. Aus diesem Grund müssen auch die nachfolgenden Tabellen wie folgt korrigiert werden.

Zu 2.4.3



Beispiel 1:

Einstellung der DIP-Schalter wie folgt

1	2	3	4	5	6	7	8
0	1	1	1	1	1	0	0

(Oszilloskopseite)

Beispiel 2:

1	2	3	4	5	6	7	8
0	0	1	1	1	1	0	0

(Oszilloskopseite)

Zu A) Einstellungen der Abbildungen pro Papierseite

Dipschalter Nr.7	Dipschalter Nr.8	Beschreibung	Größe / Format der Abbildung(en)
OFF	OFF	Eine Abbildung wird auf einer DIN-A-4 Seite ausgedruckt	175 mm x 140 mm siehe auch Abbildung 20
ON	OFF	Zwei Abbildungen pro Seite (DIN-A-4)	118 mm x 95,8 mm / Abb. siehe auch Abbildung 21
OFF	ON	Vier Abbildungen pro Seite (DIN-A-4)	87 mm x 70 mm / Abb. siehe auch Abbildung 22
ON	ON	Zwei Abbildungen pro Seite (DIN-A-4)	87 mm x 70 mm / Abb. siehe auch Abbildung 23

Zu B) Einstellungen für Stiftauswahl

DIP-Schaltereinstellung	
Dipschalter Nr. 6	“Stifte” auswechseln ?
OFF (auf “0”)	nein
ON (auf “1”)	ja

Zu C) Übertragungsgeschwindigkeit

DIP-Schalter-Nummer	3	4	5	Geschwindigkeit
	OFF	OFF	OFF	300 BAUD
	OFF	OFF	OFF	600 BAUD
	ON	ON	ON	1200 BAUD
	ON	ON	ON	2400 BAUD
	OFF	OFF	OFF	4800 BAUD
	OFF	OFF	OFF	9600 BAUD
	ON	ON	ON	9600 BAUD
	ON	ON	ON	9600 BAUD

Zu D) Datenformateinstellung

Dipschalter Nr. 2	Datenformat
OFF	1 Start-bit + 8 bit + 1 Stop-bit
ON	1 Start-bit + 8 bit + 2 Stop-bit

Zu E) Einstellung der Verbindungsart

Dipschalter Nr. 1	Verbindungsart
OFF	einseitig (Plotteranschluß)
ON	wechselseitig (Anschluß erfolgt(e) an einem PC)

Mit freundlichen Grüßen

Conrad Electronic