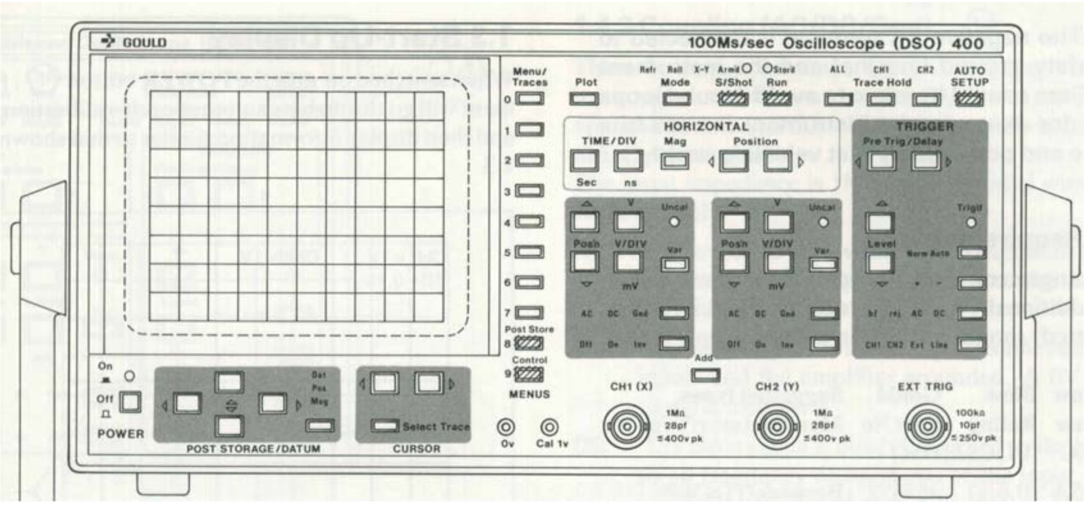

Gould 400 Series
Digital Storage Oscilloscopes
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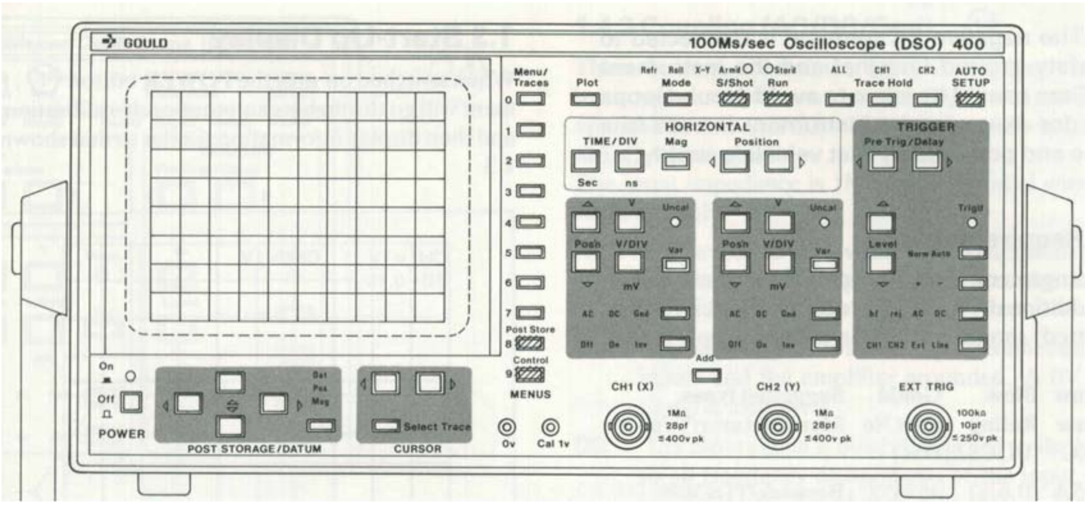

Gould 400 Series
Digital Storage Oscilloscopes
Operators Manual

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Introduction

The Gould 400 series instruments are Digital Storage Oscilloscopes (DSOs). They include all the features expected of advanced modern oscilloscopes designed for the professional engineer, whilst retaining the user-friendliness essential for those learning to use such instruments for the first time.

The 400 range consists of three basic models; the 400 the 420 and the 450. All versions can be fitted with a battery unit which provides the instrument with a fully automatic built in Nickel Cadmium battery and charger which allows uninterrupted operation of the DSO in the event of an AC supply failure and complete operation independent of an AC supply.

Obtaining a trace is especially simple - just connect the signal and press the Auto Setup button - the 400 does the rest. Having obtained a trace, readily accessible datum lines and a cursor make it easy to take automatic timing and voltage measurements directly from the display. On the 420 and 450 models, the waveform processing function increases the power of the cursor measurements in terms of both capture and post storage analysis and measurement functions.

The innovative use of ergonomically designed pressure sensitive push button controls provides a combination of precision and flexibility for ease of operation.

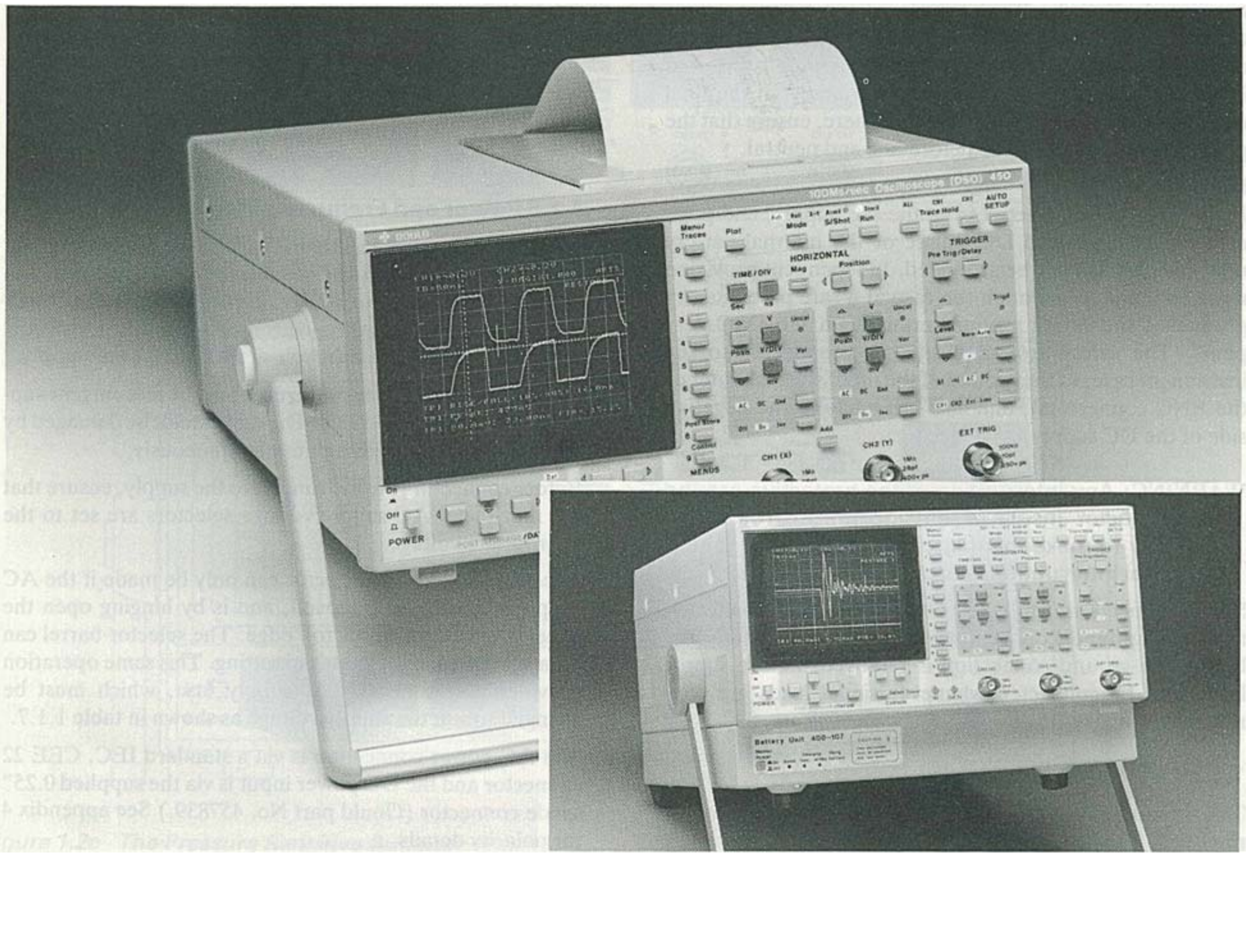
More advanced features of the 400 series include a comprehensive range of menu-controlled functions. For example, the Display and Trigger menu operates features such as the trigger delay and pre-trigger display functions. The pre-trigger display function allows the signal *prior* to the trigger point to be captured and displayed.

Three complete traces can be stored for future use and recalled to the display via the Save Trace and Recall Trace menus respectively. With the built in battery back up facility, these will be retained even when the instrument is switched off.

In addition to the above features, the 420 and 450 instruments have a built in 4 colour plotter and a battery backed Real Time Clock. This provides a simple and convenient method of obtaining permanent hard copy plots of the screen display. The plots will contain the date and time of acquisition together with the date and time of plotting.

The 450 has all the features of the 420 and has a signal bandwidth of 50MHz and an extra timebase range of 50ns/div.

Numbers circled in the text refer to the controls shown on the front panel picture in Appendix 3.



1.1 Safety and Power Requirements

1.1.1 International Safety Warning (as required for I.E.C. 348 Cat I)

This instrument has been designed and tested in accordance with IEC publication 348, and has been supplied in a safe condition. This manual contains information and warnings which must be observed to keep the instrument in a safe condition. The instrument should not be switched on if it is damaged and it should not be used under wet conditions.

For the correct and safe use of this instrument it is essential that both operating and service personnel follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

Whenever it is likely that safety-protection has been impaired, the instrument must be made inoperative and be secured against any unintended operation. Qualified maintenance or repair personnel should be informed. Safety protection is likely to be impaired if, for example the instrument shows visible damage or fails to perform the intended measurements correctly.

1.1.2 Grounding

THE INSTRUMENT MUST BE GROUNDED.

AC

The instrument must be operated with a protective ground connected via the yellow/green conductor of the supply cable. This is connected to the instrument before the line and neutral connections when the supply plug is inserted into the socket on the back of the instrument. If the final connection to the supply is made elsewhere, ensure that the ground connection is made before line and neutral.

DC

If the unit is disconnected from the AC supply, and powered from an isolated DC source or the internal battery unit, the unit will not be grounded. Independent provision must be made to maintain the case at a safe potential, by grounding the safety ground terminal on the DSO rear panel. The safety ground terminal is connected to the instrument case, to the ground of the input signals (outer of the BNC connectors), and also internally to the negative side of the DC supply.

WARNING: Any interruption of the protective ground conductor inside or outside the instrument is likely to make the instrument dangerous. Intentional interruption is prohibited.

Signal connections to the instrument should be connected after the ground connection is made and disconnected before the ground connection is removed, i.e. the supply lead must be connected whenever signal leads are connected.

1.1.3 Live Parts

The instrument should not be operated with covers removed. The covers protect the user from live parts and they should be removed only by suitably qualified personnel for maintenance and repair purposes.

WARNING: Removing the covers may expose voltages in excess of 8000V at the side of the display tube; these may be present for up to one minute after the instrument has been disconnected from the power source.

1.1.4 Ventilation and Dust

The instrument relies on forced air cooling via a fan and ventilation slots. Adequate ventilation can usually be achieved by leaving a 75mm (3" gap) around the instrument.

The instrument should not be operated in dusty environments.

If the CRT filter requires cleaning it can be easily removed by pressing in its right hand edge as shown by the moulded arrow.

1.1.5 Operating Temperatures

The instrument is designed to be operated in an environment having an ambient temperature of between 0 and 50 degrees C, (0 to 45 degrees if the battery unit is fitted) and to operate with full accuracy between 15 and 35 degrees C.

Note: *Direct sunlight, radiators and other heat sources should be taken into account when assessing the ambient temperature.*

The instrument may occasionally be subjected to temperatures between 0 and -10ºC without degradation of its safety.

1.1.6 Power and Frequency Requirements

The instrument uses less than 85V A (200V A if battery unit fitted) and operates from line voltages of 90V to 130V, and 190V to 265V, at 45 to 400Hz. Under the extreme conditions of 90V and 45Hz, the instrument will still operate correctly even if there is a half cycle dropout in the line supply.

The instrument may be powered from a direct current supply in the range 12V to 33V. The unit cannot be damaged by applying power to both inputs simultaneously.

Before connecting the instrument to the supply, ensure that the rear panel AC supply voltage selectors are set to the appropriate voltage.

Access to the voltage selector can only be made if the AC supply connector is removed, and is by hinging open the panel connector from its top edge. The selector barrel can then be moved to the required setting. This same operation provides access to the AC supply fuse, which must be changed to suit the supply voltage as shown in table 1.1. 7.

The AC power connection is via a standard IEC, CEE 22 connector and the DC power input is via the supplied 0.25" spade connector (Gould part No. 457839.) See appendix 4 for polarity details.

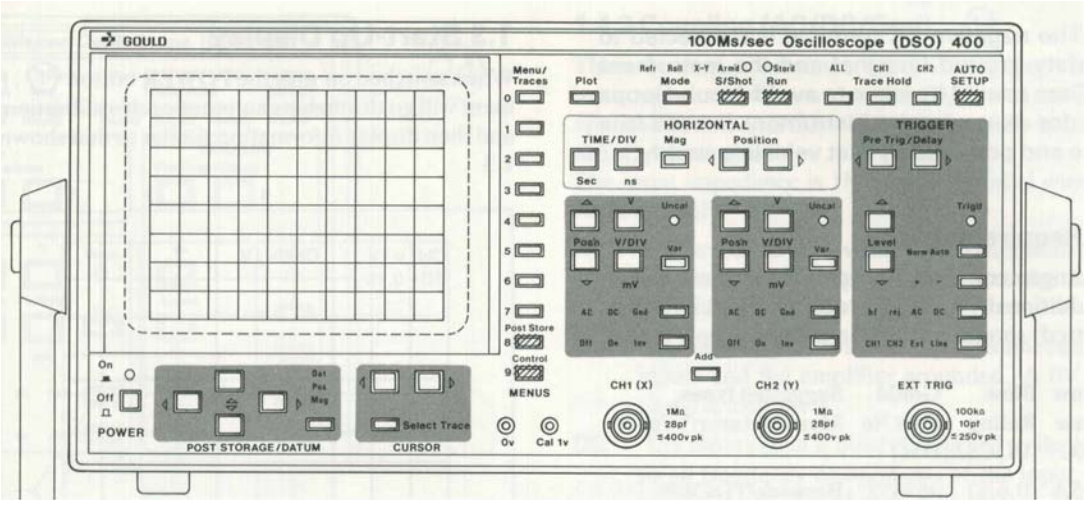


Figure 1.2a Single Function Buttons

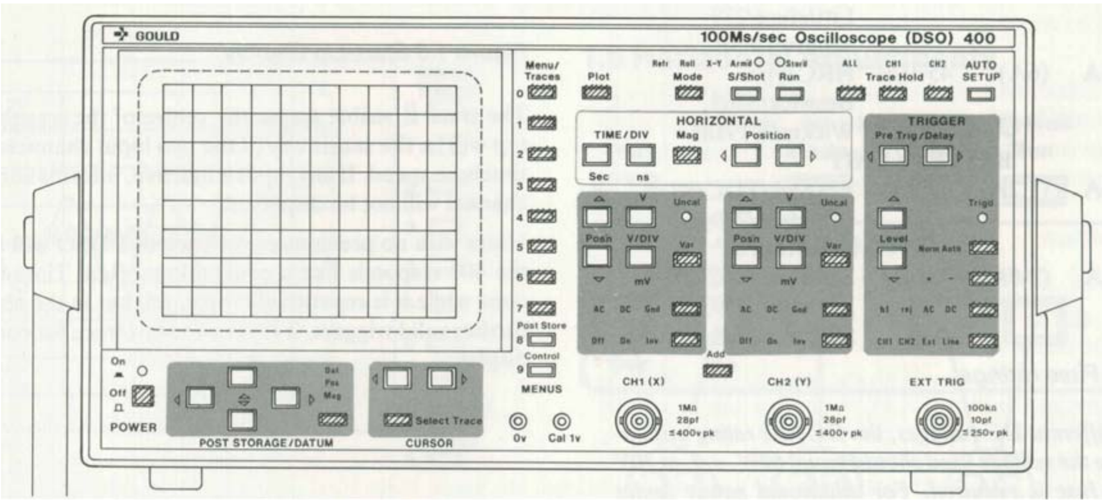


Figure 1.2b The Toggles

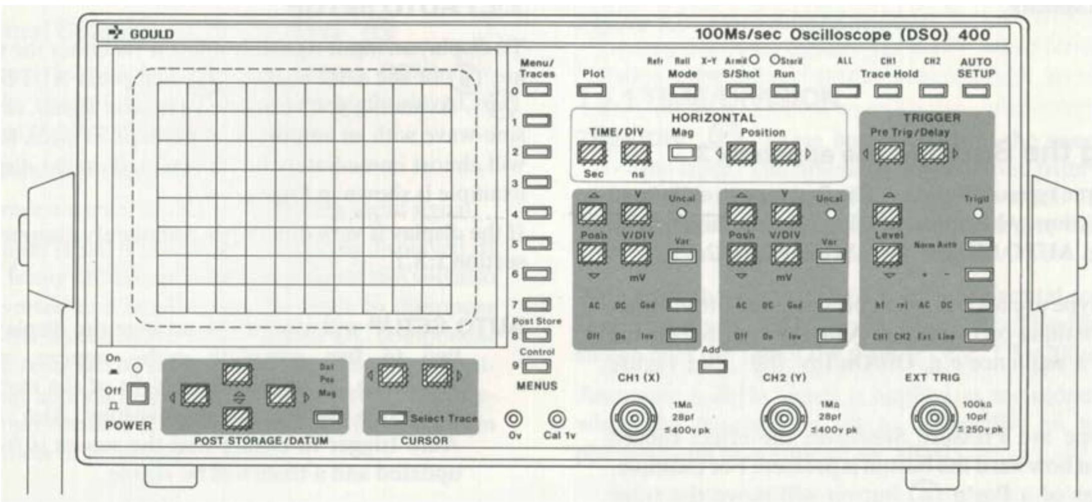


Figure 1.2c The Pressure Sensitive Buttons

CAUTION: The negative DC terminal is connected to the safety ground terminal and the instrument case. Care should be taken to avoid ground loops when, for example, the instrument is used in a vehicle and powered by that vehicle's supply.

1.1.7 Fuse Requirements

The fuse arrangement shown in table 1.1. 7 must be followed, and additionally in the UK, a 3A fuse (5A if the battery unit is fitted) should be fitted in the line supply plug .

Supply Voltage	Slow Blow Fuse Rating IEC	(ULlCSA)	Gould Part No DSO	Suggested types. Manufacturer/Type No
230V	0.5A	(0.6A)	457452	BeswickrrDC488, Littlefuse/239, Schurter/FSP
115V	lA	(1.2A)	457454	BeswickrrDC488, Littlefuse/239 *Schurter/FSP*
12VDC	5A	(6A)	457979	HRC type *Beswick/S505,* Wickman 19181
		BATTERY UNIT		
230V	lA	(1.2A)	457454	BeswickrrDC488, Littlefuse/239, *Schurter/FSP*
115V	2A	(2.5A)	457455	BeswickrrDC488, Littlefuse/239, *Schurter/FSP*

Table 1.1.7 *Fuse ratings*

Note: *For different DC voltages, the DC fuse rating multiplied by the voltage used should equal60W. e.g. at 30V a 2A fuse* is *required. For additional safety under extreme fault conditions, the DC fuse* is *a high rupture current (HRC) type. This fuse should have a 1500A break capacity.*

1.2 Using the Buttons see appendix 3

There are three types of buttons. The first type usually have only one function: when pressed, that one function will be activated e.g. AUTO SETUP (24). See Figure 1.2a.

The second type are toggles: each press of the button either switches something on or off e.g. Add (10) , or selects the next item in a sequence e.g. Off/On/lnv (13) . See Figure 1.2b.

The third type are Pressure Sensitive: the effect caused depends upon how hard the button is pressed. For example, a gentle press of a Pos'n (8) button will move the trace slowly. If the button is pressed harder, the trace will move more quickly. See Figure 1.2c.

1.3 Start-Up Display

When switched on with the POWER button (1) , the instrument will go through its automatic self-calibration sequence and then display information similar to that shown in Figure 1.3.

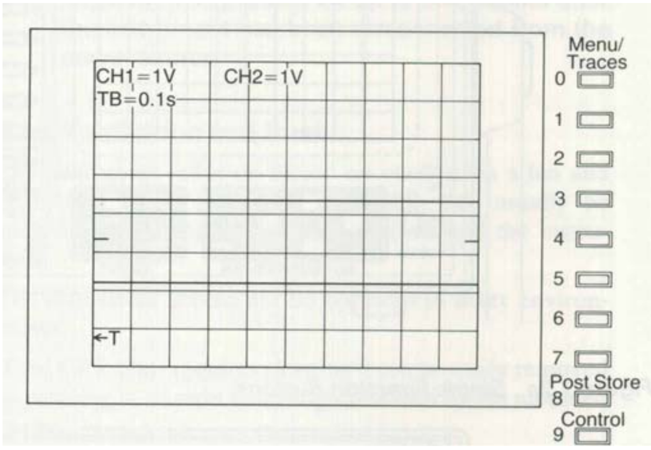


Figure 1.3 *Start-Up Display*

The trace is visible across the centre of the screen. At the top will be the sensitivity of the two input channels and the timebase speed. It any input is inactive, information for that channel will not be displayed.

Users with no previous experience of a DSO will find that the 400 responds like a conventional Real Time Oscilloscope while it is repetitively triggered, but in the absence of further valid triggers, it retains the last trace for continuous display.

1.4 Obtaining a Trace See Figure 1.4

1.4.1 AUTO SETUP

To display an input signal, connect it via either the CHI socket (9) or the CH2 socket (12) and press AUTO SETUP (24) . Assuming you've applied a regular signal, say a 2kHz sine-wave with an amplitude of perhaps 5V peak to peak, it will almost immediately be represented on the display. An example is shown in Figure 1.4.1.

It the display is very dim or has completely disappeared see section 1.8.1.

AUTO SETUP will attempt to arrange the display so that two to five complete cycles appear, with the amplitude set so that the height of the trace is between two and five screen divisions. Also, it selects Auto trigger to ensure that the screen is frequently updated and a trace will be visible.

If signals are connected to both channels, the highest amplitude takes priority.

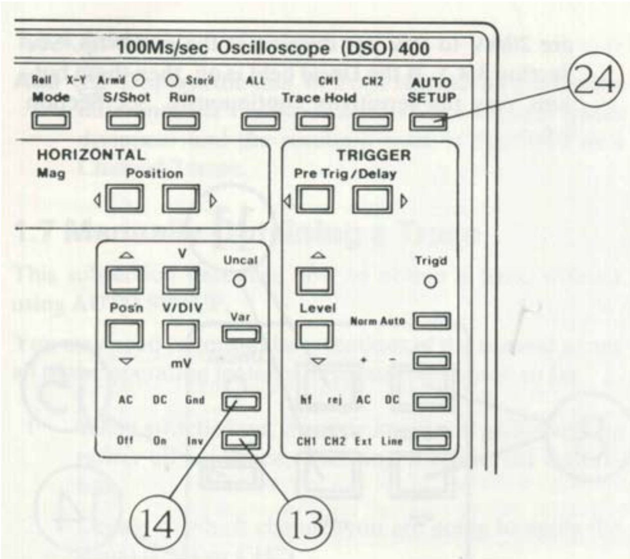


Figure 1.4 *Obtaining a Trace*

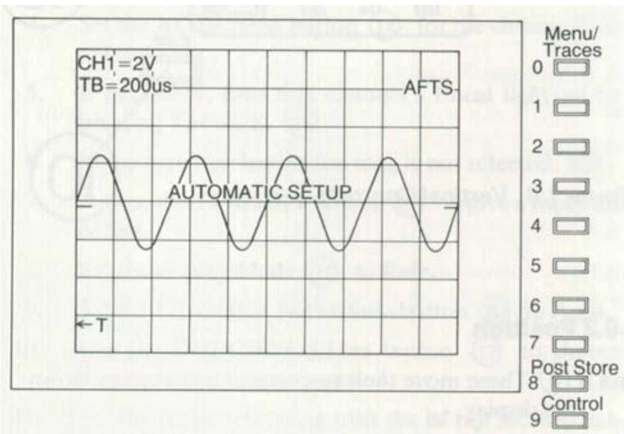


Figure 1.4.1 *An AUTO SETUP Display*

1.4.2 Channel Selection (Off/On/Inv) (13)

A channel may be switched on or off with its Off/On/Inv button. If the channel is on, its trace can be displayed in either normal or inverted mode.

Off The channel is deactivated.

On The trace is a true representation of the input signal. Inv The

input signal is inverted before being displayed. If

there is any DC component in the signal this will also be inverted and could cause the trace to disappear from the screen. Such an unwanted DC component can be removed by selecting AC coupling. Any vertical shift applied to the trace is not inverted. The trigger point remains at the same point on the waveform regardless of inversion.

1.4.3 Coupling (AC/DC/Gnd)(14)

These buttons control the type of coupling between the input signal and the instrument. DC is the most generally applicable, and AUTO SETUP will normally set this control to DC, where possible.

The input impedance is I M ohm in parallel with a capacitance of 28pF.

AC This is used to remove any DC component from input signals. Suitable input signals (i.e. the bandwidth) are from 4Hz to 20MHz.

Gnd The input signal is internally disconnected from the inputs and the amplifier grounded. A OV reference signal is displayed.

DC The input signal is directly coupled to the instrument so all frequency components of the input signal will be displayed. The bandwidth will be from DC to 20MHz.

1.5 Horizontal Adjustments

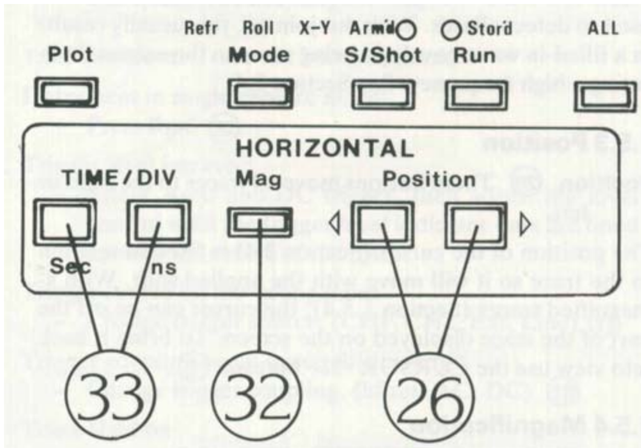


Figure 1.5 *Horizontal Controls*

1.5.1 TIME/DIVISION

TIME/DIV (33) These buttons control the sweep rate of the trace. The timebase can be varied from 100ns/div to 50s/div in a I, 2, 5 sequence of values. The button marked 'ns' decreases the time/div, the button marked 'sec' increases the time/div.

With a timebase of say 200/Ls, each horizontal screen division represents 200/Ls worth of signal. The timebase is shown near the top of the display - e.g. TB=200/Ls.

Assuming a 2kHz signal is applied as mentioned earlier, when the timebase is set to 500ms/div, an interesting phenomenon may appear: an 'alias'.

1.5.2 Aliases

An alias is a false image. The instrument is a digital oscilloscope and so takes frequent samples of the input signal in order to update the trace. Thus, if the signal frequency is higher than the sample frequency, one sample will be taken from a particular point on the waveform and the next sample may be taken from a point slightly further along on a subsequent cycle. It will then display the wave as being much slower than it really is. See Figure 1.5.2. This effect is only likely to occur if there are more than 100 cycles of waveform across the screen.

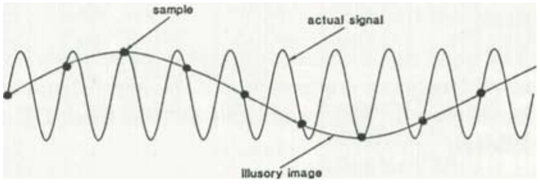


Figure 1.5.2 *Alias Generation*

There is a 'Max/Min' glitch detection feature which can be used to detect aliases. With dot join on, this usually results in a filled-in wave envelope being seen on the screen, indicating a high frequency. See Section 3 *A*.

1.5.3 Position

Position (26) These buttons move all traces to the right or left.

The position of the cursor (Section *2.4)* is fixed in relation to the trace so it will move with the applied shift. With x-magnified traces (Section 1.5.4), the cursor can be off the part of the trace displayed on the screen. To bring it back into view use the CURSOR < > buttons(5).

1.5.4 Magnification

Mag (32) Switches horizontal magnification on or off When switched on, a xl0 expansion is applied to any displayed trace, which will expand around the centre of screen. The timebase setting is adjusted to reflect the expansion.

The instrument displays 50 dots (samples) per screen division, each plotted dot value being obtained from the 512 byte acquisition memory. At an expansion of x 10. there are five dots per division.

1.6 Vertical Adjustments

Each channel has its own set of vertical controls. See Figure 1.6.

1.6.1 VOL TS/DIVISION

V/DIV (11) Adjusts the sensitivity of the instrument over discrete calibrated ranges from 2m V to 5V per screen division in 1,2,5 steps. With a x10 probe the ranges are 20mV to 50V per division at the probe tip. See Section 3.4.1. If the Uncal light is on, then these buttons vary the sensitivity continuously. See Section 1.6.3.

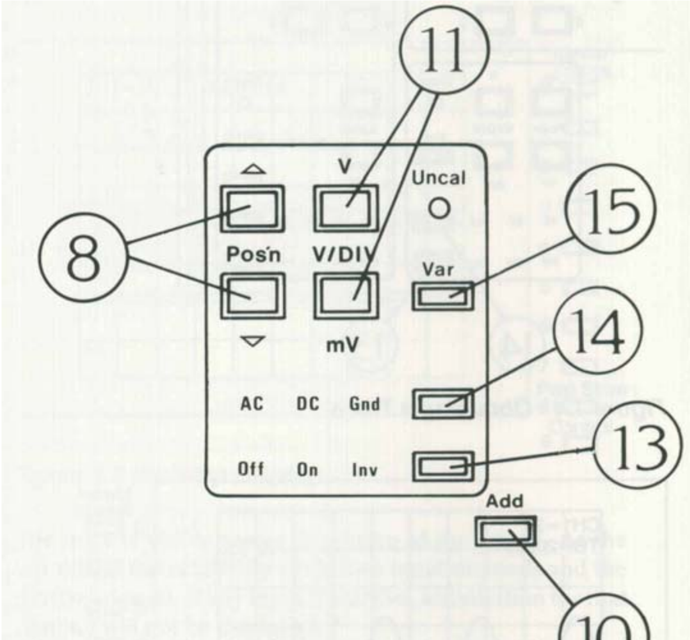


Figure 1.6 Vertical Controls

1.6.2 Position

Pos'n (8) These move their respective traces up and down the display.

If Trace **Hold** is on (Section 2.2) or a S/Shot capture has been made, any part of the trace which was captured off-screen vertically will be shown by a horizontal line.

1.6.3 Variable/Uncalibrated

Var (15) When this is set to 'Uncal', the coarse setting of the attenuator remains unchanged, but a variable attenuation is applied to the input signal in the range of 1 to *004.* Thus, with an initial setting of IV, the actual sensitivity of the channel could be set by this control to anywhere between I V and 2.5V per division. The V/DIV buttons are used to vary the uncalibrated sensitivity.

Example screen display:

CH1 =5V Channel is set to a sensitivity of 5 Volts per screen division.

CH2>20mV Channel 2 is uncalibrated and the attenuator is set to a sensitivity greater than 20m V per screen division.

1.6.4 Add

Add (10) Displays the sum, or if one channel is inverted the difference, of the input signals. The original traces disappear and the resultant trace is displayed as a Channel 2 trace.

1.7 Manually Obtaining a Trace

This subsection describes how to obtain a trace without using **AUTO SETUP**.

You may need to consult later sections of the manual as not all of the operating features have been discussed so far.

1. When switched on, the instrument will go through its power-up sequence, checking the internal calibration.
2. Decide to which channel you are going to apply the signal (CH1 or CH2).
3. Make sure the chosen channel is active by setting the **Off/On/lnv** (13) for that channel to On.
4. Set the **AC/DC/Gnd** button (14) for the chosen channel to Gnd.
5. If necessary, turn that channel's **Uncal** light out by pressing **Var** once. (15)
6. Make sure that horizontal mag is not selected. (32)
7. Adjust the **TIME/DIV** setting (33) to give a timebase of *5μs*.
8. Set the display **Mode** (31) to **Refr**.
9. Set the TRIGGER **Norm/Auto** button (20) to Auto.
10. Use the **CHl/CH2/Ext/Line** button (17) to choose the source for trigger signals.
11. Set the trigger coupling with the **hf rej/AC/DC** button. (18)
12. If necessary adjust the position of the trace using the **Position** and **Pos'n** buttons. (26) & (8)
13. Ensure that **Trace Hold** (25) is not selected.
14. Select **Run**. (27)
15. Apply the signal through a BNC connector to the chosen CH input socket. (9) or (12)
16. Set the **AC/DC/Gnd** button (14) for the channel to either DC or AC, as appropriate.
17. Adjust the gain of the chosen channel using the **V/ DIV** buttons (11) **.** For intermediate settings, set **Uncal** on by pressing the **Var** button once. (15)
18. Adjust the timebase setting using the **TIME/DIV** buttons. (33)
19. If the display is unstable, adjust the trigger **Level**. (22)

1.8 Operating Hints

The following list gives some of the more commonly met problems in operating digital oscilloscopes, how to correct them, and a brief explanation of what was wrong.

You may need to consult later sections of the manual as not all of the operating features have been discussed so far.

1.8.1 Problem: Traces and Alphanumerics very dim or completely disappeared.

Intensities too low

- Press the control button (7) to get the control master menu, then press numeric button 3 to select the intensity menu. Further presses of numeric button 3 will increase the brightness of the alphanumerics on the display. The traces can now be intensified using numeric button I.

Note:- *The display may not become visible until the numeric button* 3 *has been pressed several times.*

1.8.2 Problem: Trace off the top or bottom of the screen. Too much vertical shift

- correct with that channel's **Pos'n** buttons. (8)

Input has large DC offset

- AC couple input signal.
- Correct with **Pos'n** buttons. (8)
- Use a less sensitive range.

1.8.3 Problem: Trace not being acquired.

Instrument in single capture mode

- Press **Run**. (27)

Trigger level incorrect

- Select Auto and DC trigger, then adjust the level control until the trigger level indicator bars are lined up with the centre of the trace.

Trigger source on the wrong input

- Change trigger source. (CH1, CH2, Ext, Line) (17)

Trigger coupling on an unsuitable setting

- Change trigger coupling. (hf rej, AC, DC) (18)

Trace Hold on

- Release Trace Hold. (25)

Timebase on very slow acquisition

-Adjust **TIME/DIV**. (33)

1.8.4 Problem: Trace is unstable even when triggered.

Alias

- Check for alias using Max/Min (glitch detection), and select a faster timebase range.

Noisy input

- Select **hf rej** trigger coupling. (18)
- Adjust trigger **Level**. (22)

Trigger on Auto

- With low frequency inputs (below 20Hz), **Auto** trigger will initiate triggers overriding the input triggers. Select **Norm** trigger. (20)

1.8.5 Problem: Trace has a very flat top or bottom.

Trace captured when off screen vertically and **Pos'n** shift has been used

- Use less sensitive **V/DIV** range when acquiring trace. (11)
- Re-position trace prior to capture.

2 Advanced Features

2.1 Trigger Control

Trigger facilities discussed here are controllable directly from the front panel. For the more advanced menu-controlled facilities see Section 3.4.

The power-down trigger setting will be retained on future power-up.

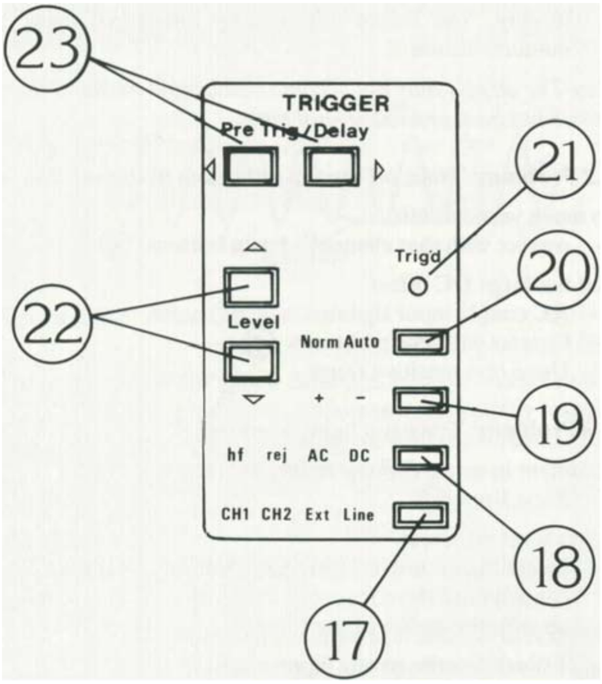


Figure 2. 1 *Trigger Controls*

2.1.1 Selecting Source and Coupling

The lowest button in the TRIGGER section of the front panel selects the source of the trigger.

CH1/CH2/Ext/line (17) Steps through the possible sources of trigger signals. When Ext is selected, the source is the 'EXT TRIG' socket (16) in the lower right corner of the front panel.

Selecting line is meaningful only if the instrument is powered from the mains. Triggering is then from an internal pulse having a fixed phase relation to the mains voltage waveform. To change this phase relationship, use the trigger delay buttons. See Section 2.1.6.

hf rej/AC/DC (18) Steps through the available trigger coupling options; hf rej is a 15kHz low-pass filter ('high frequency reject'). All the couplings can be used with any source except Line, with which the input coupling is not selectable.

Table 2. 1. 1 *Useful Frequency Ranges* of *Coupling Types*

Coupling	Input
hfrej	10Hz to 15kHz
AC	4Hz to 20M Hz
DC	DCt020MHz

2.1.2 Level

The trigger level is the threshold at which the instrument will respond to potential triggers; the trace actually has to pass through the level indicated for a trigger to be valid. See Section 2.1.3.

The level is indicated on the display by two bars, one on each side. of the screen, and is adjusted by the level buttons. (22) For an internal trigger the range is approximately +/- 10 divisions and on external approximately +/ - 3V. If the trigger signal is AC coupled, the level bars will be offset from the actual trigger position on the screen by any DC offset present.

2.1.3 Trigger Point (T)

The trigger point is indicated on the display by a 'T' near the bottom of the screen underneath the trigger. An arrow next to the T indicates that the trigger point is off the screen.

2.1.4 Slope (+/-)

A trigger is generated when the selected source signal passes through the chosen trigger level. This transition may be either on a rising or a falling edge. The rising edge is considered to be a positive slope and the falling edge a negative slope.

+/- (19)This button selects positive (+) or negative (-) slope triggers.

2.1.5 Trigger Mode (Norm/Auto)

The trigger system operates in either Normal or Auto mode.

In Normal mode, display captures can only occur when a valid trigger input has been received.

In Auto mode, if no valid trigger has been received for some time the instrument will generate its own trigger and initiate a capture. This ensures that the screen is constantly updated irrespective of the input signal. However, if valid input triggers are received at a rate of 20Hz or more, the instrument will start all captures with these triggers and not generate its own.

Auto/Norm (20)This button selects which trigger mode the instrument is operating in.

Trig'd (21) This LED lights up when the instrument is receiving valid trigger signals.

2.1.6 Trigger Delay

The amount of data which is acquired for display before or after the trigger is determined by the pre or post trigger delay selected, see figure 2.1.6. The value of this delay is shown in the bottom right hand of the trace display.

Pretrig This allows a section of the trace that occurred before the trigger point to be included in the display. The amount of pre-trigger visible can be set with the front panel **PreTrig/Delay** buttons. (23) Pre-trigger can be set anywhere between 0% and 100% of screen width, in steps as small as 0.4%.

Trig Delay With this set, the oscilloscope will acquire a trace following both the specified trigger and a specified delay. The amount of delay is shown beside the 7 key. Delay is controlled by the **PreTrig/Delay** keys. (23) The size of the steps by which the delay can be incremented or decremented is controlled by the **TIME/DIV** keys, i.e., step size is 0.04 x the time/ div setting. This can be demonstrated by varying both the timebase and delay settings, while observing the last two lines of the Display and Trigger Menu (See section 3.4). Once set, the delay time remains the same regardless of the selected timebase range.

2.2 Capture Facilities

The capture facilities allow the traces to be frozen.

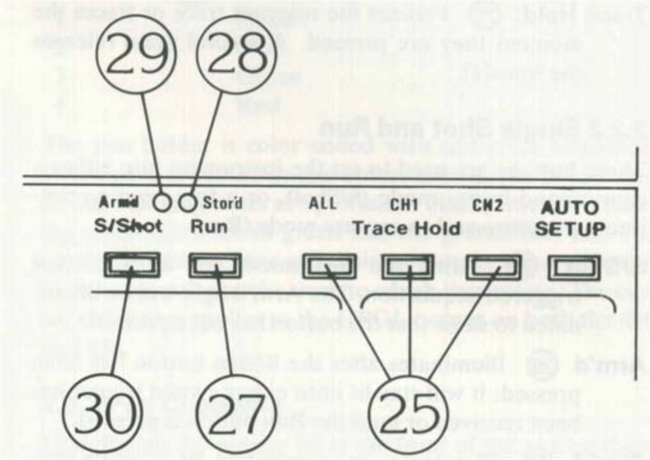


Figure 2.2 The Capture Controls

2.2.1 Trace Hold

There are two ways to freeze the display: a single-shot capture whereby a full trace is acquired then frozen (Section

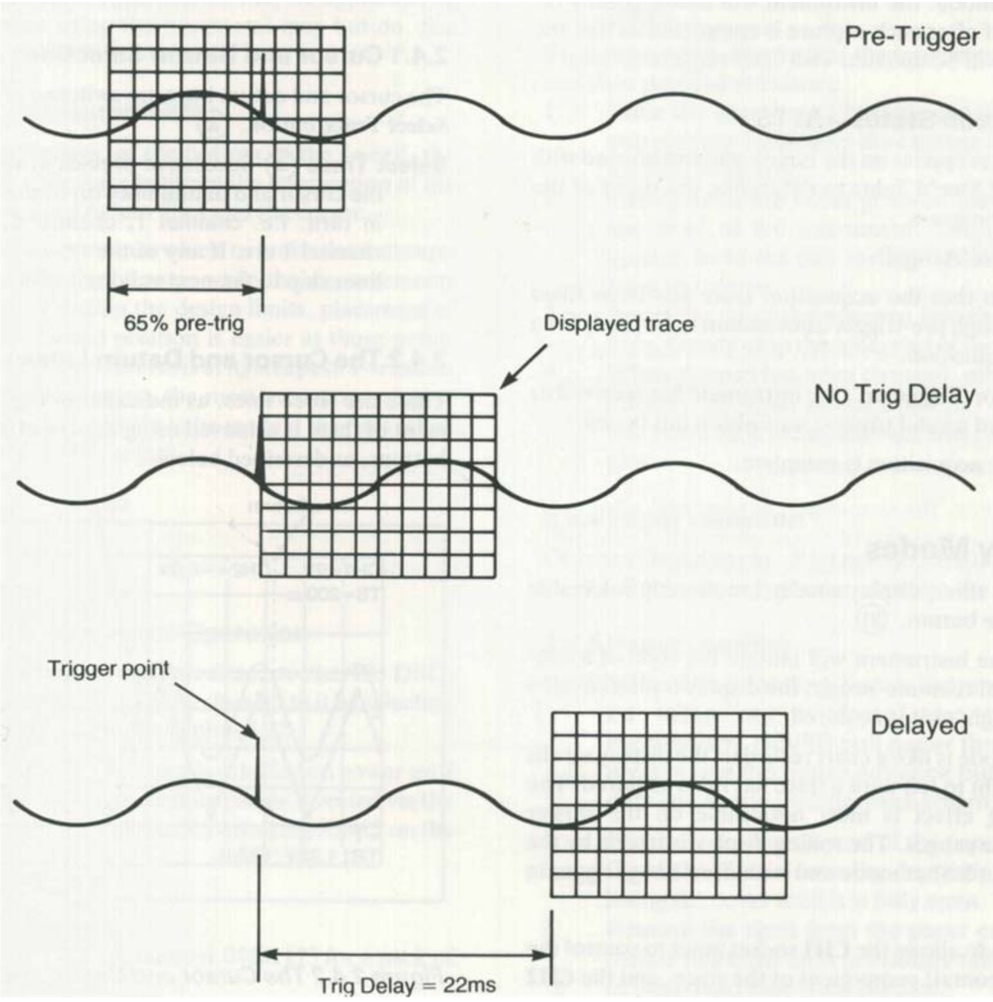


Figure 3.4a Trace Capture with Delay

2.2.2), or by pressing one of the buttons labelled **Trace Hold**.

Trace Hold: (25) Freezes the relevant trace or traces the moment they are pressed. A second press releases the trace(s).

2.2.2 Single Shot and Run

These buttons are used to set the instrument into either a capture-and-freeze mode **(S/Shot***),* or a free running continuous capture and re-capture mode **(Run)**.

S/Shot (30) Arms the instrument for a single-shot triggered acquisition. The Arm'd light will be illuminated to show that the button has been pressed.

Arm'd (29) Illuminates after the **S/Shot** button has been pressed; it will stay lit until either a valid trigger has been received or until the **Run** button is pressed.

Stor'd (28) Illuminates on completion of a single-shot acquisition. This is after the instrument has been Arm'd, triggered and a complete trace acquired. The light will stay on until the instrument is re-armed by pressing **S/Shot** again or **Run** is pressed.

Run (27) This button puts the instrument in continuous capture mode: the instrument will automatically rearm itself after each capture is completed so that the display will be updated with each triggered sweep.

2.2.3 Acquisition Status - AFTS

These characters appear on the screen and can be used with the **Arm'd** and **Stor'd** lights to determine the 'status of the acquisition in progress.

A Stands for 'Armed'.

F Indicates that the acquisition store has been filled with enough pre-trigger information to be ready for a fresh acquisition.

T Stands for 'Triggered': the instrument has received or generated a valid trigger; acquisition has begun.

S 'Stored': acquisition is complete.

2.3 Display Modes

The following three display modes are directly selectable using the **Mode** button. (31)

Refreshed The instrument will imitate the style of a conventional realtime 'scope: the display is plotted from left to right as it is acquired.

Roll This mode is like a chart recorder: the display scrolls from right to left until a trace has been acquired. The scrolling effect is most noticeable on the slower timebase ranges. The rolling display is frozen by the trigger in S/Shot mode and is unaffected by trigger in Run.

X-V This mode allows the CH1 socket input to control the X (horizontal) component of the trace, and the CH2 socket input to control the Y (vertical) component. It provides an X- Y display of the data captured by the time base and trigger systems. The timebase should be set slow enough to capture the whole of the signal of interest. This mode is not available with magnified traces (**Mag**).

2.4 Cursor Measurements

The instrument allows you to take direct measurements from the screen display automatically, using inbuilt datum lines and cursor.

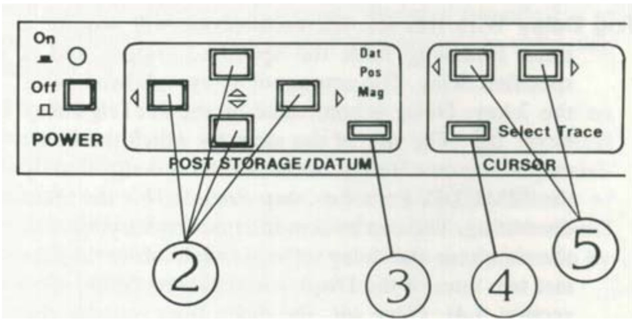


Figure 2.4 *The Cursor and Datum Line Controls*

2.4.1 Cursor and Datum Selection

The cursor and datum lines are switched on or off using the **Select Trace** button. (4)

Select Trace (4) Successive presses of this button places the cursor and datum lines on to the displayed traces in turn. i.e. channel, channel 2, reference, off, channel etc. If any of the traces are not in use the lines skip to the next valid selection.

2.4.2 The Cursor and Datum Lines

There are three lines, as indicated in Figure 2.4.2. Movement of them is aCH1eved using the **DATUM** and **CURSOR** buttons, as described below.

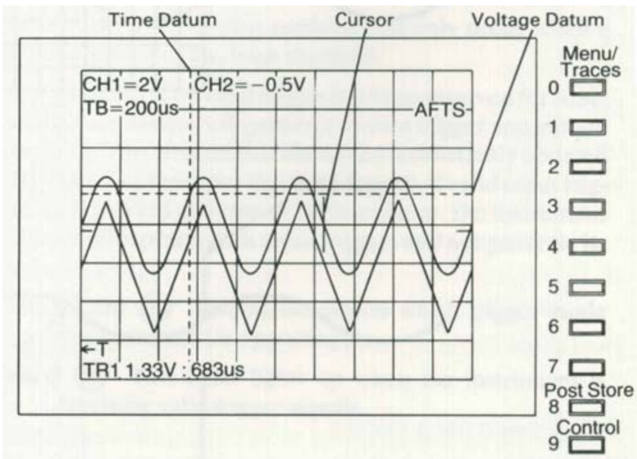


Figure 2.4.2 *The Cursor and Datum lines*

Dat Selecting this option on the **Dat/Pos/Mag** button (3) allows the position of the datum lines to be controlled using the **DATUM** buttons. (2)

DATUM (2) Used for moving the two datum lines. **CURSOR** (5) Moves the cursor to the right and left along the trace.

Pos/Mag These selections on the **Dat/pos/mag** button (3) allow the **DATUM** buttons to control post storage position and magnitude. They can only be used with stored waveforms. Pressing menu button 1 (opposite the restore message) will cancel the effect of pos and mag on the selected trace i.e. the one with the cursor on it.

Pos This option on the **Dat/Pos/Mag** button (3) allows both X and Y shift to be applied to the trace on which the cursor is placed, using the **POST STORAGE/ DATUM** keys. (2)

Mag The vertical magnitude of the selected trace can be varied from X4 to XO.062, using the **POST STORAGE/DATUM** keys. (2) The magnification factor is displayed near the top centre of the CRT.

No horizontal magnification is available using this control, but x10 magnification may be applied to all stored traces using the horizontal mag button. See Section 1.5.4).

2.4.3 Making Measurements

The instrument displays, at the bottom of the screen, the time and voltage difference between the intersection of the horizontal and vertical datum lines and the cursor.

The choice of points between which to make the measurements can influence the accuracy: while the measurements made will always be within the design limits, placement of the cursor at the desired position is easier at those points where the slope of the waveform is at its steepest. For example, on a standard sine wave, the most accurate measurements of wavelength are likely to be made if they are taken between two OV crossing points.

2.5 Plot

2.5.1 Internal Colour Plotter Operation

When the internal colour plotter is fitted to the 400 OSO, plots of the instrument's display can be sent to it by selecting internal on the Plot Menu, see section 3.12.

The internal plotter is automatically selected on power up if it is fitted. If required the plot output can be directed via the RS423 port to an external plotter by selecting RS423 on the Plot Menu, see section 3.12.

2.5.2 Pens

Only use Gould pens - part number 04101175 for a pack of 4; 1 of each colour.

The normal pen sequence is:

Pen No.	Colour
1	Black
2	Blue
3	Green
4	Red

The pen holder is colour coded with this colour sequence. When pens are fitted in this order, trace 1, the border and all the alphanumerics are plotted in black, trace 2 in blue, the reference trace in green and the graticule in red. The cursor and datum lines and their measurements are plotted in the same colour as the trace to which they relate. The cursor colour also applies to the HPGL output on both the 420 and 450.

2.5.3 Pen Changing

Underneath the plotter lid at the front of the plotter there are two small blue buttons. The right hand button when viewed from the front of the OSO is the Pen change button, and the left hand one is the paper advance button.

CAUTION: When changing a pen, extreme care should be taken not to damage any of the plotter mechanism. **NEVER** move the pen carriage by hand.

To change a pen, ensure that the instrument is switched on and then proceed as follows:

1. Press the pen change button once. This rotates the pen carriage and moves the carriage to the right hand side of the plotter.
2. Gently press the white grooved eject lever towards the front of the instrument. The top pen will be ejected from the pen carriage and can be removed from the plotter.
3. Insert the tip of the new pen into the carriage guide hole. Gently snap the other end of the pen into place.
4. When the pen has been changed, press the left hand button - the paper advance button - and the carriage will move back to the left hand side ready for the next plot.

2.5.4 Paper selection

Only use Gould paper - Part number 04101165 for a pack of 8 rolls. Other paper types may damage the mechanism.

2.5.5 Paper Loading

CAUTION: When loading paper, extreme care should be taken not to force any of the plotter mechanism. NEVER pull paper through by hand, always use the paper advance button to prevent damage to the plotter mechanism.

1. With scissors, cut the end of the paper square.
2. Open the plotter cover by depressing the catch and lifting the cover until it is fully open.
3. Remove the shaft from the paper cradle and if the plotter has been used previously remove the plastic or cardboard tube from the shaft.

4. Insert the shaft through the paper roll and fit the roll into the paper cradle.
5. Feed the paper from the top of the roll as shown in figure 2.5.5 below and push it through the slot in the rear of the printer mechanism.
6. Press the paper advance button - the left hand blue button at the front of the printer assembly - until the paper reappears at the front.
7. Feed enough paper through to pass through the top cover, ensure that it is running around the mechanism smoothly and that it is straight.
7. Close the plotter cover and ensure that it latches shut.

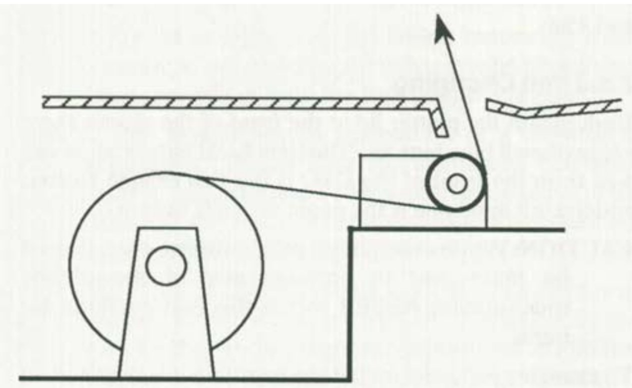


Figure 2.5.5. *Paper Loading*

2.5.6 Internal Plotting

When a plot is initiated, the Hold All lamp lights and the message "PLOTTING - PRESS PLOT TO ABORT" appears on the screen. After about 9 seconds the hold All lamp goes out indicating that the data has been transferred to the plot buffer and that the instrument can be used again. The plotting message will remain on the screen until the plot is complete when it will disappear.

In Auto Plot Mode, the instrument is re-armed after the plot data has been transferred to the plot buffer, but the front panel controls will remain in-active during plots.

If the plot button is pressed while the plot is in progress, the plot will be aborted. Any changes to the instrument status during a plot will have no effect on the plot as the data has already been transferred and stored in the plot buffer.

2.5.7 External plots

A plot of the display can be sent to an external plotter by pressing the plot button @ . The parameters for the plotter and the plot format can be set as described in section 3.7 and 3.12.

The display is held while a plot is in progress.

Plots can be aborted by a second press of the plot button. If the plot is aborted, the pen will be left in a random position and the external plotter may need to be reset to restore the pen to its start position.

2.5.8 Plot positioning and scaling

The output plot from the 400 has the relative positions shown in figure 2.5.8a. These may be shifted and scaled to position the plot exactly over a pre-defined grid using the following procedure with reference to figure 2.5.8b.

The sides of the pre-defined grid are X and Y, the exact positions of PI and P2 are found by calculating the dimensions A, B, C and D:

Measure the vertical dimension of the required grid, note this as Y.

Measure the horizontal dimension of the required grid, note this as X.

U sing these values of X and Y, A, B, C and D can be calculated as follows:

$$A = \frac{42\,Y}{240} \qquad B = \frac{196\,X}{500}$$

$$C = \frac{703\,X}{500} \qquad D = \frac{310\,Y}{240}$$

Measure and mark the exact positions of PI and P2 from the grid edges using figure 2.5.8b and the values obtained above.

The PI and P2 points can now be set on the plotter, refer to the plotter manual for details.

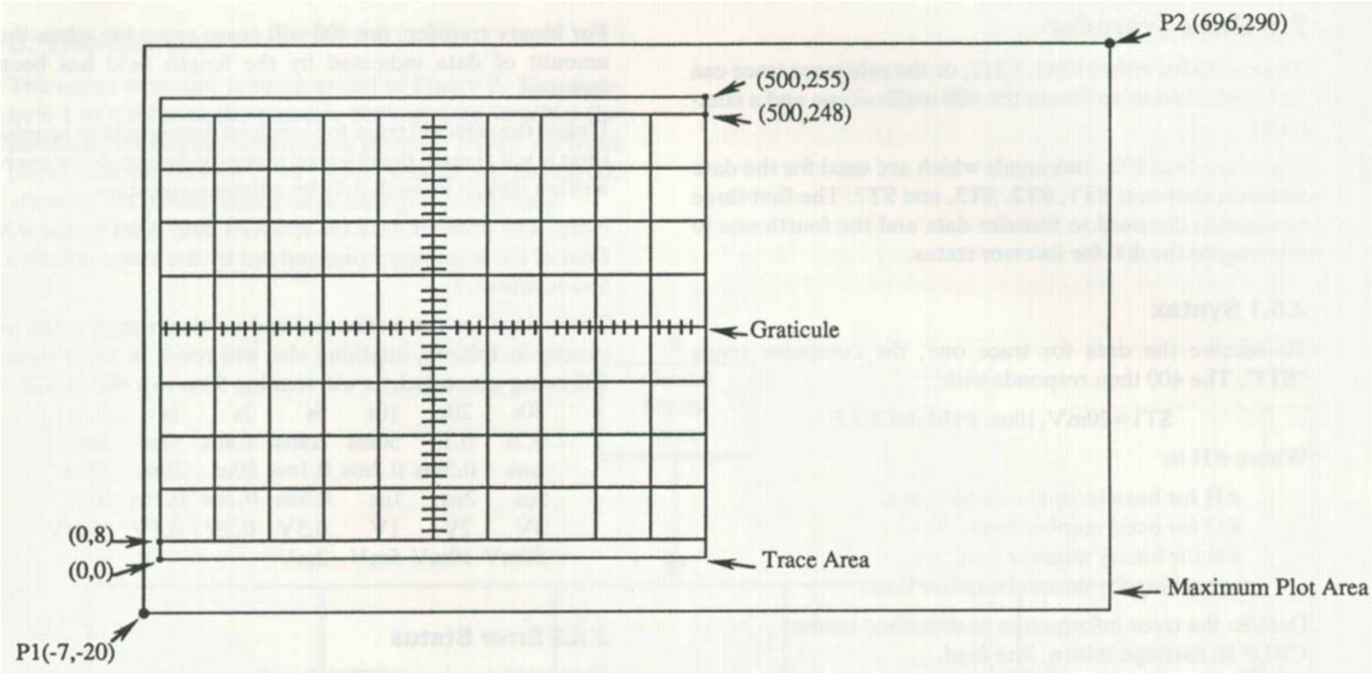


Figure 2.5.8a Relative Plot Positions

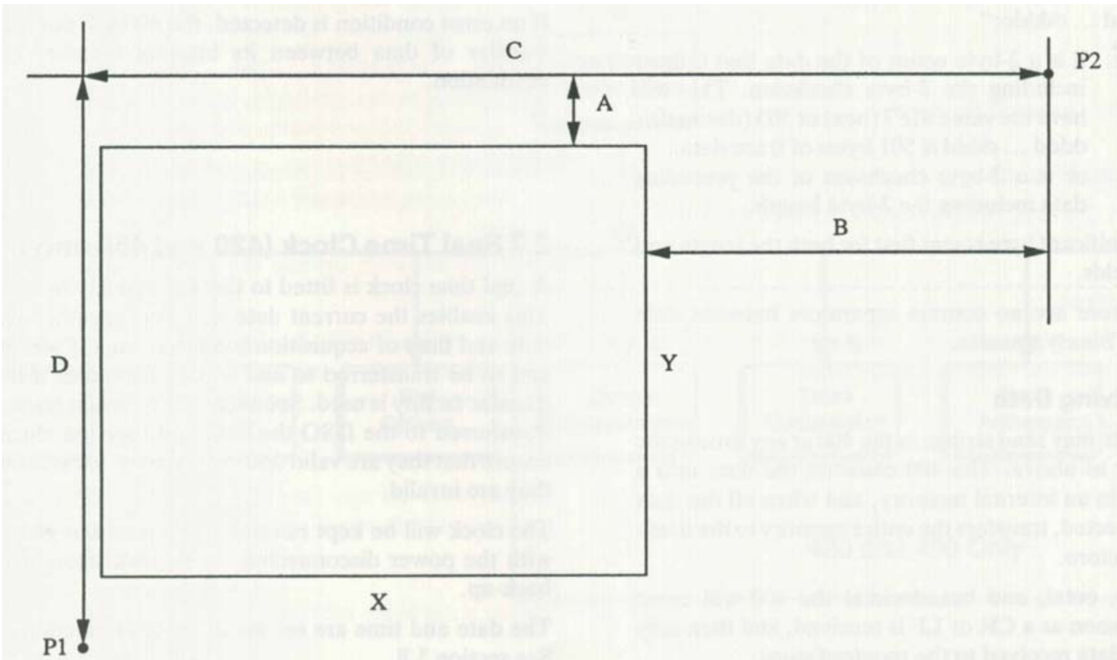


Figure 2.5.8b Plot Dimensions

2.6 Data Transfer

Trace data for either CH1, CH2, or the reference trace can be transferred to and from the 400 oscilloscope and a computer.

There are four I/O commands which are used for the data transfer, they are: ST1, STI, ST3, and ST? The first three commands are used to transfer data and the fourth one to interrogate the 400 for its error status.

2.6.1 Syntax

To receive the data for trace one, the computer sends "STl".
The 400 then responds with:

STl =20m V, 10us, # HdataCRLF

Where #H is:

#H for hexadecimal number base, #0
for octal number base,
#B for binary number base,
or nothing for decimal number base.

Data is: the trace information as described below.
CRLF is: carriage return, line feed.

If the 400 receives ST3 and the reference trace is unused, the 400 will respond with "ST3=UNUSED"

Note: When data is being sent to the 400 #D may be used for decimal number base.

For decimal, octal and hexadecimal, the "data" field consists of 501 data points separated by commas.

For binary transfer, the "data" field is as follows:
"lldddd ... ddddcc"

Where: ll is a 2-byte count of the data that follows including the 2-byte checksum. This will have the value 01F7 (hex) or 503 (decimal). dddd ... dddd is 501 bytes of trace data.
cc is a 2-byte checksum of the preceding data including the 2-byte length.

The most significant byte is sent first for both the length and checksum fields.

Note that there are no comma separators between data bytes during binary transfer.

2.6.2 Receiving Data

The computer may send strings to the 400 at any time in the same syntax as above. The 400 converts the data into a binary form in an internal memory, and when all the data has been collected, transfers the entire memory to the destination trace store.

For decimal, octal, and hexadecimal the 400 will cease receiving as soon as a CR or LF is received, and then only transfer the data received to the required store.

For binary transfer, the 400 will cease receiving when the amount of data indicated by the length field has been received.

Unless the selected trace for received data is held or acquisition is not armed, the selected memory data could be overwritten almost immediately by a fresh acquisition.

Note: The number base for received data is set by the #X field of the incoming string and not by the menu selection. See section 3.7

The strings for the horizontal and vertical ranges must be exactly as follows, anything else will result in error status 102 being generated, as will sending 50ns to a 400 or 420.

50s 20s 10s 5s 2s Is 0.5s
0.2s 0.ls 50ms 20ms10ms 5ms 2ms
1ms 0.5ms 0.2ms 0.1ms 50us 20us 10us
5us 2us 1µs 0.5µs 0.2µs 0.1µs 50ns
5V 2V IV O.SY 0.2V 0.1V 50mV
20mV 10mV 5mV 2mV

2.6.3 Error Status

If the 400 receives "ST?", it will respond with a decimal error status string as follows:

0 No error
96 Invalid command
102 Syntax error
103 Number out of range
104 Length error - Binary transfer only 105
Checksum error - Binary transfer only

If an error condition is detected, the 400 will not make the transfer of data between its internal memory and the destination.

2.7 Real Time Clock (420 and 450 only)

A real time clock is fitted to the 420 and 450 instruments. This enables the current date and time together with the date and time of acquisition to appear on any screen plot, and to be transferred to and from a computer if the data transfer facility is used. See section 2.6. When trace data is transferred to the DSO the date and time are checked to ensure that they are valid and syntax error 102 is returned if they are invalid.

The clock will be kept running for at least ten years, even with the power disconnected, by its own internal battery back-up.

The date and time are set via the special functions menu. See section 3.8.

3. The Menus

The menu structure is summarised in Figure 3. The numbers 1 to 9 refer to the numeric buttons used to select the particular menus and menu items (Section 3.1.1). All front panel controls remain "live" when menus are displayed, allowing the control status to be changed at any time.

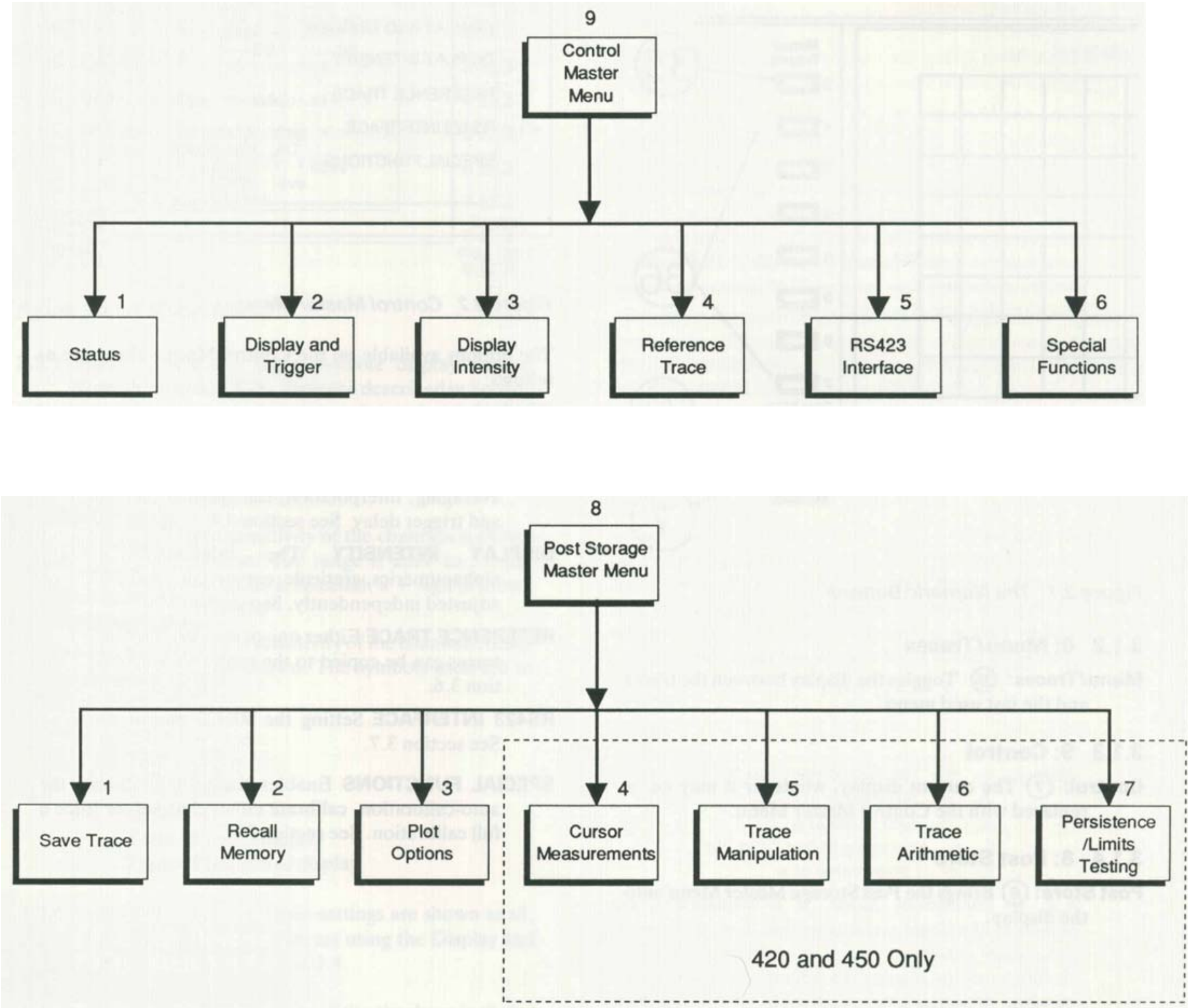


Figure 3 *Menu Overview*

3.1 Additional Buttons

3.1.1 The Numeric Buttons

The buttons 1 to 7 (36) are used in conjunction with the menu system to provide a large number of extra functions not otherwise available directly from the front panel. Pressing these buttons when the menus are displayed operates the menu functions described in Sections 3.2 to 3.12. Buttons **0, 8** and **9** have extra functions described below.

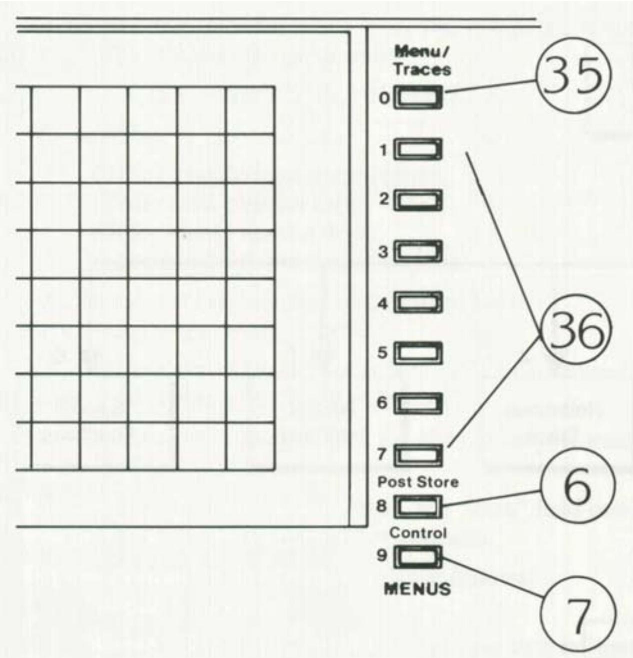


Figure 3. 1 *The Numeric Buttons*

3.1.2 0: Menu/Traces

Menu/Traces: (35)Toggles the display between the traces and the last used menu.

3.1.3 9: Control

Control: (7) The current display, whatever it may be, is replaced with the Control Master Menu.

3.1.4 8: Post Store

Post Store: (6) Brings the Post Storage Master Menu onto the display.

3.2 Control Master Menu

Each entry on the Control Master Menu is also a menu, covering one set of functions. The text is lined up with the numeric buttons **1-7** on the side of the display. To obtain any secondary menu simply press the relevant button.

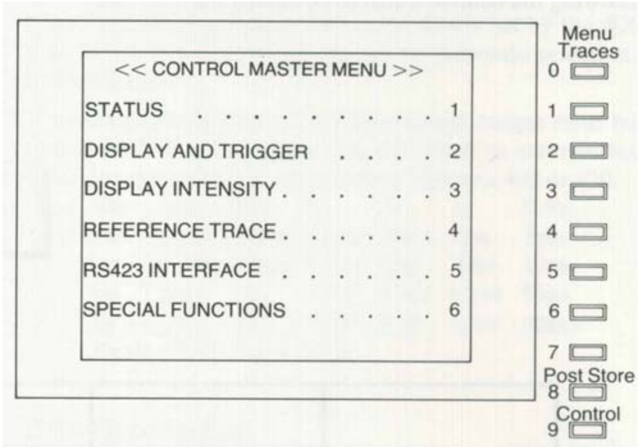


Figure 3.2 *Control Master Menu*

The options available on the Control Master Menu are as follows:

STATUS Displays information about the present setup of the instrument. See section 3.3.

DISPLAY AND TRIGGER Controls probe sensitivity, averaging, interpolation, the glitch detect function, and trigger delay. See section 3.4.

DISPLAY INTENSITY The brightness of the alphanumerics, graticule, cursor and traces can all be adjusted independently. See section 3.5.

REFERENCE TRACE Either one of the currently displayed traces can be copied to the reference trace. See section 3.6.

RS423 INTERFACE Setting the RS423 output protocol. See section 3.7.

SPECIAL FUNCTIONS Enables the user to disable the auto-calibration, calibrate either channel, or force a full calibration. See section 3.8.

3.3 Status Menu

This menu allows the various horizontal, vertical and trigger settings of the instrument to be viewed. A typical display is shown in Figure 3.3.

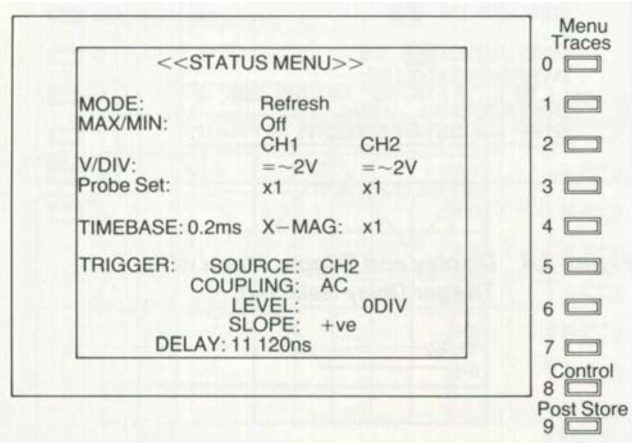


Figure 3.3 *A Status Menu*

3.3.1 Mode: There are three possible display modes: Refresh, Roll and X- Y. They are described in Section 2.3.

3.3.2 Max/Min: The glitch detector is selected using the Display and Trigger Menu. See Section 3.4.

3.3.3 V/Div: The input sensitivity of the channels is shown in volts per division. The range is 2mV to 5V per division. If Add mode is selected, a + sign is shown between the channels.

Along with the input sensitivity of the channels, other information is also shown. The symbols used are as follows:

– **Trace inverted**

> **Uncalibrated**

~ **AC coupled**

= **Calibrated**

↑ **Trace off top of display**

↓ **Trace off bottom of display**

3.3.4 Probe Set: The probe gain settings are shown as x 1 , x10 or x100. These may be set using the Display and Trigger Menu. See Section 3.4.

3.3.5 Timebase: The sweep rate of the timebase is shown in s, ms, /-LS or ns per division.

3.3.6 Trigger This section of the display shows the selected trigger options. The choices of source are CH1, CH2, Ext and Line. The available couplings are AC, DC and high frequency reject. These are discussed in Section 2.1.

The trigger level is shown in terms of the number of screen divisions above the bottom of the graticule. The trigger slope is shown as either +ve (rising edge) or -ve (falling edge).

Following this is the trigger delay setting, given in s, ms, /-LS or ns as appropriate. For pre-trigger operation, the figure is given as a percentage; 0% places the trigger point at the left-hand edge of the screen and 100% on the right-hand edge.

3.4 Display and Trigger Menu

This menu controls probe ratios, *maximin* detection, interpolation, and the trigger delay function.

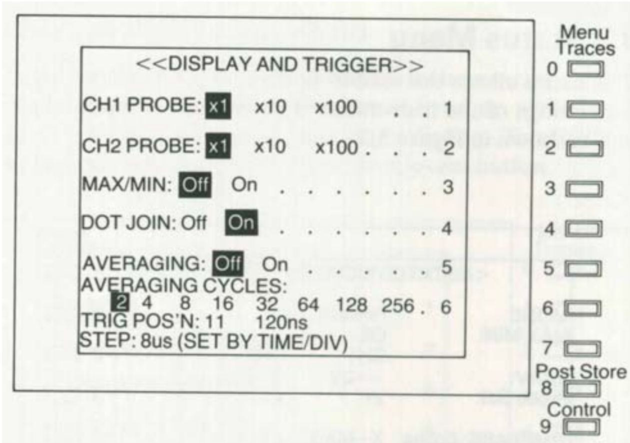


Figure 3.4 *Display and Trigger Menu with Trigger Delay Selected.*

3.4.1 Probe Ratio: An independent probe attenuation ratio can be set for each of the two input channels with successive presses of buttons 1 and 2. The ratios available are xl, x10 and x100. Thereafter, probes of the chosen ratios may be attached to the appropriate inputs; the new sensitivities at the probe tip will be displayed correctly.

3.4.2 MaxiMin: Using the number 3 key, the *maximin* or glitch detection function can be switched on or off.

The Max-Min function is designed to detect narrow glitches which may occur between samples. It operates on the signal before it is placed in the acquisition store and can detect very narrow glitches, down to 2f.Ls wide. Any glitches detected will at least be displayed as a spike. They will be detected whether they are positive (max) or negative (min). The function works in the timebase ranges of 100 microseconds per division down to 50s per division.

3.4.3 Dot Join Button 4 selects the dot-joining function.

On some X-magnified or high speed traces, gaps can be visible between the sample points; if Off is selected, the points alone will be displayed. Selecting On causes the data to be automatically joined by straight lines.

3.4.4 Averaging It is possible to improve the signal to noise ratio of repetitive signals by averaging them. This function, which converts the display into a weighted average of previous acquisitions is toggled **On** and **Off** by button 5. Button 6 is used to determine the averaging factor to be used in the algorithm

$$A_n = \frac{a_n\,(f-1) + d}{f}$$

Where: n = The data point (1 to 501)
A = New value at n
an = Old value at n
f = averaging factor (2 to 256)
d = Latest value at n

e.g. In continuous mode, if 8 acquisitions are selected, any single acquisition that deviates from an otherwise consistent level, contributes 1/8 of its deviation to the display. In **S/Shot** only the selected number of acquisitions contribute to the resultant held display.

3.4.5 Trig Pos'n: This displays the current value of either the pretrigger percentage or the post trigger delay time. The value can be altered as described in section 2.1.6. Figure 2.1.6 shows the display relative to the trigger position for both pre and delay trigger values.

3.5 Display Intensity

This menu allows independent control over the brightness of various display features.

TRACES/CURSOR: The brightness of the cursor, datum lines and all traces will be adjusted. The number 1 key increases the intensity and the number 2 key decreases it.

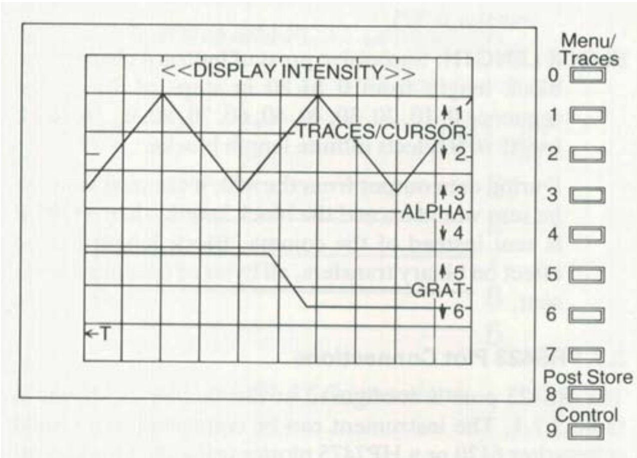


Figure 3.5 Display Intensity Menu

ALPHA: The brightness of all the alphanumerics will be adjusted. The number 3 key increases the intensity and the number 4 key decreases it.

GRAT: The brightness of the graticule (or grid) will be adjusted. The number 5 key increases the intensity and the number 6 key decreases it.

3.6 Reference Trace

The menu provides the option of temporarily storing a trace for comparison with the two Channels. It will be lost when it is replaced with an alternative trace.

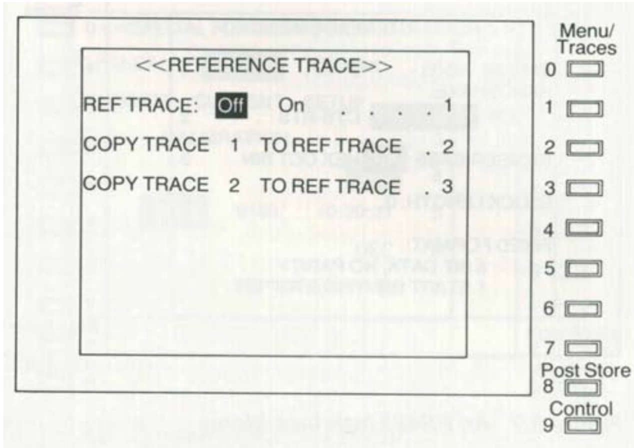


Figure 3.6 Reference Trace Menu

To copy a currently displayed *and held* trace into the reference trace, simply press either button 2 or button 3 depending on whether the held trace is in Channel or Channel 2 respectively. A copy of the trace will then be automatically taken. If the trace is not held prior to pressing the button, a fresh acquisition will be made before the copy is taken.

To display a previously stored reference trace, use the button to toggle the selection to **On.**

3.7 RS423 Interface Menu

This menu allows the parameters of the RS423 output to the remote plotter or other data handling device to be set.

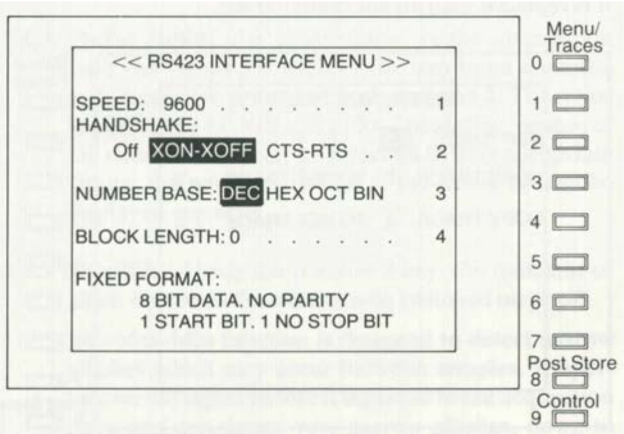


Figure 3.7 *An RS423 Interface Menu*

Data is always output with no parity, one start bit, eight data bits and one stop bit.

The data that is output is the complete waveforms, including the reference trace, plus information about the timebase and volts per division. The data is output in a form suitable for HPGL plotters, such as the Gould 6120. See section 3.12.

SPEED: This is selected with button 1. The data rate may be 75,150,300,600, 1200,2400,4800 or 9600 baud.

HANDSHAKE: Key 2 is used to select from handshaking Off, XON-XOFF, or CTS-RTS.

NUMBER BASE: Button 3 sequentially selects from decimal, hexadecimal, octal, and binary as the number base to be used in any data transmission from the 400. See section 2.6

The value range for the data points for each number base is as follows:

Decimal:

Each data point is sent as a signed decimal number. -128 represents the bottom of the screen,
0 represents the middle of the screen, and
128 represents the top of the screen.
The maximum number of characters per trace transfer is 2522

Octal:

Each data point is sent as three unsigned octal digits.
000 represents the bottom of the screen,
200 represents the middle of the screen, and
377 represents the top of the screen.
The maximum number of characters per trace transfer is 2023

Hexadecimal:

Each data point is sent as two unsigned hex digits. 00 represents the bottom of the screen,
80 represents the middle of the screen, and
FF represents the top of the screen.
The maximum number of characters per trace transfer is 1522

Binary:

Each data point is sent as a single byte.
00000000 represents the bottom of the screen,
10000000 represents the middle of the screen, and
11111111 represents the top of the screen.
The maximum number of characters per trace transfer is 525

BLOCK LENGTH: Successive press of button 4 changes the block length from 0 to 80 in steps of 10 i.e. the sequence 0, 10,20,30,40,50,60,70,80, 0 ... A block length of 0 selects infinite length blocks.

During data output from the 400, if the next value to be sent would exceed the block length, then a CRLF is sent instead of the comma. Block length has no effect on binary transfers, all bytes of data are always sent.

3.7.1 RS423 Plot Connections

The RS423 port is configured at the factory as shown in table 3.7.1. The instrument can be connected to a Gould colorwriter 6120 or a HP7475 plotter using the Gould plotter cable part number 0409-1232. The connections of this cable are shown in figure 3.7.1.

Pin No.	Name	Description
1	0V	Protective Ground
2	RXD	Receive Data
3	TXD	Transmit Data
4	CTS	Clear to send
5	RTS	Request to send
7	0V	Signal Ground
9	0V	Ground

Table 3.7. 1 *Standard RS423 Pin Connections*

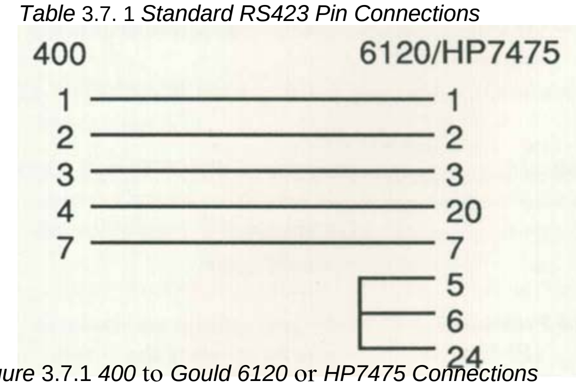


Figure 3.7.1 *400* to *Gould 6120* or *HP7475 Connections*

3.7.2 RS423 Data Connections

To connect the 400 to a computer use the connections shown in figure 3.7 .2a or figure 3.7 .2b. A prewired cable for each of these arrangements is available; part number 0410-9248 for the PC/XT and part number 0410-1247 for the AT.

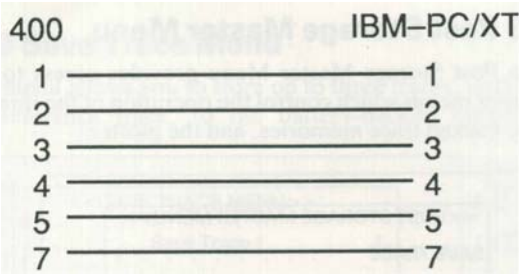


Figure 3. *7.2a 400* to *IBM-PC/XT Connections*

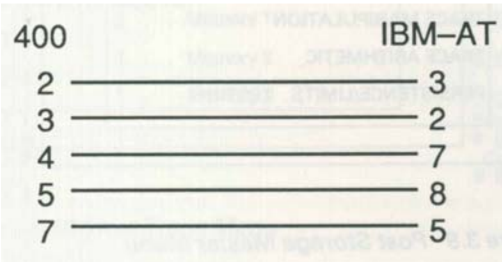


Figure 3. *7.2b 400* to *IBM-A T Connections*

3.8 Special Functions

This menu controls the selection of auto calibration and can force the instrument to perform a full calibration.

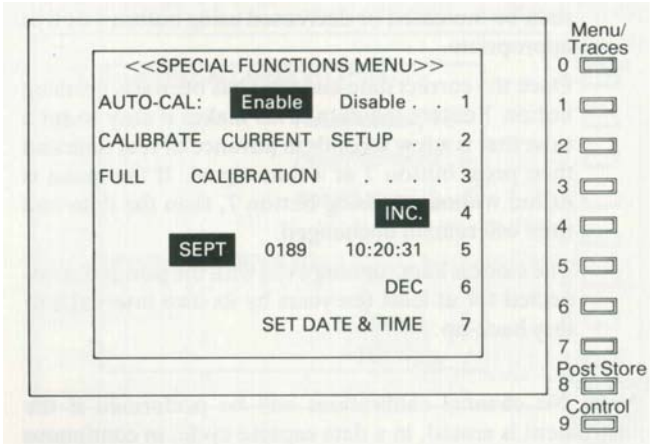


Figure 3.8 *Special Functions Menu*

AUTO-CAL: successive presses of button I enables and disables the instrument's automatic re-calibration procedure.

When Auto-cal is enabled, the change of any vertical or timebase range will, after a 2 second pause, initiate a calibration of the new operating conditions. If the operating conditions are not changed, a recalibration is initiated at 15 minute intervals, alternating between channels 1 and 2. Each calibration takes about one second.

If the occasional interruption of the normal function of the instrument is unacceptable to the user the Auto-cal facility can be disabled as described above. Recalibration is then recommended 30 minutes after switch on from cold, and additionally if there is a significant change in the ambient operating temperature.

CALIBRATE CURRENT SETUP: Pressing button 2 forces the instrument to recalibrate for the vertical range and mode and the timebase range that it is currently set at. The actual calibration occurs approximately 2 seconds are pressing the button. This feature does not operate when the instrument is in Roll mode.

FULL CALIBRATION: Button 3 forces the instrument to perform a complete internal recalibration ignoring existing information. All internal memories are cleared including the instrument status data and any stored traces. To obtain the best results from this calibration, the instrument must have been operating for a minimum of 1/2 hour. This calibration should only be required if there have been repairs to the signal processing sections of the unit or if the internal battery maintaining the status memories has been totally discharged or disconnected.

REAL TIME CLOCK (420 and 450 only): The real time clock is set using buttons Menu. The entire date and time is displayed, with one section highlighted. The highlighted element is selected using button 5 and can then be increased or decreased using button 4 or 6 as appropriate.

Once the correct date and time has been set, pressing button 7 enters the data. This makes it easy to set a time that is a few seconds in advance of real time and then press button 7 at a time signal. If the menu is exited without pressing button 7, then the date and time will remain unchanged.

The clock is kept running even with the power disconnected for at least ten years by its own internal battery back-up.

Note: No channel calibrations will be performed if the instrument is armed, in a data capture cycle, in continuous roll mode or if Auto-cal is disabled, they will simply be postponed until these conditions end. Full calibration is always available.

If the unit is unable to complete any of the above self calibrations. an error message will appear. See appendix 1. These messages should only occur if there is a major fault requiring the unit to be serviced.

When performing a full calibration connect a SOn termination to the Ext Trig input. This ensures that the trigger input is correctly calibrated for a SOn source signal.

3.9 Post Storage Master Menu

The Post Storage Master Menu provides access to three further menus which control the operation of the three battery-backed trace memories, and the plotter.

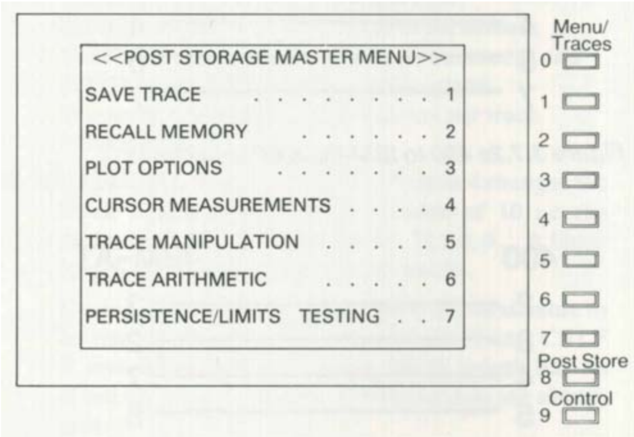


Figure 3.9 *Post Storage Master Menu*

Lines 4 to 7 only appear on a 420 or 450 instrument and are the waveform processing functions. Their operation is fully described in section 5.

3.10 Save Trace Menu

This menu allows you to store up to three traces, including the reference trace, to the battery-backed memories.

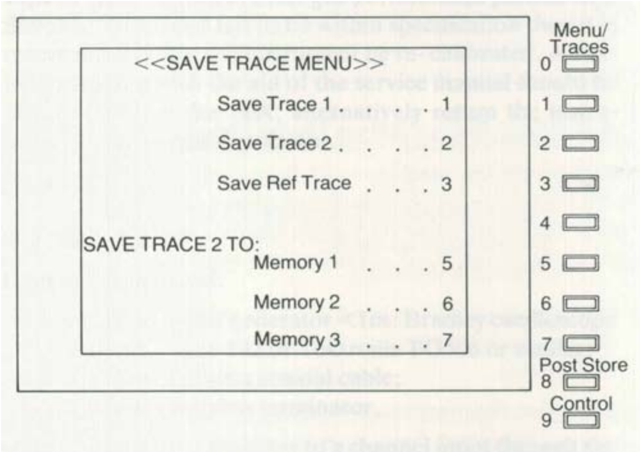


Figure 3. 10 Save Trace Menu

Because these memories are battery-backed, the traces stored in them will not be lost even when the instrument is powered down.

SAVE TRACE: Using the **1,** 2 or 3 keys selects either Trace 1, Trace 2 or the Reference Trace respectively to be saved. Once the trace has been selected, a fresh option will appear, described below.

SAVE TRACE TO MEMORY: Any of the three battery backed memories may be selected.

3.11 Recall Memory Menu

Traces previously saved using the Save Trace menu can be recalled using this menu.

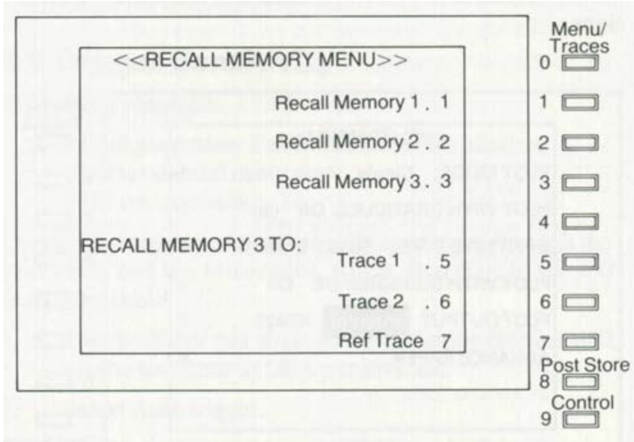


Figure 3. 11 Recall Memory Menu

RECALL MEMORY One of the three memories may be recalled by pressing the button 1,2 or 3. Having chosen a memory, you will be asked into which display trace you would like to place it.

RECALL MEMORY TO TRACE Pressing button 5, 6 or 7 will cause the trace data from the previously selected memory to be displayed on trace 1, trace 2, or the reference trace.

NOTE: *Unless the selected trace* is *held, or acquisition* is *not armed, the selected memory data could be overwritten soon after it* is *displayed.*

3.12 Plot menu

This menu allows the user to set the format of the plot sent to the internal colour plotter or to the external plotter via the RS423 interface. Refer to Section 3.7 for RS423 connections.

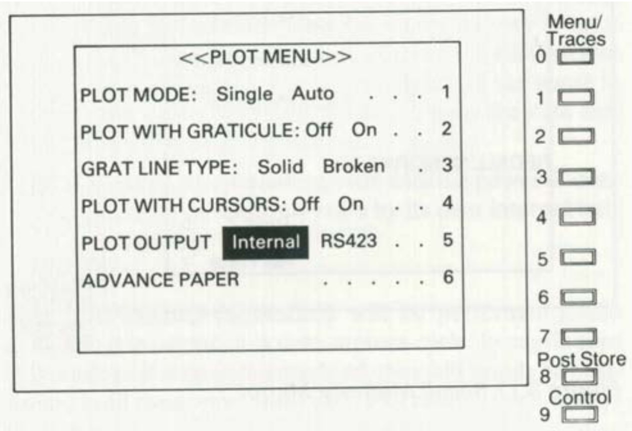


Figure 3.12 *Plot Menu*

PLOT MODE: This can be set to either Single or Auto with successive presses of the number 1 button. In Single plot mode one press of the Plot button wil1 produce one plot output. In Auto mode, a press of the plot button will initiate a plot. The sequence thereafter continues automatically. At the end of the plot the trigger circuit is rearmed for the next acquisition, and at the end of an acquisition, the plot is started. An external plotter must have an auto feed facility to function correctly in this mode. If it does not, then the feed command from the 400 may confuse the plotter.

PLOT WITH GRATICULE: The user has the option of including the screen grid in the plots with On or excluding it with Off.

GRAT LINE TYPE: A solid or broken graticule can be selected for the plot, by successive presses of button 3.

PLOT WITH CURSORS: If On is selected, then any plots made will include the cursor and datum lines. Otherwise, they will be omitted.

PLOT OUTPUT: This line only appears if the instrument is fitted with an internal colour plotter. The internal plotter is automatical1y selected on power up if it is fitted. If required the plot output can be directed, via the RS423 port, to an external plotter by selecting RS423 with button 5.

ADVANCE PAPER: Pressing button 6 when the internal plotter is selected causes the paper to be advanced approximately 15mm per press. This line only appears if the internal plotter is selected on line 5.

4. Performance Checking

The aim of this section is to allow the user of a 400 oscilloscope to verify the major analogue performance parameters. Should any of these fail to be within specification then it is recommended that the instrument be re- calibrated. A skilled technician with the aid of the service manual should be able to perform this task; alternatively return the instrument to your Gould distributor.

4.1 Risetime

Equipment required:

Fast edge pulse generator <Ins: Bradley oscilloscope calibrator type 192 or Tektronix PG506 or similar; 50 Ohm precision coaxial cable;
50 Ohm precision terminator.

Connect the pulse generator to a channel input through the coax cable and the terminator, which should be at the 400 end of the cable.

1. Select 100mY per division on the input channel and set the timebase to *Suss* per division.
2. Set the generator to give 600mY peak to peak at a repetition rate of 1 MHz and adjust the trigger level to give a stable trace.
3. Select the cursor and change the time base to 500ns per division.
4. Apply x10 trace magnification using the Mag button to give 50ns per division, and adjust the horizontal Position buttons to centre the fast edge.
5. Position the cursor and datum lines on the edge such that the cursor is 60m Y below the high level and the datum lines cross 60m Y above the low level.

The rise time can now be read from the cursor line on the bottom row of text. This figure should not be greater than 18ns.

4.2 Bandwidth

Equipment required:

Levelled signal generator: Tektronix SG503 or similar;
50 Ohm coaxial cable;
50 Ohm terminator.

Connect the signal generator to a channel input through the coax cable and the terminator, which should be at the 400 end of the cable.

1. Select 5mY per division on the input channel and set the timebase to 50jLs per division.
2. Set the amplitude of the signal generator to give six divisions at 50kHz or similar reference frequency.
3. Change the timebase range to 500ns per division.
4. Increase the frequency on the signal generator until the peak to peak amplitude reduces to 4.2 divisions.

The measured frequency should be greater than 20MHz.

4.3 Trigger Sensitivity

Equipment required:

Signal generator: Tektronix SG503 or similar; 50 Ohm coaxial cable;
50 Ohm terminator.

Connect the signal generator to a channel input through the coax cable and the terminator, which should be at the 400 end of the cable.

1. Select 100mY per division on the input channel and set the timebase to 50jLs per division.
2. Select Auto trigger.
3. Set the signal generator to 50kHz or similar reference frequency and adjust the amplitude to give 0.3 of a division peak to peak.
4. Select AC Coupling and Norm on the trigger controls.

It should be possible to find a suitable trigger level to obtain a stable triggered picture.

4.4 Trigger Bandwidth

Equipment required:

Levelled signal generator: Tektronix SG503 or similar;
50 Ohm coaxial cable;
50 Ohm terminator.

Connect the signal generator to a channel input through the coax cable and the terminator, which should be at the 400 end of the cable.

1. Select 100m Y per division on the input channel and 500ns per division on the timebase.
2. Set the signal generator to 20MHz and adjust its amplitude to give one and one half divisions on the screen.

It should be possible to adjust the trigger level to give a stable triggered trace.

4.5 Timebase Calibration

Equipment required:

Time calibrator: Bradley oscilloscope calibrator type 192 or Tektronix TG501 or similar;
50 Ohm coaxial cable;
50 Ohm terminator.

Connect the calibrator to a channel input through the coax cable and the terminator, which should be at the 400 end of the cable.

1. Select a suitable timebase range to view the signal and set the channel attenuator to give between two and five vertical divisions of signal.
2. Select DC Coupling and Norm on the trigger controls.
3. Adjust the trigger level to give a stable trace.
4. Change the timebase to 500ns per division.
5. Set the calibrator to produce markers every 500ns.
6. Select the cursors.

With the cursor and time datum on identical positions on any two markers, the time difference should read in multiples of 500ns to within 1 %.

Note: *Failure of this specification point is indicative of a major system fault and the instrument should be serviced immediately.*

4.6 Vertical Calibration

Equipment required:

Oscilloscope calibrator: Bradley type 192 or similar;
Coaxial cable.

Connect the vertical calibration output of the oscilloscope calibrator to the 400 through the coax cable.

1. Set the timebase to *500ILs* per division and select 5m V per division for the input channel.
2. Set the calibrator to give 25mV peak to peak, i.e. 5 screen divisions.
3. Adjust the trigger level to give a stable picture.
4. Switch the cursor on.

The peak to peak measurement should be 25m V to within 3% and the trace should be 5 divisions high to +/- 0.1 divisions.

These measurements should be repeated on all the attenuator ranges, each time setting the calibrator to 5 screen divisions for the selected range.

4.7 Max-Min (Alias Detector)

Equipment required:

Signal generator: Tektronix SG503 or similar; 50 Ohm coaxial cable;
50 Ohm terminator.

Connect the signal generator to an input channel through the coax and the terminator, which should be at the 400 end of the cable.

1. Set the timebase to 500ns per division and select 100m V per division on the input channel.
2. Set the generator to give approximately 5 divisions at 1 MHz and adjust the trigger level to give a stable trace.
3. Select *20ILs* per division on the timebase. You should notice that the screen picture will change considerably with small changes in input frequency.
4. Carefully adjust the frequency of the signal generator to produce a sine wave of approximately 2 to 5 cycles. This is an alias.
5. Select the Max-Min function from the Display and Trigger Menu.

If Max-Min is functioning correctly and dot join is off then two roughly horizontal lines will be displayed. These will be at the peak levels of the input signal.

5. WAVEFORM PROCESSING FUNCTIONS (420 and 450 only)

All the waveform processing functions are accessed through the Post-Storage Master Menu. Selections 1, 2 and 3 on this menu perform as described in section 3.9 to 3.12.

Selections 4 to 7 provide the waveform processing functions.

When performing any waveform processing that modifies a displayed trace, the new data could be overwritten almost immediately by a fresh acquisition unless the selected trace is held or further acquisitions are prevented e.g. the instrument is in single shot mode and the trace stored or no triggers are provided.

5.1 Cursor Measurements

The 400 DSO has 3 user controlled lines for use with this section of facilities. Their operation is fully described in section 2.4. The cursor is moved along the selected trace using the ◄► cursor buttons (5) the two datum lines are moved using the datum buttons (2) the time datum line with ◄► and the voltage datum with ▲ and ▼.

Pressing button 4 on the Post Storage Master Menu changes the display to the Cursor Measurements Menu - figure 5.1a. The cursor is used to determine the trace of interest and the cursor and time datum lines define the portion of the trace to be measured. Most trace measurements are with respect to the voltage datum line.

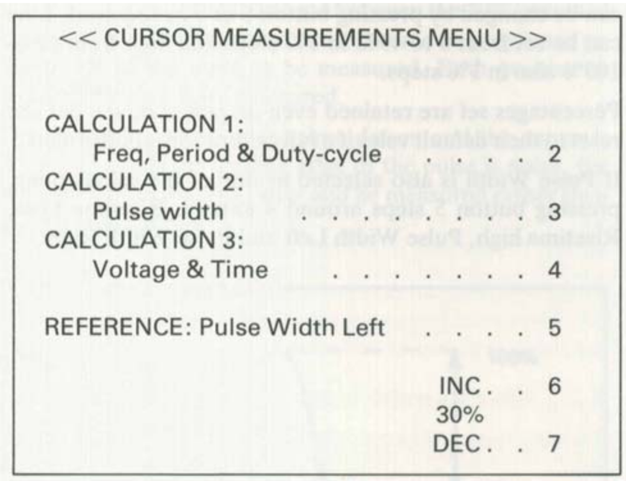


Figure 5.1a. Cursor Measurements Menu

Three calculations are possible using buttons 2, 3 and 4. Each calculation is selected from a roll around list containing the following options. Voltage and Time, Peak-Peak, Max-Min, Risetime (falltime), Overshoot (preshoot), Pulse Width, Frequency, Period, Duty Cycle, RMS, Area and off. A calculation can only be selected once e.g. if calculation 1 is set to its default of Voltage and time, then Voltage and time will not appear in the possible selections for calculations 2 or 3.

If any of the calculations are set to either Pulse Width or Risetime, lines 5,6 and 7 are displayed.

The calculation results are displayed in the three lines at the bottom of the trace display; figure 5.1b shows an example. Cursor measurements on timebase speeds of 200 and 100ns/div, i.e. when ETS - equivalent time sampling - is in operation, are only valid on traces that the cursor is on and that are triggered.

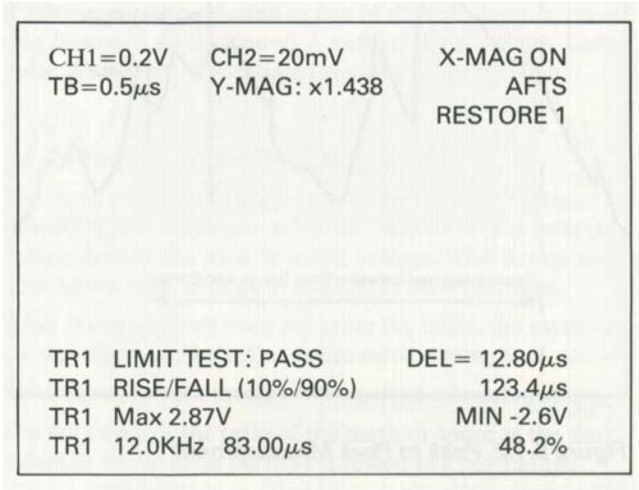


Figure 5.1b. Example of Calculations on Trace

If all the cursor measurements are set to off, the cursor data line on the display will show the message; "**TRI CURSOR MEASUREMENTS OFF**", and if the data is invalid for the measurement selected, the cursor line will display the message "**TRI INVALID DATA**". The trace number in both the above messages will change according to the selected trace.

5.1.1 Voltage and Time

The display shows the voltage between the voltage datum line and the point where the cursor line crosses the trace and the time between the time datum line and the cursor line.

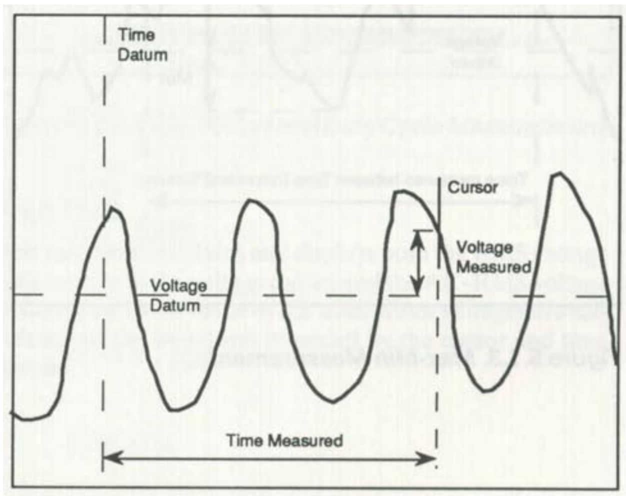


Figure 5.1.1. Voltage and time Measurement

5.1.2 Peak-Peak

The display will show the peak to peak voltage difference between the most positive and negative points of the trace between the cursor and the time datum.

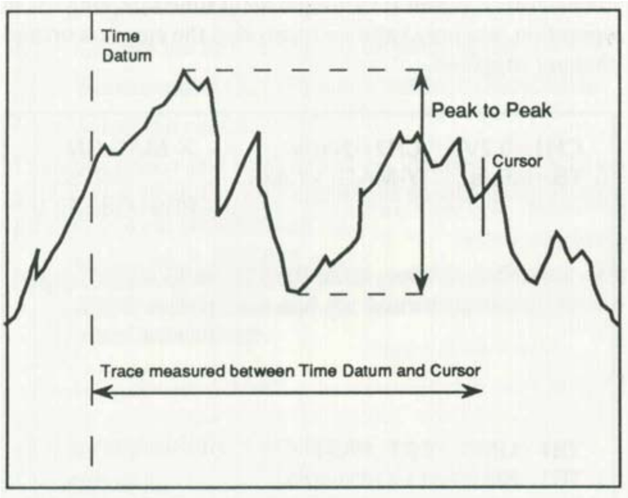


Figure 5.1.2. *Peak* to *Peak Measurement*

5.1.3 Max-Min

The display shows the voltages of the maximum and minimum points of the waveform between the cursor and time datum measured with respect to the voltage datum.

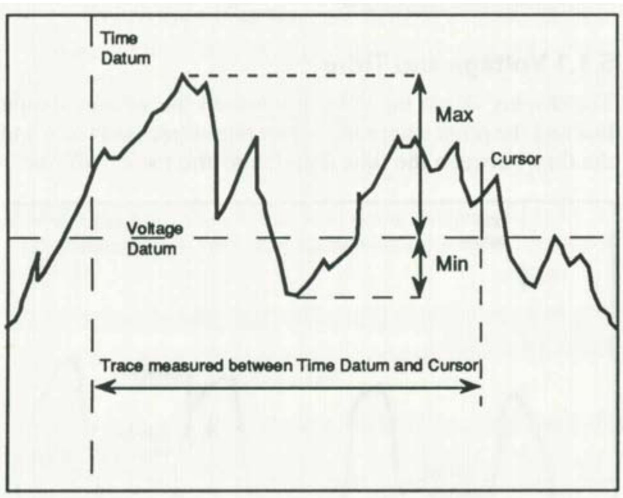


Figure 5.1.3. *Max-Min Measurement*

5.1.4 Risetime (falltime)

Position the cursor and the time datum at the 0% and 100% points of the waveform. The software will calculate the rise or fall time between the low and high percentage points of the waveform.

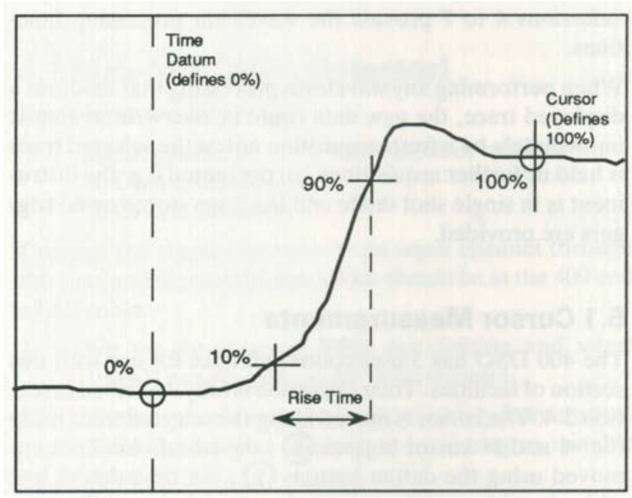


Figure 5.1.4. *Risetime Measurement*

The default percentage points are 10% and 90%. Using buttons 5, 6 and 7 these values can be changed. Button 5 selects the point to be changed, either Risetime High or Risetime Low. When the appropriate point is selected, it can be changed by pressing button 6 or 7 as required. Low can be set from 0 to 49% in 1 % steps and high from 51 to 100% also in 1 % steps.

Percentages set are retained even on power down, but are reset to their default vales if a full calibration is performed.

If Pulse Width is also selected as one of the calculations, pressing button 5 steps around 4 entries; Risetime Low, Risetime high, Pulse Width Left and Pulse Width Right.

5.1.5 Overshoot (preshoot)

Position the cursor and the time datum at the 0% and 100% points of the waveform. The software calculates the overshoot as a percentage of the voltage difference between the 0% and 100% points.

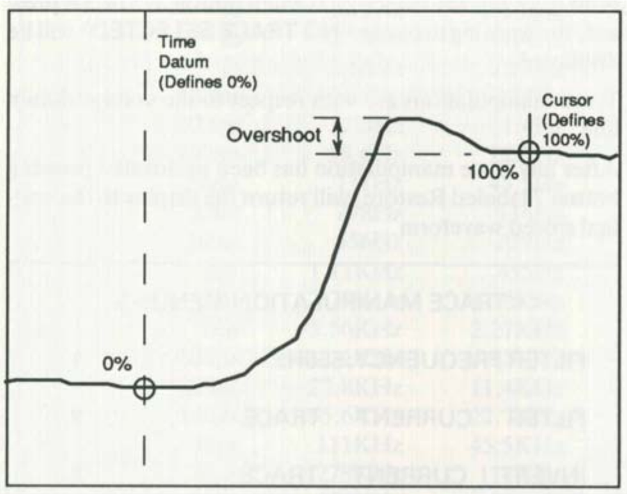


Figure 5.1.5 *Overshoot Measurement*

5.1.6 Pulse Width

The software measures the time between the 50% points of a pulse. The time datum and cursor should be positioned on either side of the pulse to be measured. Both positive or negative pulses can be measured.

The first pulse between the time datum and the cursor is measured and if the leading edge of the pulse is noisy, the noise may be taken as a pulse and be measured rather than the pulse of interest.

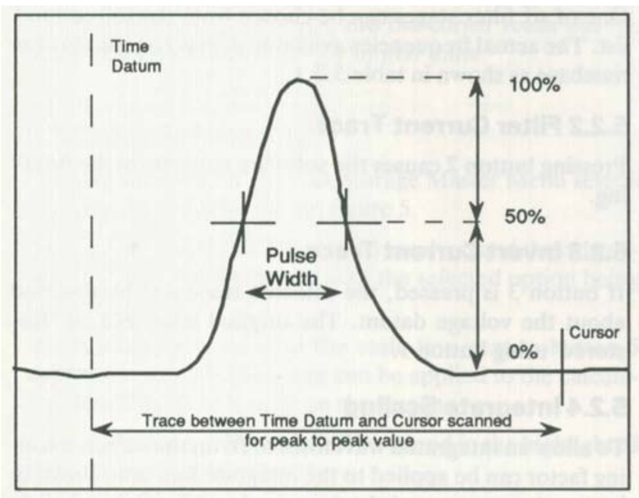


Figure 5.1.6. *Pulse Width Measurement*

The default percentage points are 50% and 50%. Using buttons 5, 6 and 7 these values can be changed. Button 5 selects the point to be changed, either Pulse Width Left or Pulse Width Right. When the appropriate point is selected, it can be changed by pressing button 6 or 7 as required. Both of them can be set from 5% to 95% in 1 % steps.

Percentages set are retained even on power down, but are reset to their default vales if a full calibration is performed.

If Risetime is also selected as one of the calculations, pressing button 5 steps around 4 entries; Pulse Width Left, Pulse Width Right, Risetime Low and Risetime High.

5.1. 7 Frequency, Period, Duty Cycle

The three parameters frequency, period and duty cycle of a waveform are displayed with this selection. The voltage datum defines the zero crossing voltage. The cursor and time datum must enclose at least three zero crossings.

If the voltage datum does not cross the trace, the mean of the waveform will be taken as the zero crossing line.

The frequency is the inverse of the period calculated above. The duty cycle is the ratio of the mark or space at the time datum to whole pulse period expressed as a percentage.

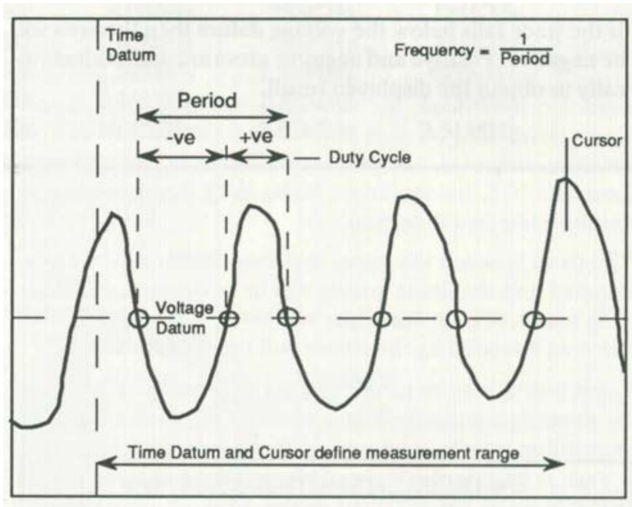


Figure 5.1.7. *Freq. Period and Duty Cycle Measurement*

5.1.8 RMS

This selection calculates and displays both the RMS voltage with respect to the voltage datum and the AC-RMS voltage with respect to the mean of the trace. Both voltages are calculated on the waveform bounded by the cursor and time datum.

5.1.9 Area

This selection calculates the area bounded by the trace and the cursor and datum lines.

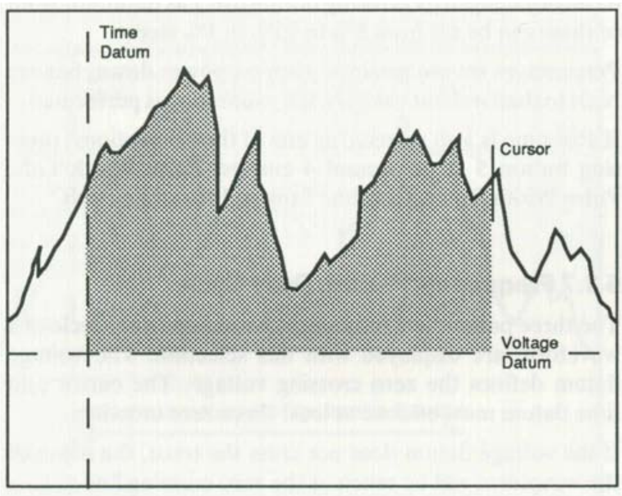


Figure 5.1.9. *Area Measurement*

The result is given in volt-seconds or similar units.

If the trace falls below the voltage datum then the area will be negative. Positive and negative areas are added algebraically to obtain the displayed result.

5.2 Trace Manipulation

Pressing button 5 on the Post Storage Master Menu changes the display to the Trace Manipulation Menu - figure 5.2. The trace to be manipulated is selected with the cursor and the required function with button 2, 3 or 5.

If no trace has the cursor on it when button 2, 3 or 5 is pressed, the warning message "NO TRACE SELECTED" will be displayed.

Trace manipulations are with respect to the voltage datum line.

After any trace manipulation has been performed pressing button 7 labelled Restore, will return the display to the original stored waveform.

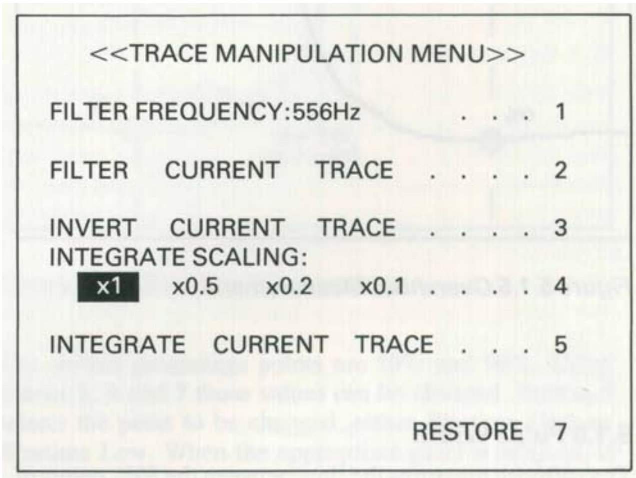


Figure 5.2. *Trace Manipulation Menu*

5.2.1 Filter Frequency

The trace can be filtered by a single low pass filter and the 3dB point displayed on the trace display.

The frequency of the filter applied to the waveform when button 2 is pressed is selected using button 1.

One of six filter stages can be chosen from the roll-around list. The actual frequencies available depend on the current timebase as shown in table 5.2.1.

5.2.2 Filter Current Trace

Pressing button 2 causes the software to perform the filtering.

5.2.3 Invert Current Trace

If button 3 is pressed, the selected trace will be inverted about the voltage datum. The original trace can be 'Restored' using button 1.

5.2.4 Integrate Scaling

To allow an integrated waveform to fit on the screen a scaling factor can be applied to the integrate function. Pressing button 4 steps around the factors xl, xO.5, xO.2 and xO.1. The selected factor is highlighted.

Timebase	F1	F2	F3	F4	F5	F6
50s	111mHz	4504mHz	21.3mHz	1O.3mHz	5.05mHz	2.51mHz
20s	278m Hz	114mHz	53.2mHz	25.8mHz	12.6mHz	6.27mHz
10s	556mHz	227mHz	106m Hz	51.5mHz	25.3mHz	12.5mHz
5s	1. 11Hz	455mHz	213mHz	103mHz	50.5mHz	25.1mHz
2s	2.78Hz	1.14Hz	532mHz	258mHz	126mHz	62.7mHz
Is	5056Hz	2.27Hz	1.06Hz	515mHz	253mHz	125mHz
500ms	l1.1Hz	4055Hz	2.13Hz	1.03Hz	505mHz	251mHz
200ms	27.8Hz	1104Hz	5032Hz	2058Hz	1.26Hz	627mHz
100ms	55.6Hz	22.7Hz	1O.6Hz	5.15Hz	2053Hz	1.25Hz
50ms	111Hz	45.5Hz	2103Hz	1003Hz	5.05Hz	2.51Hz
20ms	278Hz	114Hz	53.2Hz	25.8Hz	12.6Hz	6.27Hz
10ms	556Hz	227Hz	106Hz	5105Hz	2503Hz	12.5Hz
5ms	1. 11KHz	455Hz	213Hz	103Hz	50.5Hz	25.1Hz
2ms	2.78KHz	1.14KHz	532Hz	258Hz	126Hz	62.7Hz
1ms	5.56KHz	2.27KHz	1.06KHz	515Hz	253Hz	125Hz
500J.Ls	11.1KHz	4.55KHz	2.13KHz	1.03KHz	505Hz	251Hz
200J.Ls	27.8KHz	1104KHz	5032KHz	2.58KHz	1.26KHz	627Hz
100J.Ls	55.6KHz	22.7KHz	10.6KHz	5.15KHz	2.53KHz	1.25KHz
50J.Ls	111KHz	45.5KHz	2103KHz	1003KHz	5.05KHz	2051KHz
20J.Ls	278KHz	114KHz	53.2KHz	25.8KHz	12.6KHz	6.27KHz
10J.Ls	556KHz	227KHz	106KHz	5105KHz	2503KHz	12.5KHz
5J.Ls	l.11MHz	455KHz	213KHz	103KHz	5005KHz	25.1KHz
2J.Ls	2.78MHz	1.14MHz	532KHz	258KHz	126KHz	62.7KHz
1J.Ls	5.56MHz	2.27MHz	1.06MHz	515KHz	253KHz	125KHz
500ns	11.1MHz	4.55MHz	2.13MHz	1.03MHz	505KHz	251KHz
200ns	27.8MHz	l104MHz	5.32MHz	2.58MHz	1.26MHz	627KHz
100ns	55.6MHz	22.7MHz	1O.6MHz	5.15MHz	2.53MHz	1.25MHz
(450 only) 50ns	111MHz	45.5MHz	21.3MHz	1O.3MHz	5.05MHz	2.51MHz

Table 5.2. 1. *Filter Frequencies*

5.2.5 Integrate Current Trace

When button 5 is pressed, the display will show the integrated waveform of the selected trace. The voltage datum is taken as zero for integration and the cursor reads out the value in Vs - volt-seconds - or similar units.

5.3 Trace Arithmetic

Pressing button 6 on the Post Storage Master Menu selects the Trace Arithmetic Menu, figure 5.

Using buttons 1,2 and 3 the traces involved and the calculation required can be chosen with the selected option being highlighted.

When multiply is selected the scale line next to button 5 appears so that a scale factor can be applied to the calculation result to allow it to fit on the screen.

The result of the arithmetic will be stored in the highlighted trace selected with button 4.

Pressing button 7 - Execute - causes the calculation to happen.

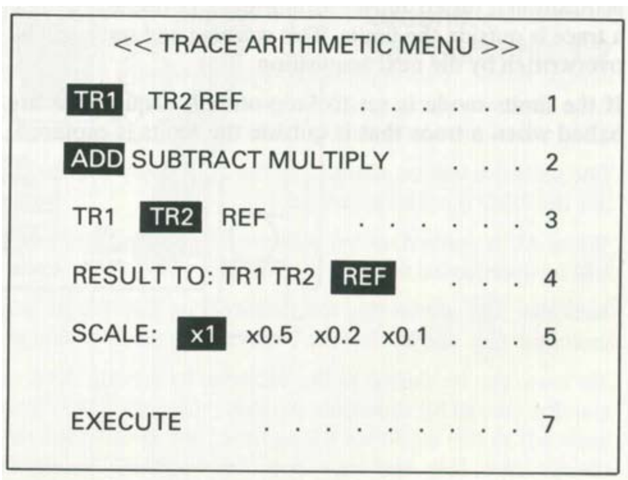


Figure 5.3. *Trace Arithmetic Menu*

5.4 Persistence/Limits Testing

Button 7 on the Post Storage Master Menu selects the Persistence/Limits Menu - figure 5.4.

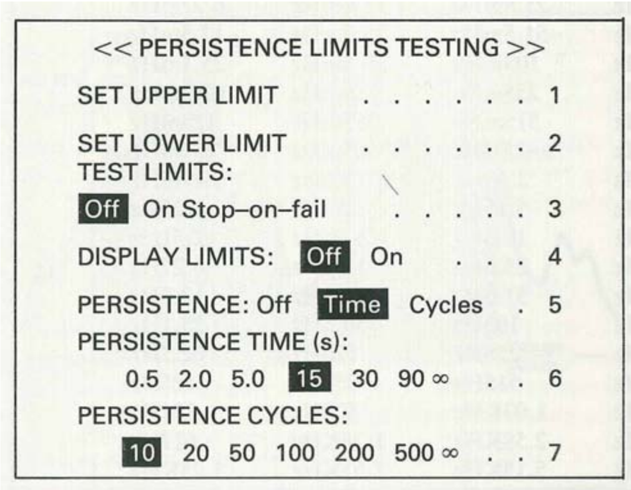


Figure 5.4. Persistence/Limits Testing Menu

5.4.1 Limits

The upper and lower limits to be tested against are set by displaying the desired limit trace on the screen and then pressing either button 1 or 2 as required. When a limit has been successfully set, the message LIMIT SET is displayed. Limit traces may be sent to or read from the 400 with an external computer, using the mnemonics STU for the upper limit and STL for the lower limit, using the data transfer facility described in section 2.6.

The band between the upper and lower limits will be cross-hatched and the limits testing will be performed on all the data points of both the upper and lower limit traces within the area bounded by the cursor and time datum lines.

Limit testing may be turned On or Off or set to Stop-on-fail by pressing button 3. When turned On, each successive acquisition is tested and a warning message displayed when a trace is outside the limits. This warning and trace will be overwritten by the next acquisition.

If the limits mode is set to Stop-on-fail, acquisitions are halted when a trace that is outside the limits is captured, allowing it to be examined. This screen picture can be plotted, and with the internal colour plotter, the upper and lower limits will be in the same colour as the reference trace to distinguish them from the failed trace.

During limits testing the trigger level and position markers are not displayed.

Test Limits and Display Limits cannot be turned on if the DSO is in X- Y mode or if X-Mag is turned on. Similarly, XMag or X - Y mode cannot be selected if either Test Limits or Display Limits is on. If any of these situations occur one of the following messages will be displayed as appropriate.

NO LIMITS DISPLAY IN XY
NO XY WHEN LIMITS DISPLAYED
NO LIMITS DISPLAY IN X-MAG NO
LIMITS TESTING WITH X-MAG
NO X-MAG WHEN LIMITS DISPLAYED
NO X-MAG WITH LIMITS TESTING

Also, Display Limits cannot be turned on if persistence is on. Trying to select this mode results in the message; NOT WHEN PERSISTENCE.ON.

A record of all failing traces can be automatically plotted by setting the limits testing mode to stop on fail, and selecting Auto Plot from the plotter menu. Any acquired trace that then falls outside the limits will be plotted. If the plot button is not pressed to initiate a continuous sequence, only the first failing trace will be acquired and plotted.

5.4.2 Persistence

The 400 is not capable of variable persistence but either the number of acquisitions accumulated before the display is cleared or the absolute time between display clearances can be set from the Persistence/Limits Menu.

The choice of Persistence for time or number of acquisitions is made using button 5 with the actual time of number of cycles set by button 6 or 7 as appropriate.

When using the persistence mode, the trigger level and position markers are not displayed.

If Display Limits is on, then persistence cannot be selected and the message NOT WHEN LIMITS DISPLAYED is shown if button 5 is pressed.

6.0 Battery Unit Operation

The 400-107 battery unit option for the 400 series DSOs provides the instruments with a fully automatic built in Nickel Cadmium battery and charger which allows uninterrupted operation of the DSOs in the event of an AC supply failure and complete operation independent of an AC supply.

The battery is fully protected against damage from overcharge or over-discharge and automatically receives a fast recharge followed by a continuous trickle charge when AC power is restored or re-applied to the unit.

A DSO with the battery option operates as an integral unit. All the normal functions of the DSO with the exception of line trigger are available and function according to the main operators manual. Full operation of the DSO is also available while the battery is recharging.

In the following text, battery unit refers to the option and DSO refers to the main oscilloscope. The circled numbers in this section refer to the numbered controls in figure 6.2

An AC supply is applied to the battery unit. This charges the batteries and is linked through the battery unit to power the DSO. The battery unit then also provides a DC supply to the DSO for use in the absence of an AC supply.

The battery unit is electrically connected to the DSO by two rear panel cables; one for the AC supply and one for the DC supply.

CAUTION: Before use ensure that the connections between the battery unit and the DSO are correct, see figure 6.0.

6.1 AC Supply Operation

To operate either the DSO or the battery unit the master on/off switch (37) on the front of the battery unit must be turned on.

If the instrument has been unused for a period of a month or more at 20°C or for a week or more at 50°C, individual cells within the batteries may have lost different amounts of charge. 24 hours operation on charge is required prior to discharge.

With an AC supply applied to the battery unit, and the master power switch (37) turned on, the batteries are on charge. See section 6.3.

When the DSO power is also switched on, the DSO operates from the AC supply. Normal operation of the oscilloscope is possible, and the batteries remain on charge.

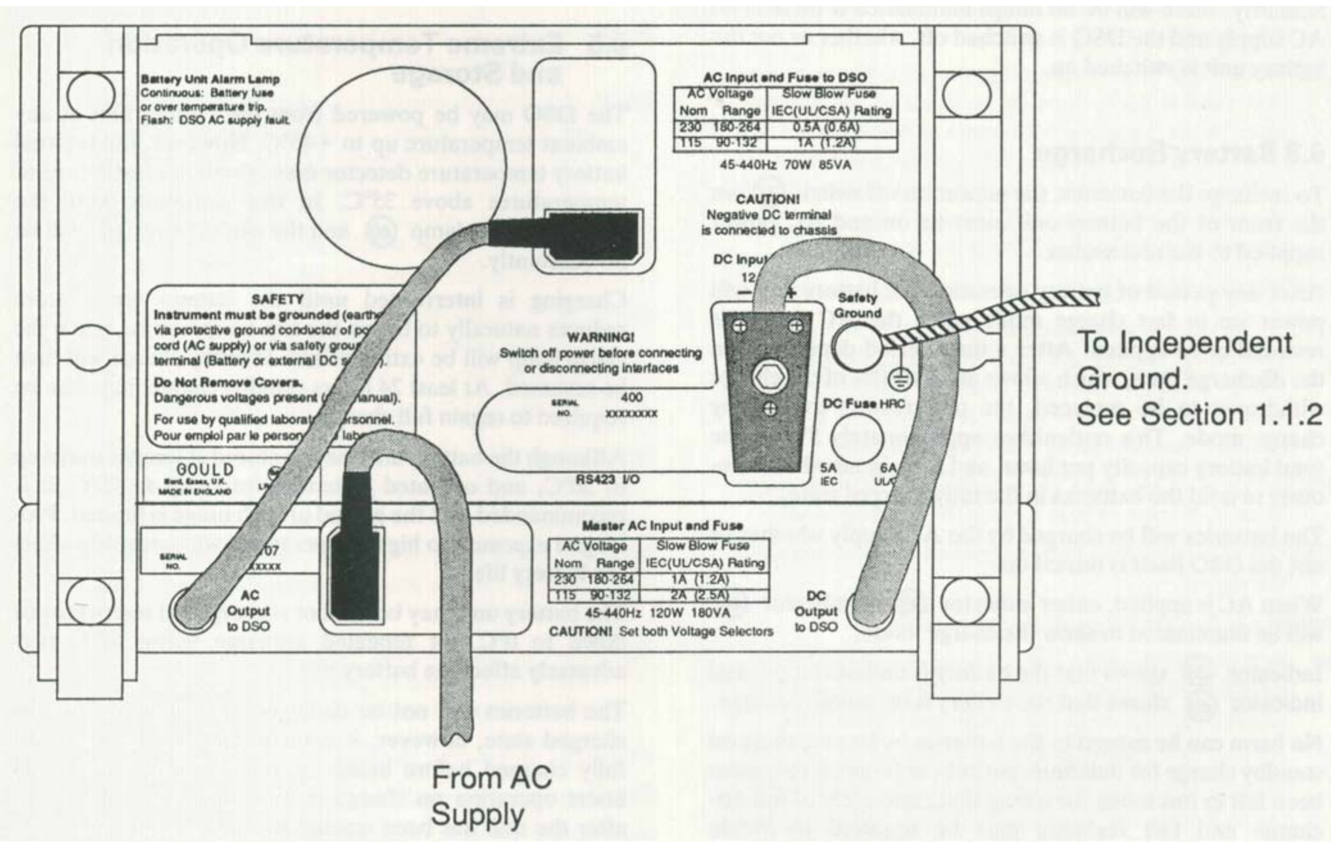


Figure 6. Battery Unit Interconnections

6.2 DSO Battery Operation

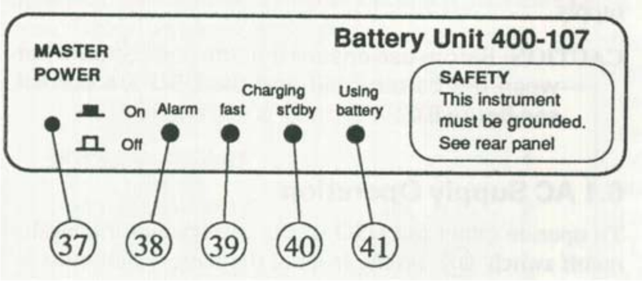


Figure 6.2 *Battery Unit Front panel indicators*

If no AC supply is available, the DSO can be powered from the battery unit simply by turning both the Master power switch (37) and the DSO power switch (1) on. If the DSO is in use on an AC supply that is interrupted, the operation of the DSO is uninterrupted as it changes to DC operation.

Whenever the batteries are supplying power to the DSO the Using battery lamp (41) is illuminated.

When the batteries approach full discharge their output is automatically cut off to prevent damage due to deep discharge. In this state no lamps on the battery unit will be illuminated.

Similarly, there will be no lamps illuminated if there is no AC supply and the DSO is switched off, whether or not the battery unit is switched on.

6.3 Battery Recharge

To recharge the batteries, the master on/off switch (37) on the front of the battery unit must be on and AC power supplied to the rear socket.

After any period of battery operation the battery unit will power up in fast charge mode when the AC supply is restored or re-applied. After a time period dependant on the discharge time, which allows at least 80% of the charge withdrawn to be replaced, the unit reverts to standby charge mode. This replenishes approximately 5% of the total battery capacity per hour, and is maintained continuously to hold the batteries in the fully charged state.

The batteries will be charged by the AC supply whether or not the DSO itself is turned on.

When AC is applied, either indicator (39) or indicator (40) will be illuminated to show the charge mode.

Indicator (39) shows that the battery is on fast charge, and indicator (40) shows that the battery is on standby charge.

No harm can be caused to the batteries by leaving them on standby charge for indefinite periods, although if they have been left in this mode for a long time, one cycle of full discharge and fast recharge may be required to obtain maximum capacity.

Limited battery capacity is available to operate the DSO if the AC supply is removed for any reason during fast charge. After full discharge, the battery capacity will be approximately half the elapsed recharge period.

If the unit is used outside the temperature range of + 15°C to + 35°C, the normal operation may be limited as discussed in section 6.5.

6.4 Alarm Conditions

The alarm lamp (38) will flash if the DSO attempts to draw power from the batteries while an AC supply is present. i.e. when the DSO should operate from the AC supply. This condition only occurs if the interconnecting AC cable is not connected or the DSO's AC supply fuse is open.

Once this condition is detected, the battery supply to the DSO is automatically switched off.

When the fault has been remedied, the alarm condition can be cleared by turning the master power switch (37) off for at least 10 seconds and then on again.

The alarm lamp (38) will be illuminated constantly if the battery temperature trip operates - see section 6.5 - or if a severe fault blows the internal battery protection fuse. Replacement of this fuse requires removal of the instrument covers and it should only be attempted by suitably qualified personnel. See section 1.1.3.

6.5 Extreme Temperature Operation and Storage

The DSO may be powered from the battery unit at any ambient temperature up to +45°C. However, the internal battery temperature detector may inhibit full fast charge at temperatures above 35°C. In this condition, both the standby charge lamp (40) and the alarm lamp (38) will be on constantly.

Charging is interrupted until the battery temperature reduces naturally to below the trip temperature, when the alarm lamp will be extinguished. Standby charge will then be resumed. At least 24 hours standby charge may then be required to regain full charge.

Although the battery unit may be stored at temperatures up to 50°C, and operated at temperatures up to 45°C, it is recommended that the period of such usage is limited. Prolonged exposure to high temperatures will adversely affect the battery life.

The battery unit may be used or recharged at temperatures down to O°C but repeated recharge below 15°C may adversely affect the battery life.

The batteries will not be damaged by storage in the discharged state, however, it is recommended that they are fully charged before being unused for long periods. 24 hours operation on charge is recommended before use, after the unit has been unused for more than a month at 20°C or a week at 50°C.

6.6 Independent Operation of DSO

In any circumstances if the battery facility is not required the AC supply link from the battery unit to the DSO can be disconnected and an AC supply fed directly into the DSO. In this mode, the master power switch (37) must be off or the DC cable disconnected from the DSO.

This mode of operation allows the use of the DSO on an AC supply above the 45°C limit for battery operation, but below the 50°C limit for the DSO alone.

Similarly, if the DC cable from the battery unit is removed from the DSO, an external DC supply can be used to power the DSO. For example, a high capacity battery could operate the DSO remote from an AC supply for long periods. The batteries cannot be re-charged from an external DC supply.

7. Alphabetical Summary of Controls

AC As part of **AC/DC/Gnd**, **AC** removes DC components from signals of between 4Hz and 20MHz. As part of **hf rej/ AC/DC** it sets AC coupling for the trigger signal, which may be between 10Hz and 20MHz.

AC/DC/Gnd (14) Controls the type of coupling between the instrument and the input signal. **AC** is used to remove DC components from signals of between 4Hz and 20MHz. **DC** couples the input signal directly to the instrument, so all frequency components of the signal up to 20MHz will be displayed. **Gnd** internally disconnects the inputs from the instrument; a 0V reference signal is displayed instead.

Add (10) Displays the sum (or difference if one channel is inverted) of the channels. The original traces disappear and the resultant trace is displayed as a new Channel 2 trace.

Arm'd (29) Illuminates after **S/Shot** is pressed; it will stay lit until either a valid trigger has been received or the Run button has been pressed.

AUTO SETUP (24) Will attempt to arrange the display so that two to five complete cycles appear, with the amplitude set so that the height of the trace is between two and five screen divisions. Also, it selects **Auto** trigger to ensure that the screen is frequently updated and a trace will be visible. If the frequency of the input signal is less than 20Hz, this function may not operate correctly.

Auto/Norm (20) Selects the trigger mode. **Norm** means that valid triggers must be received to initiate captures. **Auto** triggering is the same as **Norm** except that if no valid trigger has been received for some time, an artificial trigger will be generated: the instrument will generate its own triggers if no valid trigger has been received for 0.05s (i.e. 20Hz is the lower limit).

CH1/CH2/Ext/Line (17) Steps through trigger sources.

CH1(X) (9) One of two channel signal input sockets, this one being for the connection of signals up to +/ -400Y peak to Channel. It is used for the X component of an X- Y mode trace. It can also be a trigger source if selected using **CH1/CH2/Ext/Line**.

CH2(Y) (12) As CH1, but CH2 is used for the Y component of an X- Y trace, where CH1 is the X component.

CURSOR (7) These two buttons control the movement of the cursor.

Control (2) Selects the control master menu.

Dat Part of **Dat/Pos/Mag** (3) . Allows the **POST STOR·AGE/DATUM** and **CURSOR** keys to be used to control the movement of the cursor and datum lines.

DC As part of **AC/DC/GND**, DC couples the input signal directly to the instrument so that all frequency components from DC to 20MHz are displayed. As part of **hf rej/AC/DC** it couples triggers from DC to 20M Hz to the instrument.

Ext External trigger source (connected via **EXT TRIG** socket).

EXT TRIG Socket (16) for the connection of external triggers of up to +/-250Y peak.

Gnd Part of **AC/DC/Gnd, Gnd** disconnects the input signal from the instrument and displays a 0V reference signal instead.

hf rej/AC/DC (18) Selects trigger coupling. The **hf rej** (high frequency reject) option is a 15kHz low-pass filter. Any coupling may be used with any trigger source except **Line** where the coupling is not selectable.

Inv Part of **Off/On/Inv**; this option is used to invert the display of a channel's trace - i.e. to negate it so that it is displayed upside down.

Level (22) Adjusts the trigger level, which is indicated by two trigger bars on the display.

Line Mains frequency triggers. Input coupling may not be selected with this option.

Mag (32) Used to control the horizontal magnification of the traces; when selected, a xl0 expansion around the centre of the screen is applied to the traces. The timebase setting is altered to reflect the expansion.

Mag part of **Dat/Pos/Mag** (3) this allows the vertical magnitude of a stored waveform to be varied using the **POST STORAGE/DATUM** keys.

Menu/Traces (35) Swaps the display between the last used menu and the trace display.

Mode (31) Selects one of three display modes. Refreshed mode is the normal oscilloscope mode whereby the trace is plotted from left to right. Roll mode is like a chart recorder: the display scrolls from right to left as the trace is acquired. **X-Y** mode takes the **CH1 (X)** input as the x (horizontal) component and the **CH2(Y)** input as the y (vertical) component.

Norm Part of Auto/Norm. The instrument will only initiate captures when a valid trigger is received when in Norm mode.

ns (33) Decreases the horizontal **TIME/DIV**.

Off/On/Inv (13) Switches the channel On or Off. If the channel is on, its trace can be displayed Inverted (upside down).

Plot (34) Produces a plot of the current display on a suitable plotter. If a plot is in progress, pressing this button will abort it.

Pos Part of **Dat/Pos/Mag** (3) this allows the trace on which the cursor is placed to be shifted using the **POST STORAGEIDATUM** keys.

Pos'n (8) Moves that channel's trace vertically.

Position (26) Moves all traces horizontally.

Post Store (6) Selects the post storage master menu.

POWER (1) Used to switch the instrument on or off.

Pre-Trigger (23) Used in conjunction with the menus to control the degree of pre-trigger.

Refr Refreshed mode is the normal oscilloscope mode whereby the trace is plotted from left to right.

Roll This display mode operates like a chart recorder: the display scrolls from right to left as the trace is acquired.

Run (27) Puts the instrument in continuous capture mode; the instrument automatically re-arms itself after each acquisition.

Sec (33) Increases the horizontal **TIME/DIV**.

Select Trace (4) Places the cursor onto a displayed trace.

S/Shot (30) Arms the instrument for a single-shot triggered acquisition sweep (capture). The **Arm'd** light will be illuminated to show that this button has been pressed.

Stor'd (28) Illuminates on completion of a single-shot acquisition. It will stay lit until the instrument is re-armed or until **Run** is pressed.

TIME/DIV (33) Controls the sweep rate of the trace. The timebase can be varied from 100ns/div to 50s/div in a 1,2,5 sequence of values.

Trace Hold (25) Freezes the relevant trace or traces until pressed again.

Trig'd (21) This lights up when the instrument is receiving valid triggers.

Uncal Controlled by the **Var** button. When lit, the coarse setting of the attenuator remains unchanged, but a variable gain is applied to the input signal. This control applies attenuation in the range of 1 to 0.4. Thus, with an initial setting of 1 V, the actual sensitivity of the channel may be set anywhere between 1 V and 2.5V per division. The **V/DIV** buttons are used to vary the sensitivity.

Var (15) Toggles between **Uncal** & **Cal**.

V/DIV (11) Adjusts the sensitivity of the instrument over discrete calibrated ranges from 2mV/div to 5V/div in 1, 2, 5 steps. With a x10 probe the ranges are 20m V/ div to 50V/div at the probe tip. Input voltages must not exceed +/-**400V** peak. If the **Uncal** light is on, then these buttons control the sensitivity over an uncalibrated continuous range of values.

X-V mode takes the **CH1(X)** input as the x (horizontal) component and the **CH2(Y)** input as the y (vertical) component.

+/- (19) Selects triggering on positive or negative slopes.

Appendix 1: Error Messages

When something is wrong, an error message will be displayed in inverse text near the bottom of the display. Also in some cases a message appears to confirm that an action has occurred. Brief explanations of when these messages occur are given below in alphabetical order.

1. CALIBRATION DISABLED
   If Calibrate channel or 2 is pressed when Auto-cal is disabled.
2. LEVEL FIXED WHEN SOURCE=LINE
   If the trigger level controls are touched when line trigger is selected.
3. NO ADD IN XY MODE
   If trying to select ADD when in X- Y mode.
4. NO ADD WHEN HELD
   If the add button is pressed when either or both CH1 or CH2 are held.
5. NO BINARY WITH X-ON X-OFF
   If X-ON X-OFF is selected and binary number base is also selected.
6. NO CURSORS IN XY
   If either the Datum or Cursor position keys or the select trace button is pressed when in X-Y mode.
7. NO HORIZONTAL MAG
   If the post storage <l or l> keys are pressed when the cursor and X-MAG are on.
8. NO LIMITS DISPLAY IN XY
   If limit display is turned on while the instrument is in X-Y mode.
9. NO LIMITS DISPLAY IN X-MAG
   If limit display is turned on while the instrument is in X-MAG mode.
10. NO LIMITS TESTING ON REF TRACE
    If limit testing is turned on while the cursor is on the reference trace.
11. NO LIMITS TESTING WITH X-MAG
    If limit testing is turned on while the instrument is in X-MAG mode.
12. NO POST STORAGE IN XY
    If the cursor is selected and then the unit is switched to X-Y mode and then a post storage key is pressed.
13. NO TRACE SELECTED
    If the cursor is off and either the restore, cursor position or post storage movement keys are pressed.
14. NO X-MAG IN ACTIVE ROLL
    a) If the X-MAG key is pressed while the instrument is in ROLL mode on timebase ranges slower than 20ms/div, with the traces not stored or either channel not held.

    b) If in ROLL mode on timebase ranges faster than 50ms/div with continuous acquisitions and X-MAG on, and then the timebase range is changed to be 50ms/div or slower.
15. NO X-MAG IN XY MODE
    If X-MAG is pressed when in X-Y mode.
16. NO X-MAG WHEN LIMITS DISPLAYED
    If X-MAG is pressed while display limits is on.
17. NO X-MAG WITH LIMITS TESTING
    If X-MAG is pressed while the instrument is in limits testing mode.
18. NO XY WHEN LIMITS DISPLAYED
    If XY is pressed while display limits is on.
19. NO XY WHEN CHANNELS ADDED
    If trying to select X-Y mode when channel ADD is on.
20. NO XY WITH X-MAG
    If trying to select X- Y mode when X-MAG is on.
21. NOT WHEN LIMITS DISPLAYED
    If persistence is turned on while display limits is on.
22. NOT WHEN PERSISTENCE ON
    If display limits is turned on while the instrument is in persistence mode.
23. PLOTTING - PRESS PLOT AGAIN TO ABORT
    Appears whilst plot is in progress.
24. TR1 CURSOR MEASUREMENTS OFF
    If all three cursor measurement options are set to off, this message appears.
25. TR1 INVALID DATA
    If the data is invalid for the measurement selected.
26. TRACE COPIED
    To confirm that a trace has been copied to the reference trace.

    (Note also that if a trace is copied to the reference trace, the reference trace is automatically turned on as well).
27. TRACE MEMORY UNUSED
    a) If trying to turn the reference trace on when it has not been previously copied/saved.

    b) If an attempt is made to recall a backup memory when that memory has not been previously saved.
28. TRACE NOT YET STORED
    If the cursor is selected and a post-storage key pressed but the trace is not stored or held.
29. TRACE RECALLED
    To confirm that a trace has been recalled.
30. TRACE SAVED
    To confirm that a trace has been saved.
31. USE CH1 POS'N KEYS IN XY
    If either horizontal position key is pressed when in X-Y mode.
32. WAITING FOR TRIGGER
    If S/SHOT has been selected but no trigger has been detected within 2s.

33. X-MAG RESTORED WHEN STORED/HELD

If the traces are stored or held in **ROLL** mode. Then if **X-MAG** is selected and either **S/SHOT** or **RUN** is pressed, or either channel unheld.

i.e. **X-Mag** has been turned off while the display is in active roll mode, but it will be restored when the display is once again stored or held.

34. O.IILS TO IOOILS/DIV, NO MAX-MIN

If max/min is selected when timebase is faster than 100µs/DIV.

Appendix 2: Specification

DISPLAY

CRT: 5 inch diagonal screen
Raster scan, vertically scanned

Graticule: Electronically generated 8 x 10 divisions with 0.2 sub divisions

Intensity: Separate controls for Traces, Graticule and Alphanumerics

VERTICAL SYSTEM

Two identical channels, CH1 and CH2. Inputs via BNC connectors

Sensitivity: 2mV/div to 5V/div in 1-2-5 sequence

Accuracy: +/- 2.5% of reading +/- 1 digitising level (1/30 of a division)

Variable Sensitivity: >2.5:1 range allowing continuous adjustment of sensitivity between ranges

Input Impedance: lMnl28pF

Input Coupling: DC-GND-AC

Bandwidth:

400and420: DC: 0-20MHz (-3dB) AC: 4Hz-20MHz (-3dB)
450: DC: 0 - 50MHz (-3dB) AC: 4Hz - 50MHz (-3dB)

Input protection: 400V DC or peak AC at 10kHz or less

Expansion: Post storage x 0.062 to x 4.00

HORIZONTAL SYSTEM
(Timebase)

Sweep rate:

400 and 420: 27 ranges in 1-2-5 sequence
450: 28 ranges in 1-2-5 sequence

Transient capture: 500ns/div to 50s/div.

Repetitive sampling:

400 and 420: 200 and 100ns/div
450: 200,100 and 50ns/div

Sample rate accuracy: +/- 0.01 % of sample time

Expansion: x 10 with linear dot interpolation

TRIGGER DELAY

Trigger delay range: 20ns to 5000s

Trigger delay accuracy: +/- 0.01 %, +/- 1 ns

Pre-trigger: 0 to 100% of sweep in 0.4% steps

Resolution: 2% of time/div, 20ns min

TRIGGER SYSTEM

Variable level control with Auto/Normal facility, resolution of less than 0.1 div.

Auto/Normal Mode: In Auto the timebase free runs when insufficient signal (20Hz - 20M Hz) is present or when the selected level is outside the range of the input signal.

Source: CH1, CH2, External or Line

Coupling: DC, AC, high frequency reject filter

Slope: +ve or -ve

Sensitivity 400 and 420:

Internal DC Coupled <0.3 div DC to 2M Hz
<1.5 div DC to 20MHz
AC Coupled <0.3 div 10Hz to 2 MHz
<1.5 div 4Hz to 20MHz
External DC Coupled <150mV DC to 2MHz
<600mV DC to 20MHz
AC Coupled <150mV 10Hz to 2MHz
<600m V 4Hz to 20MHz

Sensitivity 450:

Internal DC Coupled <0.3 div DC to 2MHz
<1.5 div DC to 50MHz
AC Coupled <0.3 div 10Hz to 2MHz
<1.5 div 4Hz to 50MHz
External DC Coupled < 150m V DC to 2MHz
<600mV DC to 50MHz
AC Coupled <150mV 10Hz to 2MHz
<600mV 4Hz to 50MHz

Range:

Internal +/- 10 divisions
External +/- 3V

External input impedance: 100K!1/10pF

External input protection: 250V DC or peak AC

Trigger jitter: 50s/Div to 0.5fLs/Div, +/- 2% of time/Div (unexpanded), +/- 2ns
0.2fLS/Div and 0.lfLs/Div, +/- 2ns

DISPLAY MODES

Refreshed: Stored data and display updated by triggered sweep

Roll: Stored data and display updated continuously for timebases 50ms/div to 50sec/div. Trigger stops the updating process

Refresh and roll operate as repetitive single shot for timebase ranges faster than 50ms/div

Dot join: Dots are joined by vertical raster lines. Linear dot interpolation is provided when the trace is X-expanded

X-Y: X-Y display is 8 x 8 divisions. Stored data and display are updated by triggered sweep. There is no dot joining, x 10 expansion or cursor in this mode. CH1 is used as the X (8 bit resolution 25 steps/div) and CH2 as the Y (7 bit resolution 15 levels/div) deflection

Single trace: CH1 or CH2

Dual trace: CH1 and CH2

Add: CH1 and CH2 can be added to give the algebraic sum of the two channels. Addition is post storage

Invert: Both channels may be independently inverted **Single**
Shot: Freezes store at the end of a single triggered sweep

Display trace hold:(all) Freezes the display immediately
Channel 1 Trace hold: Freezes channel 1 display immediately

Channel 2 Trace hold: Freezes channel 2 display immediately

Reference trace: One reference trace can be displayed in addition to the two input channels. This can display a waveform memory of a trace copied from CH1 or CH2

ACQUISITION SYSTEM

Maximum sample rate: 100 megasamples/sec simultaneously on each channel

Vertical resolution: 8 Bits (1 in 256) 30 levels per division

Record length: 501 points per channel

ACQUISITION MODES

Normal mode: Transient and repetitive signal capture. (Repetitive capture is only on timebase ranges 100 or 200ns/div, which gives an equivalent sample rate of 2ns/sample on the 100ns/div range.)

X-Y Mode: Bandwidth 20MHz (-3dB) 50MHz on 450.
Phase difference <4° @20MHz. Acquisition rate dependent on the timebase range.

Averaging: Averages can be set from 2 to 256 in binary sequence, selected from the menu system. Averaging operates continuously or, using single shot for the set number of acquisitions. (weighted average)

Peak detection: Minimum pulse width *Zus,* 100% probability of capture. Operates on timebase range 100p..s/ div or slower

MEMORY

Waveform memory: 3 reference memories are selectable for waveform data storage. These memories are Nonvolatile

Set-Up: The control set-up is retained on memory during power down

Retention time: The memory support is trickle charged and will retain information for 1 month after power down

ON SCREEN MEASUREMENTS and ALPHANUMERIC DISPLAY

Datum Lines: Horizontal and vertical full screen amplitude time and voltage datums

Cursor: The measurement cursor can be assigned to a trace and measurements made in time and voltage with respect to the datums

Cursor measurement display: 6 Voltage and 6 Time displayed on screen

Accuracy: Voltage +/- 2.5% of reading, +/- 1 digitising level (1/30 of a division)
Time +/- 0.01%, of reading +/- 1 digit

Resolution: Voltage 0.4% of F.S.D.
Time 0.2% of F.S.D.

Trigger Indication: On screen trigger level and trigger point indication

Alphanumerics: Display on screen to indicate vertical sensitivity and input coupling for each channel, timebase speed and pre-trigger or trigger delay. Arrow for off screen indication of trigger point and traces

MENU SELECTION

Control master menu: Selects menus for prime functions:- Status, display and trigger facilities, display intensity, reference trace control, RS423 interface, and special functions

Menu/traces: Alternately switches between trace display and the last menu selection

Post storage master menu: Selects menus for fast access to save/recall trace and plot output parameters

AUTO SET UP

Automatically sets the front panel controls to display any applied repetitive input signal for frequencies greater than 20Hz. Trigger and timebase priority is CH1, CH2 and Line

RS423 INTERFACE

Serial interface port for bi-directional waveform data and associated range parameter transfer

Baud rate: 75, 150,300,600, 1200,2400,4800,9600

Data bits: 8

Parity: None

Start-stop: Fixed, one start bit, one stop bit

DIGITAL PLOTTER OUTPUT

The instrument can directly output to suitable HPGL format plotters via the RS423 interface port

Plot mode: Manual or auto selection to output a stored trace

Annotation: Range and scaling annotation, graticule , cursors and cursor readout can all be included in the plot output

Colors: Color pens automatically selected when available

Internal Color Plotter (420 and 450 only)

Paper type: Gould part No. 04101165 (8 roll pack). **Paper length:** 55 metres, equivalent to approximately 300 plots.

Pen type: Gould part No. 04101175 (4 color pack).

Pen life: Minimum of250 metres line length approximately 175 plots.

WAVEFORM PROCESSING FUNCTIONS (420 and 450 only)

Cursor Measurements

Voltage and Time

The cursor measures the voltage and time relative to the voltage and time datum lines respectively.

Peak-Peak

Calculates peak-to-peak voltage of the waveform bracketed between the time datum and cursor.

Max-Min

Displays maximum and minimum voltage excursions of a waveform relative to the voltage datum position. The cursor and datum bracket the waveform of interest.

Risetime (falltime)

Calculates the rise or fall time between the 10% and 90% points of a signal; The 0% and 100% points are set by the cursor and time datum.

Overshoot (preshoot)

Calculates the over or pre shoot of a signal as a percent of the 100% point; The 0% and 100% points are set by the cursor and time datum.

Pulse Width

Calculates the time between 50% points of a pulse, with the pulse being bracketed between the time datum and the cursor.

Frequency, Period, Duty Cycle

Calculates the average frequency, period and duty cycle of a waveform. Uses either the voltage datum as the zero crossing point or the mean of the waveform. The cursor and time datum set the limits of the area of interest.

RMS

Calculates the root mean square (RMS) voltage of a waveform bracketed between the cursor and time datum. The voltages are calculated with respect to both the voltage datum (DC-RMS) and the mean of the waveform (AC-RMS).

Area

Calculates the area under a waveform bracketed between the cursor and the voltage and time datum lines.

Trace Manipulation

Filter

6 selectable stages of low pass filter for each timebase range.

Invert

Inverts the trace about the voltage datum.

Integrate

Calculates the indefinite integral and displays the resultant waveform. A scaling factor of xl, x0.5 , x0.2 or x0.1 can be applied to the integrated waveform.

Trace Arithmetic

Add

Adds any two traces and displays the result in a selected trace.

Subtract

Subtracts any two traces and displays the result in a selected trace.

Multiply

Multiplies any two traces and displays the result in a selected trace. A scaling factor of xl, x0.5 , x0.2 or x0.1 can be applied to the multiplied waveform.

Limits testing

Tests a waveform with respect to two definable limit waveforms and will display a TEST FAILED message if the acquired signal fall outside the limits. Acquisition can be continuous or stop-on-fail.

Persistence

Either the time, or number of acquisitions between screen clearances can be set to give a persisted trace display. Times of 0.5, 2, 5, 15, 30 or 90 seconds or multiple acquisitions of 10, 20, 50, 100, 200 or 500 traces can be selected. Both options can be set to infinity to give a permanent persistence display.

REAL TIME CLOCK (420 and 450 only)

24 hour time and date set via a menu. Printed out on plots to give a permanent record of acquisition time. The time and date is maintained for approximately ten years with the instrument's power disconnected.

BATTERY UNIT 400-107

Operation of DSO from fully charged battery:
1.5 hours minimum.

90% recharge time from full discharge: 5 hours maximum

Battery life to 70% capacity:
200 complete discharge cycles at 20°C
100050% discharge cycles at 20°C.

AC supply range: 90 to 130V or 180 to 265V, 45 to 400Hz.

Indication provided for:
Battery in use (discharging)
Battery on fast charge Battery
on standby charge Alarm
conditions

ENVIRONMENTAL

Temperature: Full Specification: + 15°C to + 35°C.
Operating:0°C to +50°C.
(0°C to +45°C with battery unit)
Storage: -l0°C to +70°C.
(-l00C to +50°C with battery unit)

Humidity: Operating IEC 68-2-Ca at 45°C with 95% RH.
Non-operating IEC 68-2-Db cycling 25°C to 45 °C with 95% RH, 6 cycles (144 hours)

Vibration: MIL spec 8100. Random frequency vibrations of 5-500Hz at 1g rms for 15 minutes
IEC 68-2-6 Test Fc.
15 cycles of I minute duration 10 to 55Hz at 0.6mm peak to peak displacement in each of the three major axis (4g at 55Hz)

Safety: Designed for IEC 348 Cat I standard

EMC: EMI to BS6527, VDE 0871 Class A ESD
10kV to IEC 801-2, BS6667-2

MISCELLANEOUS

Calibrator: 1V peak to peak +/- 1%, frequency approx 1 KHz calibration signal on front panel

Ground: Front panel ground reference

POWER REQUIREMENTS

AC Voltage: 90 to l30V or 190 to 265V

Frequency: 45 to70 Hz. 400Hz operation is available as an option.

DC Voltage: 12 to 33V

Power: 85V *A170W* approx

WEIGHT

400:	5.5Kg (12Ib) approx.
420&450:	6.5Kg (14.2Ib) approx.
400 with battery unit:	1l.7Kg (25.7Ib) approx.
400 and 450 with battery unit:	12.7Kg (27.9Ib) approx.

DIMENSIONS

See Figure A2.

ACCESSORIES SUPPLIED

Operating manual
Line cord
DC power connector

OPTIONAL ACCESSORIES

Rack mounting kit	PN 04090490
Carrying case (soft padded)	PN 04101221
Carrying case (hard, foam lined)	PN 04101222
Front facia cover	PN 04101220
Accessory Pouch	PN 04101223
Service manual	PN 04101224
Probe DC to 100MHz switched x 1 and x I 0	PBI2
Probe DC to 250MHz 1200V x 100	PBI7
Probe DC to 7MHz 15kV x 1000	PB27
External TV Trigger Unit	

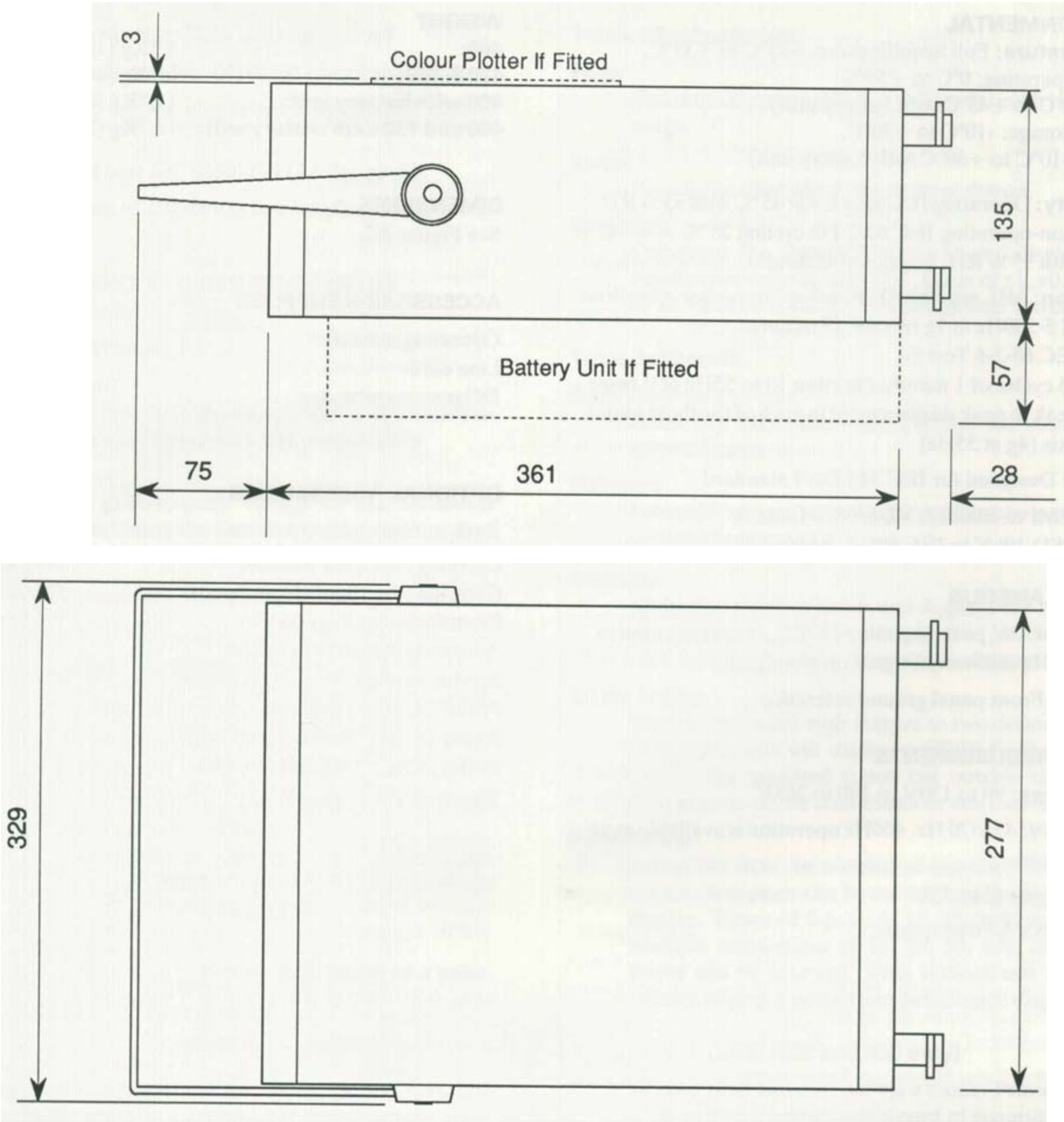


Figure A2 *400 Family Dimensions*

Appendix 3: Remote DC Operation of the 400 series DSOs

As well as the possibility of having an internal battery unit - option 107 see section 6- the 400 series DSOs can be operated from external DC voltages between 11.5 and 33V measured at the DSO. This has the advantage of uninterruptible operation which an oscilloscope powered from an inverter type of DC supply does not have. Inverter type DC supplies are powered by batteries and generate AC power in the absence of an incoming AC supply. In order for them to start working they first have to detect the loss of the AC supply which can take a few seconds.

Any applications which require continuous operation of a DSO regardless of AC supply fluctuations or drop-outs, as well as those requiring a remote power source will benefit from the versatility of the 400 series' DC power feature. Some examples of these applications are uninterruptible power supply development and troubleshooting, and troubleshooting of supply interference caused by large electric maCH1nes.

The DC operation power dissipation of the 400 is about 60W and of the 420 and 450 about 62W (67W when printing.) This dissipation is a constant power load to the source.

This means that less current is drawn at higher voltages and conversely more current at lower voltages. The user should ensure that there is sufficient source voltage to overcome cable and connector voltage losses that may occur because of the relatively high current involved. See table A3.1.

Figure A3.2 below shows the 400's internal arrangement of the power connections. It can be seen that current will be drawn from the AC supply as long as the external DC input voltage is lower than the AC input voltage minus the two diode voltage drops in the bridge rectifier.

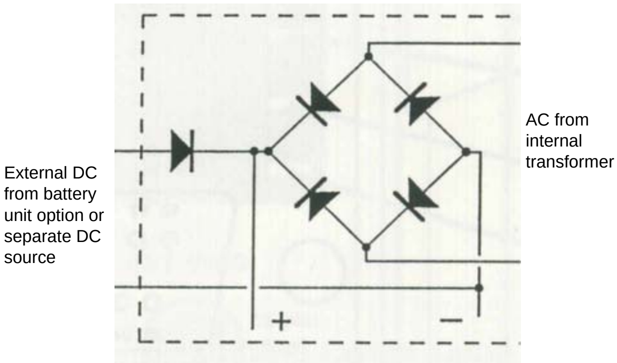
This simple diode O-Ring of the two power sources means that switCH1ng from one source to another is very quick there is no interruption in the operation of the instrument while one source takes over from the other.

The diode in series with the external DC source protects the instrument against reverse polarity voltages and allows both the AC and DC supplies to be connected at the same with the source supplying the higher voltage being the one from which current is drawn.

Table of Annealed Copper wire sizes vs. length for O.5V drop at 5 Amp current

Diameter (mm)	Cross Sectional Area (mm)	Length M
0.8	0.5	2.9
0.98	0.75	4.35
1.26	1.25	7.25
1.78	2.5	14.5
2.26	4.0	23.2
2.76	6.0	34.8
3.19	8.0	46.4
3.57	10.0	58.0

TableA3.1



FigureA3.2

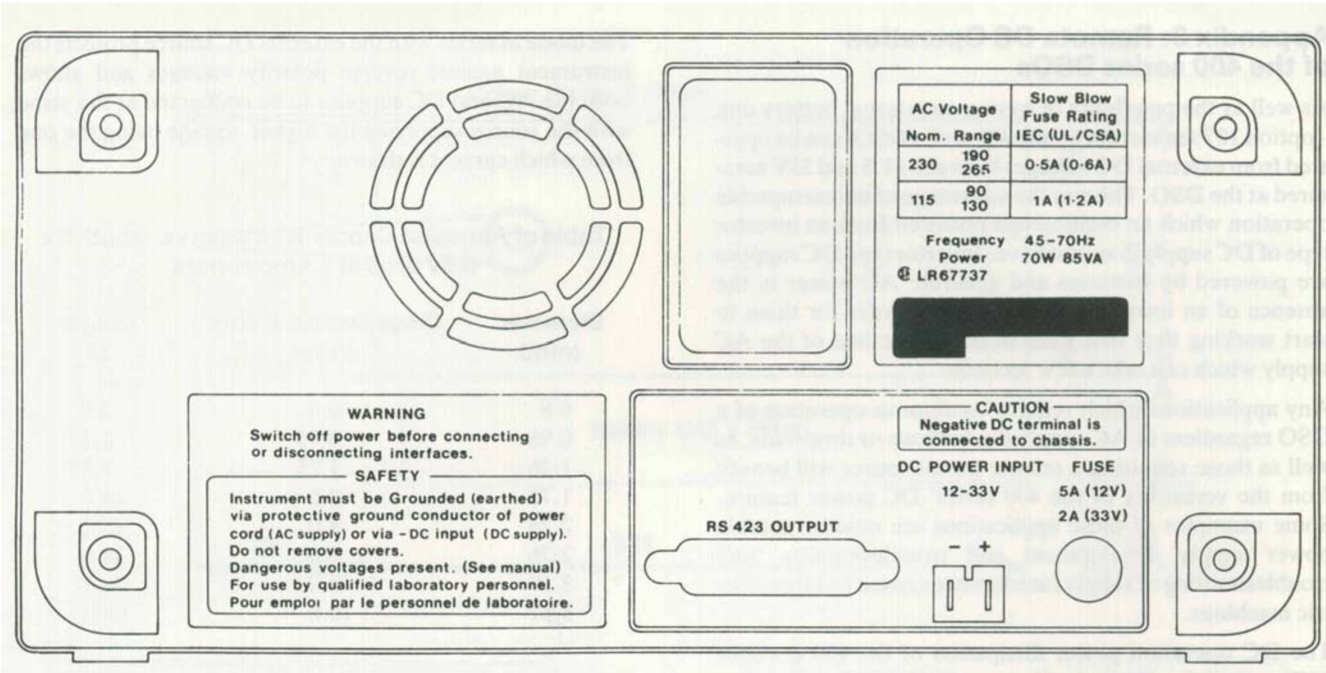


Fig. A4a Rear View

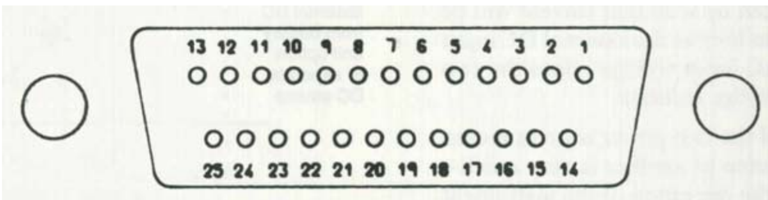


Fig. A4b RS423 Connections

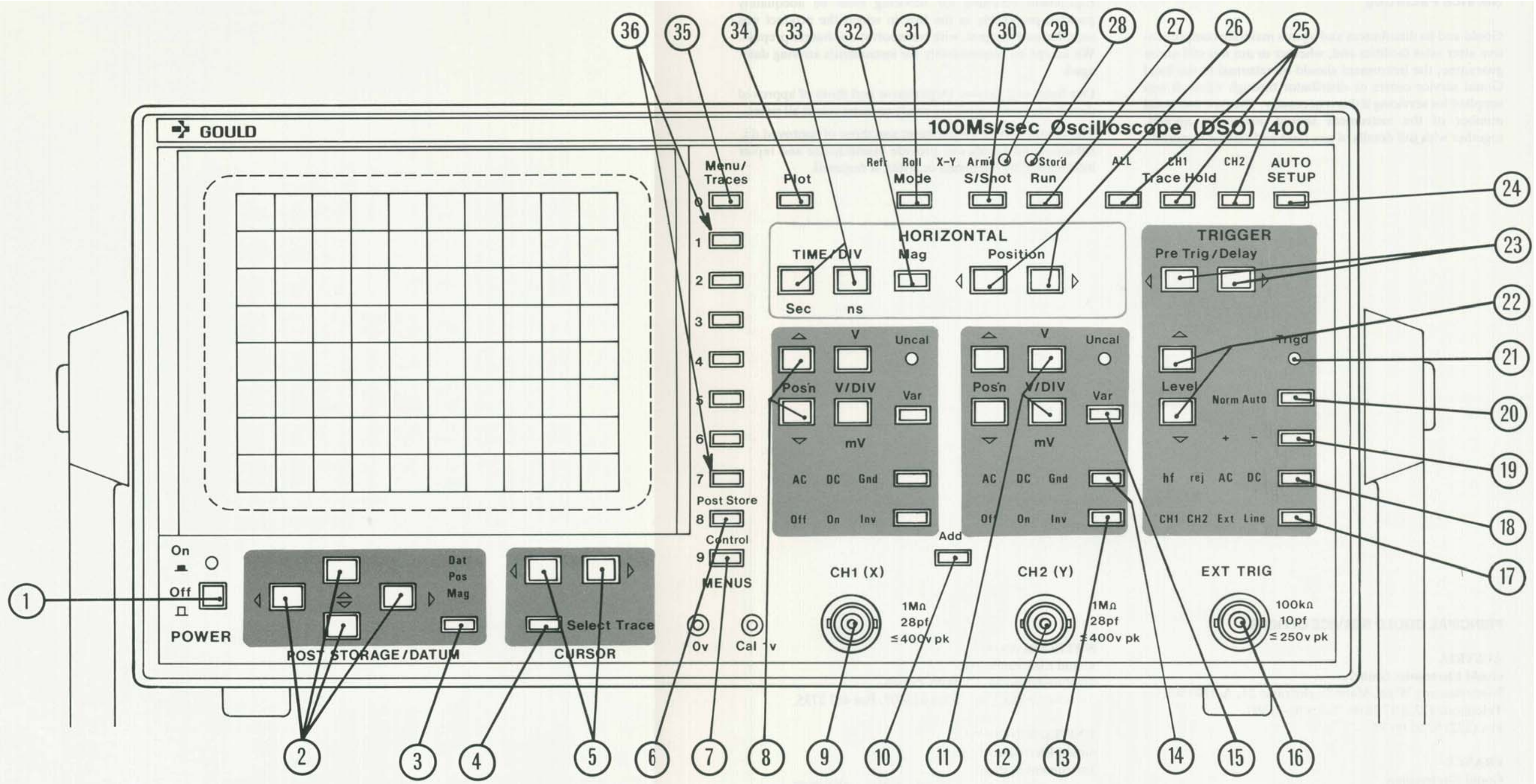


Fig. A4c Front Panel Control

Service Facilities

Gould and its distributors and agents maintain comprehensive after sales facilities and, whether or not it is still under guarantee, the instrument should be returned to the local Gould service centre or distributor through whom it was supplied for servicing if this is necessary. The type and serial number of the instrument should always be quoted, together with full details of any fault and service required.

Equipment returned for servicing must be adequately packed, preferably in the box in which the product was supplied and shipped, with transportation charges prepaid. We accept no responsibility for instruments arriving damaged.

Our Sales and Service Department and those of approved distributors and agents are ready to assist you at all times.

The Gould Service Department and those of approved distributors and agents can provide maintenance and repair information by telephone or letter, if required.

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WL490

Manual Part Number 457400

Notes

GOULD Electronics

400 Operators Manual Amendment Sheet
November 1990

400 System Reset
Should the system memory become corrupted, the instrument could lock out the front panel operation or begin to behave erratically. Since the internal system variables are held in non-volatile memory, turning the set off an on again may not clear them. In this unlikely event a system reset may be necessary.

A system reset should only be used as a last resort as all the internal memories will be cleared erasing all reference traces, calibration details, and set-up details.

To perform a system reset, switch the instrument off. Press and hold the Hold All and the Plot buttons. Keep these buttons pressed and turn the instrument on using the Power button. The instrument will then start up in its reset condition. This can be confirmed by noting that on power up the instrument performs a complete calibration.