# Gould 4072/4074
# Operators Manual

GOULD
Electronics

# Introduction

**NOTE:** This is a combined operating manual for both the 4072 2-Channel and the 4074 4-Channel Digital Storage Oscilloscope.

Throughout the operating manual the following convention applies:–

4070 – refers to both the 4072 and 4074.
4072 – refers to only the 2 channel 4072.
4074 – refers to only the 4 channel 4074.

Gould's 4070 series of digital oscilloscopes have been designed with the user in mind. These highly sophisticated instruments are particularly easy to use.

To obtain a trace is especially simple – just connect the signal and press the Auto Setup button – the 4070 does the rest. Having obtained a trace, three readily accessible cursors make it easy to take timing and voltage measurements directly from the screen. The built-in plotter or an external plotter using HPGL can be used to make a hard copy of the display for future reference as well.

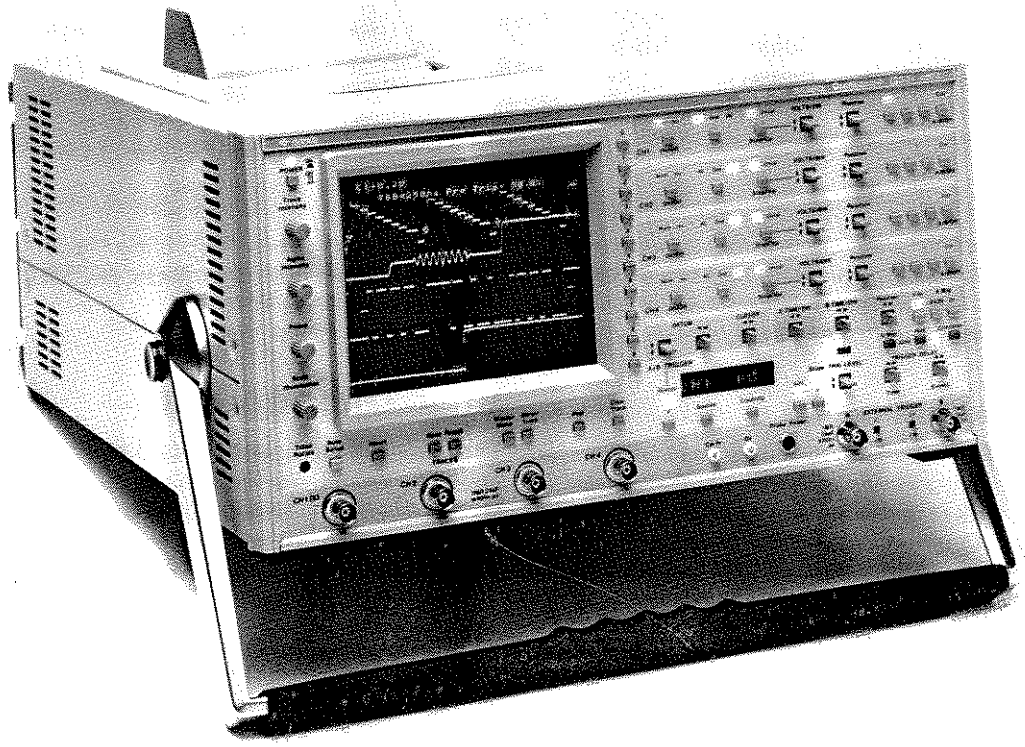
For the more advanced user, the 4070 series have a great deal to offer. The GPIB(IEEE488) and RS423(RS-232) interfaces allows control by a computer, hence the oscilloscope can be left unattended whilst it continues to take measurements and plot traces as and when required. All of the operating functions can be controlled by the computer and the oscilloscope can output complete trace data to the computer for further analysis.

The 4070 incorporates a software menu system allowing functions to be easily accessed. For example, up to four control setups including attenuator, trigger, GPIB and RS423 settings can be stored in battery-backed memory for future use with the 'Save and Recall Setups' menu.

The trigger menu allows the 4070's triggering system to be controlled using a 'Trigger Configuration Diagram'. This is designed to mimic the way that most users think about complex triggering requirements. It displays a flow diagram allowing various conditional triggering options to be set and combined appropriately. Options include event counting, time delays, and trace B to wait for triggering on trace A.

The Display menu allows control of some of the 4070's most advanced facilities. For example, using this menu, it is possible to select the glitch detection function. This can be used to detect transients as brief as 5ns even on the slowest timebase ranges. It is also useful for alias detection in certain circumstances. Another option, particularly useful when a trace has been magnified in the X direction, is interpolation. The 4070 is able to perform rapid sine interpolation on captured signals. Points are calculated and inserted between the actual samples which make up the originally captured trace. The original trace data is not lost and the uninterpolated display can be retrieved at any time. The 4070 can also perform linear interpolation if required.

The oscilloscope is also fitted with a keypad interface, allowing Gould waveform processors to be connected to provide extra functions. These include automatic measurement of risetime, overshoot and frequency.



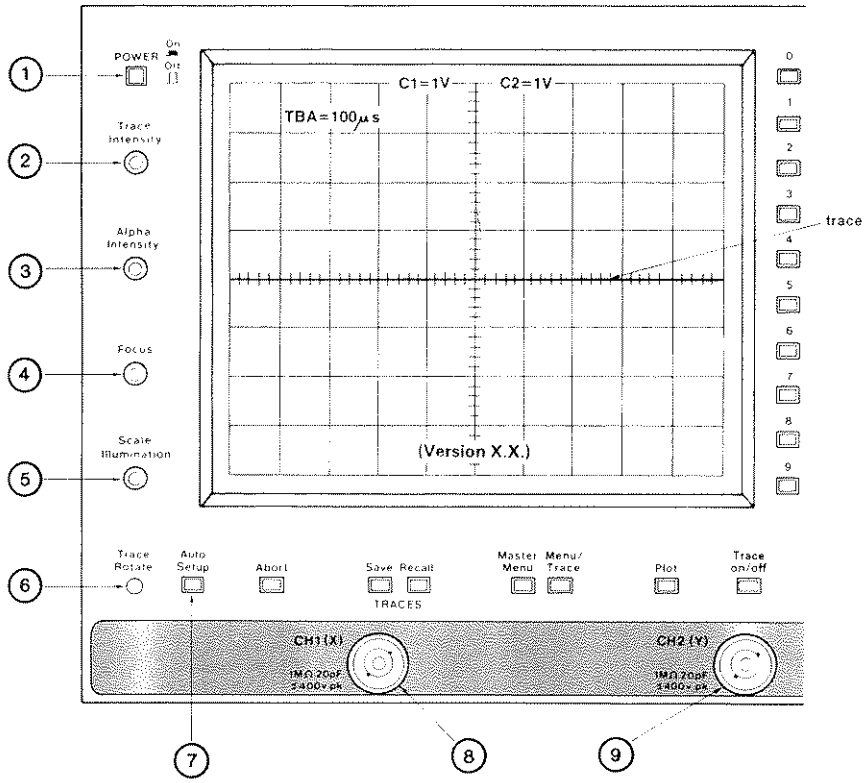



*Figure 1.1.1 Power-on Display (4072)*

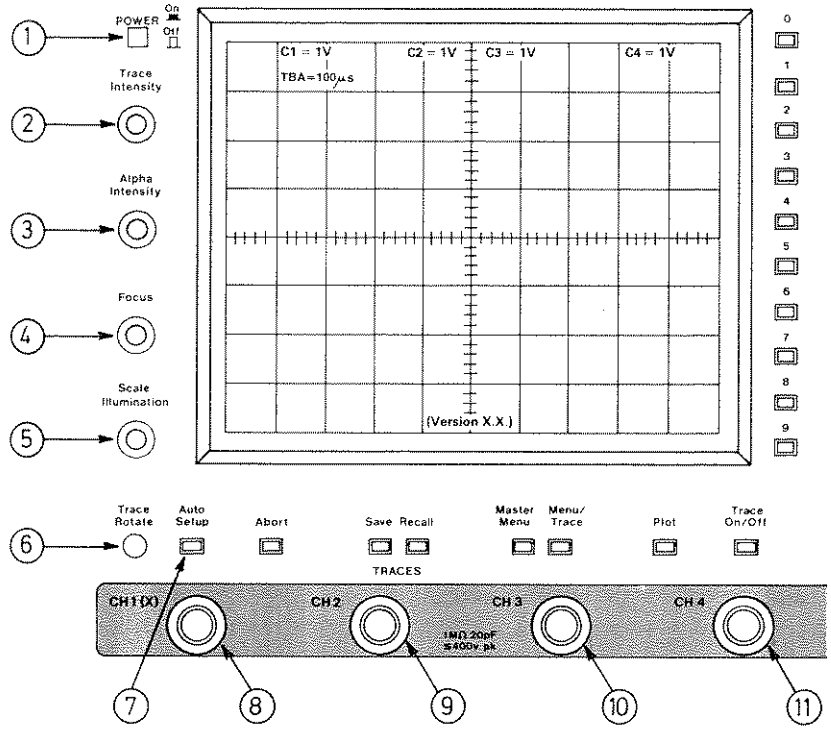



*Figure 1.1.2 Power-on Display (4074)*

**Auto Setup** (7) will always 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 roughly two to five screen divisions. It also selects auto trigger to ensure that the screen is frequently updated and a trace will be visible.

## Adjusting the Trace

The trace can be altered in two main ways: horizontally and vertically. Basic horizontal adjustments involve altering the sweep rate of the trace, so that the image on the screen stretches or contracts horizontally. The main vertical adjustment is the height of the displayed signal - i.e. the volts per screen division.

## Horizontal Adjustment (A TIME/DIV)

To alter the sweep rate of the trace, for example to look more closely at part of the image, the **A TIME/DIV** paddle is used (the **B TIME/DIV** paddle is discussed in Section 1.3.). With the 4kHz signal applied as discussed earlier, Auto Setup may have set the sweep rate to 50$\mu$s per screen division horizontally - i.e. each horizontal screen division represents 50$\mu$s worth of the input signal. This is shown by the 'TBA=50$\mu$s' near the top of the display. The 'TBA' means that the A timebase is in use: two timebases are available for each channel, namely A and B. Use of the B timebase is discussed in Section 1.3.

**A TIME/DIV** (3) This is a five position paddle which controls the sweep rate of the trace. A gentle push causes a small change in the sweep rate, whilst a firmer push will cause a large change in the sweep rate.

Given that the current sweep rate is 50$\mu$s per screen division, a single push and release of the paddle to the right will change the 'timebase' from 50$\mu$s per division to 20$\mu$s per division. The displayed signal will stretch accordingly. A second single push to the right will change the timebase again, this time to 10$\mu$s.

If you keep pushing the paddle to the right, you will find that the fastest timebase is 20ns per screen division. You may notice that at 100, 50 and 20ns per division, the oscilloscope builds up the image gradually. This is because it uses a method called 'Equivalent Time Sampling' or ETS for the faster timebases. It takes a number of random samples of the signal and adds them to the display to build up the final result. This is only useful for repetitive input signals.

If you now push the paddle to the left you will see the timebase change in the opposite direction. The maximum time per division is 20s; the 4070 will take over 3 minutes to acquire a full trace at this speed. However, assuming you are applying the 4kHz signal mentioned earlier, when the timebase reaches 50ms, an 'alias' becomes visible.

## Aliases

An alias is a false image. The 4070 is a digital oscilloscope and so takes frequent samples of the input signal in order to update the trace. Thus it may take one sample from one point on the input waveform and the next sample from a point slightly further along on the next wave. It will then display the wave as being much longer than it really is. The effect is similar in principle to the false motion of wagon-wheels as seen on a television.

The 4070 does however have a feature which will often help you to spot aliases. If the input signal peaks or troughs at any point between samples, a peak/trough can be displayed. This Max-Min function is discussed further in Section 2.4.

## Vertical Adjustment (VOLTS/DIV)

Each of the channels has its own set of vertical controls. The main control in each case is the **VOLTS/DIV** (volts per division) paddle. Again this is a five-position switch. A gentle push either up or down will result in a slow single step change in the sensitivity of the instrument. A firmer push will cause a more rapid change.

**VOLTS/DIV** (2) This is a five-position paddle. It adjusts the volts per division. Pushing the paddle upwards will adjust the sensitivity as far as 5V/div and the height of the image will be seen to decrease in accordance with the changes. In the other direction, sensitivity can be increased as far as 2mV per division, increasing the height of the screen image.

**Note:** *The 4070 can accept input signals with a peak voltage as high as plus or minus 400V. Larger signals can cause damage to the internal circuitry.*

## AC/Gnd/DC(1)

This button controls the type of coupling between the input signal and the 4070. DC is the most generally applicable, and auto setup will normally set this control to DC where possible. However, if when using the instrument you find that there is a permanent vertical offset in the display - i.e. the signal is consistently displayed too high or too low on the screen - you could try pressing this button once to set it to AC. This will cause the 4070 to remove any DC component which may be causing the offset. Repeated pressing of this button will cause it to cycle through the three settings AC, Ground and DC.

With this control set to DC, the 4070 can display signals in a frequency range of 0Hz(DC) to 100MHz. On AC, the range is 10Hz to 100MHz. With the setting on Gnd (ground) a 0V reference only is displayed (the input signal is not connected to ground or coupled to the trace in this case).

This control is discussed in more detail in Section 1.2.

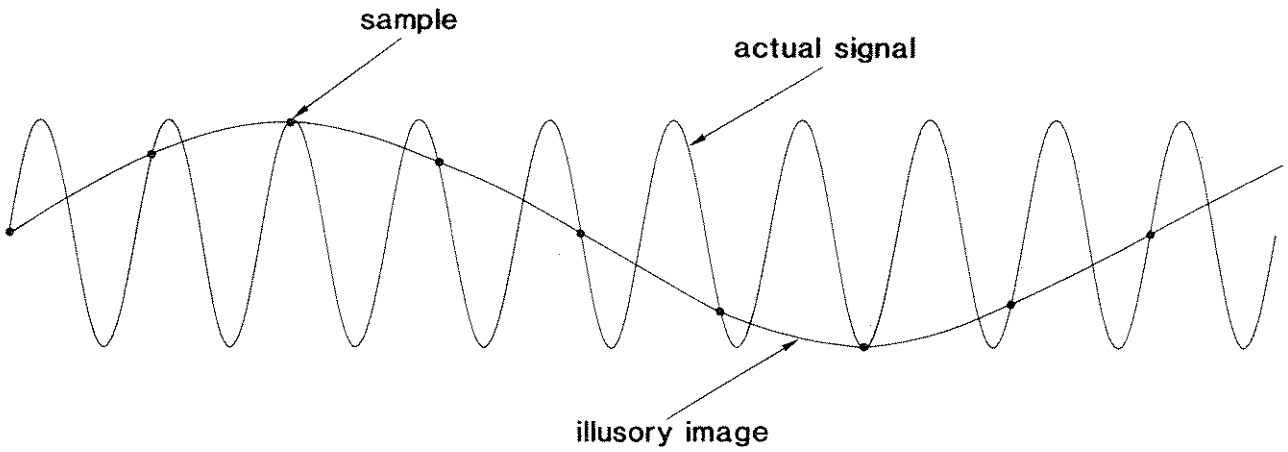



*Figure 1.1.6 Alias Generation*

## 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 the operating features have been discussed so far.

**Problem:** No trace visible.

| | |
|---|---|
| Trace intensity too low | - Correct with Trace Intensity Control.<br>Turn on other trace. |
| No stable trigger | - Select Auto Trigger until trace found. |
| Too much vertical shift | - correct with the vertical Position paddle. |
| Too much post storage shift | - cancel post storage shift. |
| Input has large DC offset | - AC couple input signal.<br>- correct with position paddle.<br>- use a less sensitive range. |

**Problem:** Trace not being acquired.

| | |
|---|---|
| Trigger level incorrect | - select AUTO and DC trigger, then adjust the level control until the trigger level 'bars' are lined up with the centre of the trace. |
| Trigger source on the wrong input | - change trigger source. |
| Trigger coupling on an unsuitable setting | - change trigger coupling. |
| Hold on | - release Hold. |
| Timebase on very slow acquisition | - adjust timebase speed. |
| Insufficient signal to trigger on | - use Auto Trigger. |
| Instrument in single capture mode | - press Continuous. |

**Problem:** Trace is unstable even when triggered.

| | |
|---|---|
| Alias | - check for alias with max-min glitch detect and select a faster timebase range. |
| Noisy input | - select DCLP or ACLP trigger coupling.<br>- select bandwidth limit.<br>- adjust trigger level. |
| Trigger on AUTO | - With low frequency inputs, below 40Hz, AUTO trigger will not work correctly. Select Normal trigger. |
| Input non-repetitive | - Select NORM trigger mode and S/Shot. |
| Input has many non-identical trigger points | - use divide by N. |

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

| | |
|---|---|
| Trace captured when in limit and post storage shift has been used. | - adjust pre-storage shift.<br>- use less sensitive range. |

**Problem:** Trace is very 'dotty'.

| | |
|---|---|
| Too much horizontal expansion | - decrease expansion.<br>- use linear or sine interpolation.<br>- re-capture on a faster timebase range. |

shown in front of the attenuator setting when variable is used. Also,when switching between Cal and Uncal the variable setting is memorised so that the 'Uncal' ratio can be recalled.

*Example screen display:*

C1=5V Channel 1 is set to a sensitivity of 5 volts per screen division.

C2>20mV Channel 2 is uncalibrated and the attenuator is set to a reduced sensitivity. (i.e. greater than 20mV per screen division.)

The status of the **Step/Var** button is indicated by the illuminated letters above the button. Depending upon this, the **VOLTS/DIV** paddle will operate as follows:

**Cal** When Cal is illuminated the paddle steps the attenuator through the discrete calibrated ranges from 2mV 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 input.

**Uncal** The coarse setting of the attenuator remains unchanged, but a variable gain is applied to the input signal. This gain has a range of 1 to about 0.4. Thus, with an initial setting of 1V, the actual sensitivity of the channel could be set by the paddle to anywhere between 1V and 2.5V per division.

**Note:** *If the Gould PB36 x10 probe is used, it will be detected and the correct sensitivity will be displayed.*

### Position (5)

The **Position** paddle controls the vertical position of the trace(s) for its channel. It has the following settings: Fast up, slow up, no shift, slow down and fast down.

If either of the A or B Post Storage lights are lit, then the **Position** paddle will apply 'post-storage shift' to the relevant trace(s). The paddle will move the trace in the same way as before. When the light is off, the trace will return to its original vertical position. This shifted position is memorised and can be recalled later by switching the light on again. When post-storage shift is used, any part of the trace which would have been off-screen at the ADC limits will be replaced by a horizontal line.

### Post Storage (7)

The three Post Storage buttons, **Hold, A** and **B,** are used for freezing a trace and determining which traces may be affected by the **Position** paddle:

**Hold** Freezes the trace on the screen the moment it is pressed. In dual timebase mode, both traces will be held. It is not possible to have one timebase held whilst keeping the other one live.

**A** Pressing this button switches the A light on and off. When the A light is illuminated, the **Position** paddle will add post-storage shift to the A trace.

**B** Pressing this button switches the B light on and off. When the B light is illuminated, the **Position** paddle will add post-storage shift to the B trace.

**Note:** *Post-storage shift is only available on live traces when in dual timebase mode, when it is useful for producing trace separation. Post-storage shift may be added to traces in single timebase modes, but only when held.*

### Cursors (6)

The cursors may be called onto any channel by pressing the respective channel's **Cursor** button. If only one timebase is in use then the cursors will go onto the only displayed trace. In dual timebase mode, the cursors will initially appear on trace A; a second press of the button will transfer them to the B trace. A third press of the button switches the cursors off.

For a full description of cursor operation, see Section 1.6.

## 1.3 HORIZONTAL POSITION AND TIMEBASE

The controls discussed in this section allow the trace to be moved sideways, magnified (i.e. stretched), and observed at widely varying sweep rates, allowing signals of greatly differing characteristics to be examined with equal ease.

### Timebase Settings (1)

The two timebases which are available for the input signal are set by the **A** and **B 'TIME/DIV'** paddles. As with all the paddles, these are five position switches; they control the rate at which the timebase is changed.

Moving either of the paddles to the left reduces the sweep speed (acquisition rate) for that trace. When 20 seconds per division is reached, further leftward presses will be ignored. Moving the paddle to the right increases the sweep speed, up to a maximum of 20ns/div (see 'Equivalent Time Sampling' below). The paddles change the timebase in 1, 2, 5 steps.

One of the special features of this oscilloscope is its ability to display the input signals alternately on two independent timebases. For example, it is permissible to display the A trace with its timebase set to 1ms/div and then display the B trace with its timebase set to 20μs/div. Visually of course, the alternation is so fast that no flickering is visible.

**Note:** *The fastest non-ETS (see below) capture rate is 250ns per division. There is no 200ns/div range.*

### Equivalent Time Sampling

The three fastest timebase ranges, 100, 50 and 20ns/division, are produced by Equivalent Time Sampling, or ETS.

### Trace Position (2)

The **Position** paddle is used to move the trace to the right and left. The paddle has five settings: fast right, slow right; no shift; slow left; and fast left. In addition, after a few moments on the fast settings the rate of shift accelerates.

The position of the cursors (see Section 1.6 for more about these) is fixed in relation to the trace and they will move with the applied shift. With X magnified traces, the cursors can be off-screen. To bring them back into view it is necessary to use the **CURSOR** position paddles.

## 1.4 BASIC TRIGGER CONTROL

The trigger facilities offered by the 4070 are very comprehensive; those discussed here are controllable directly from the front panel. For the more advanced menu-controlled facilities, see Section 2.3.

The default setting of the instrument on first power-up is as follows:

> The A trigger will be set to initiate captures on the A timebase range and the B trigger will be set to initiate captures on the B timebase range.

If no buttons are pressed within 30 seconds of power down, then the power down trigger setting will be retained on future power-up.

### Selecting Source and Coupling

The two trigger channels A and B may be set independently to any of the allowable combinations of source and coupling. When EXT, external input, is selected as the trigger source, A takes its input from the EXTERNAL TRIGGER A BNC socket, and B takes its input from the EXTERNAL TRIGGER B BNC socket.

**A/B TRIGGER** (8) This button controls which channel's status is viewed on the LED display. The light above the button shows which channel is currently being displayed. When selected in this way the source and coupling buttons will change the setup of the channel.

**Source** (9) Steps through the available options of trigger source. After line has been selected, a further press of the button returns the selection to CH1.

The options are:–

4072 – CH1, CH2, EXT and LINE.
4074 – CH1, CH3, EXT and LINE.

**Coupling** (10) Steps through the available options of trigger coupling. These are AC, ACHP(AC High Pass), ACLP(AC Low Pass),DC, & DCLP(DC Low Pass). After DCLP has been selected, a further press of the button returns the selection to AC. All the couplings can be used with the internal and EXT sources. For LINE, the input coupling is not selectable.

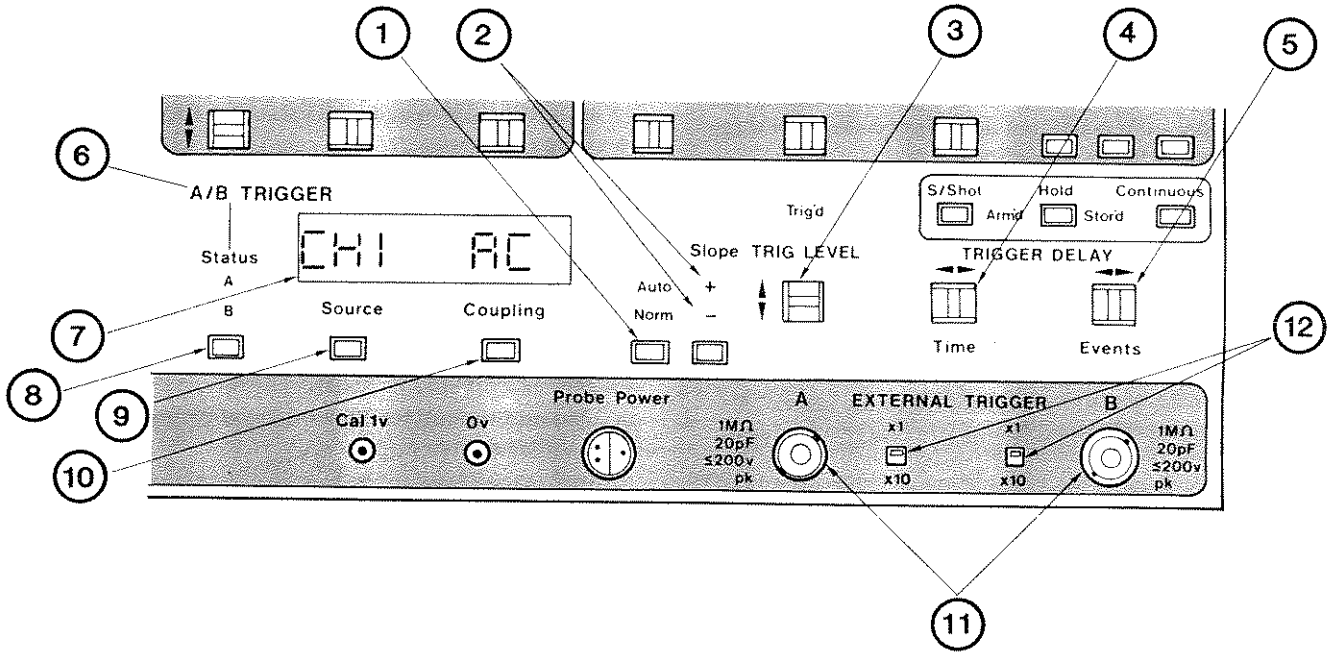



*Figure 1.4.1 Trigger Controls (Both 4072 and 4074)*

### Trigger Delay

This option allows the user to set two types of delay: delay by time and delay by events. The initiation of a capture will not then take place until the delay conditions, as described below, have been met. The two types of delay are completely independent and it is possible to combine the two. A trigger event as discussed below is a valid trigger as set by the **Source, Coupling, TRIG LEVEL** and **Slope** controls.

### Delay by Time (4)

This is set by the **Time** TRIGGER DELAY paddle. This has five settings: decrease time fast, decrease time slow, no change, increase time slow and increase time fast. The delay time step size is dependent on the chosen timebase setting.

**Time** A gentle push to the left decreases the time delay; a firmer push causes the delay to decrease at a faster rate. A gentle push to the right increases the time delay; a firmer press increases it at a faster rate. If the delay changes to zero, there will be a pause before the change continues.

If the time delay is zero, the trigger point will be at the left-hand edge of the screen. When the delay increases from zero, the display shows events after the trigger point; i.e. the trigger point moves to the left and disappears from the screen altogether. The maximum delay is dependent upon setting.

| Timebase Range | Maximum Delay |
|---|---|
| 20s/div to 0.1ms/div | 99.9s |
| 50$\mu$s/div to 50ns/div | 0.99s |
| 20ns | 0.4s |

The current trigger delay setting is shown in the screen text, e.g.

TBA = 100$\mu$s Trig Dly = 300.0$\mu$s

The A timebase is set to 100 microseconds per division and there is a delay of 300 microseconds from the trigger point to the start of acquisition, i.e. 3 screen divisions.

When the time delay is decreased from zero, the display shows events leading up to the trigger point: i.e. the trigger point moves to the right and pre-trigger events are captured. The maximum amount of pre-trigger or negative delay time that can be captured is 1 whole screen. When this is reached, the trigger point is on the right-hand edge of the screen.

Negative delay time is displayed on the screen as a percentage of pre-trigger, e.g.

TBA = 50$\mu$s Pre Trig = 30.2%

The A timebase is set to 50 microseconds per division and there is -150.5 microseconds delay. In other words, the trigger point is just over three divisions from the left-hand side of the screen.

### Delay by Events (5)

**NOTE:** This function is available when either A divided by N or B delayed by N is selected from the trigger menu (see section 23.

This option allows the user to control the number of trigger events to be detected before a trace is to be acquired. The delay is set by the Events TRIGGER DELAY paddle. This too has five settings: fast decrease; slow decrease; no change; slow increase and fast increase.

**Events** A gentle push to the left decreases the number of events, a firmer push decreases the number of events at a faster rate. A gentle push to the right increases the number of events, a firmer push increases the number more quickly.

The number of events currently selected is shown on the screen; e.g.

TBA = 100$\mu$s Events = 3

The A timebase is set to 100 microseconds per division and the displayed trace was captured after three valid trigger events were detected.

The minimum number of events delay is zero, whereby the trace will be captured following the first trigger event. The maximum number of events by which capture can be delayed is 999999 (see Section 2.3).

Note that A ÷ N and B delayed by N cannot be selected together.

## 1.5 BASIC CAPTURE FACILITIES

The basic capture facilities on the 4070 allow the user to freeze the trace on the display. There are two ways to do this: a single-shot capture whereby a full screen is acquired then frozen, or by pressing a **Hold** button. Using a **Hold** button freezes the display the moment it is pressed; this can cause a discontinuity in the trace as the displayed waveform may contain data from more than one capture.

**S/Shot** (5) This button arms the instrument for a single-shot capture. The Arm'd light will be illuminated to show that the button has been pressed.

**Arm'd** (4) This light illuminates after the **S/Shot** button has been pressed; it will stay lit until either a valid trigger has been received or until the **Continuous** button is pressed.

**Stor'd** (3) This light illuminates on completion of a single-shot acquisition. This is after the instrument has been Arm'd, triggered and a trace acquired. The light will stay illuminated until the instrument is re-armed or **Continuous** is pressed.

**Continuous** (2) This button puts the 4070 in continuous capture mode (i.e. its default state). The instrument will automatically re-arm itself after each capture is completed; this enables the displayed traces to be updated as frequently as possible.

On the 4070 there are three buttons labelled **'Hold'**. One is located in a group including buttons **S/Shot** and **Continuous:**

**Hold** (1) Freezes the displayed traces immediately irrespective of the stage any ongoing acquisition may have reached. The **Hold** lights of the respective channels will be illuminated. To release hold simply press the Hold button again.

The other two **'Hold'** buttons are associated with the two vertical channels; they can be found next to the **Position** paddles. (See Section 1.2).

**Hold** These buttons freeze the traces of the selected channel only. The Hold light will be illuminated. To release the channel hold simply press the channel **Hold** button again. (See also Sections 1.2 and 1.3).

## 1.6 CURSOR MEASUREMENTS

The 4070 allows you to take direct measurements from the screen display automatically, using inbuilt cursors. These are movable reference lines which the oscilloscope can display. It takes the measurements between these lines.

### Cursor Selection (1)

The cursors for each channel are switched on or off using the **Cursor** button for the respective channel. If the cursors are on, this will be indicated by a light above the button. If X magnification (see Section 1.3) is in use, the cursors may not be visible on the screen, but this is easily remedied using the paddles described below. The cursors can be used on either the A or B traces, selected by successive presses of the button, assuming both traces are active.

**Cursor** One press of this button brings the cursors on the A timebase trace. Another press moves them to the B timebase trace. A third press of the button switches the cursors off. If only one timebase is displayed, the cursors will be called up onto that trace; a further press of the button will de-select the cursors.

### The Cursors

Once activated by a press of the **Cursor** button, three cursors will appear, as indicated in Figure 1.6.2. The large dashed vertical line is the 'time datum' cursor and the short vertical line is the 'minor' cursor. The dashed horizontal line is known as the 'voltage datum' cursor. Note that if the cursors are already selected for one channel, selection of cursors for the other channel will automatically swap them over to the new channel. Movement of the cursors is achieved using the **DATUM** and **CURSOR** paddles.

### Movement (2)

The three cursor movement paddles are each five-position switches. The left-hand **DATUM 3** paddle moves the voltage datum cursor vertically, and the right-hand **DATUM** paddle moves the 'time datum' cursor horizontally. The **Cursor** paddle moves the minor cursor along the trace - i.e. the minor cursor, when moved horizontally, automatically follows the trace up and down as well.

### Making Measurements

*Example: Frequency and Peak to Peak Voltage.*

In Figure 1.6.2, the time and voltage datum cursors have been positioned using the **DATUM** paddles so that they cross at the trough of the waveform. The minor cursor has been positioned at the peak of the waveform using the **Cursor** paddle. The voltage is given at the bottom of the display in the form 'TR1A: 5.25V'. In other words, the vertical difference between the point where the minor cursor intersects the trace and the voltage datum cursor is 5.25 Volts. The 'TR1A' tells you that the measurement was obtained from channel 1 trace A.

At the bottom right of the screen is the reading '551.0 $\mu$s', i.e. the time difference between the minor cursor and the time datum cursor is 551 microseconds. This reading is for half a cycle, so the reading for a full cycle should be 1102 microseconds. The frequency is therefore 1/0.001102 = 907Hz. Greater accuracy could be obtained by moving the minor cursor to the next trough (where the voltage difference is zero) and finding the frequency for a complete cycle. In general, greatest accuracy is obtained by taking measurements where the slope of the waveform is at its steepest, such as at 0 Volts rather than at -2.125V as in this example.

*Example: Rise Time*

The rise time of a wave is the time it takes to traverse the central 80% of its vertical movement. To measure the rise time of, say, a simple sine wave such as that shown in Figure 1.6.3, you would first of all measure the peak to peak voltage as shown in the previous example. Suppose the result of this measurement is 5.25V. Now you would move the time datum cursor to the right using the right-hand **DATUM** paddle until it is at a point 10% of the way up the waveform. Also, use the left-hand **DATUM** paddle to move the voltage datum cursor up so that it intersects the time datum cursor at the point where it crosses the trace. This would be where the vertical difference between the voltage datum cursor and the minor cursor was 5.25-0.525=4.725V. You would then move the **CURSOR** paddle so that the vertical difference reduces to 4.725-0.525=4.2V. The reading in the lower right-hand corner of the screen would then be the rise time.

## 1.7 INPUT/OUTPUT

The 4070 is equipped with RS423 and GPIB(IEEE488) interfaces, allowing communication with a host computer. In addition, there is also a keypad option and a Miscellaneous I/O connector, which among other things is used for the analog plot outputs.

## Waveform Processor

Waveform processors are optional extras. They provide a variety of waveform processing functions such as automatic measurement of risetime, overshoot, frequency, period, and a number of filter and summation functions. Operation information on the current waveform processors available from Gould is available in section (6).

**Note:** Only a Gould keypad should be fitted to the waveform processor socket. Incorrect connection could damage the internal circuitry.

## Miscellaneous Input/Output

This connector is fitted to the rear panel and allows connection to the analogue plot outputs.

The connections are as below.

*Table 1.7.1 The Miscellaneous Input/Output Connector.*

| Pin No. | Name | Description |
|---|---|---|
| 1 | Plot X out | Plot X ramp |
| 2 | Y2 Plot out | Y2 output channel |
| 3 | not used | |
| 4 | PL2 | Pen Lift 2 |
| 5 | 0VA | 0V analogue |
| 6 | EXT PC | External Plot Clock |
| 7 | 0VL | 0V Logic |
| 8 | not used | |
| 9 | Plot Y out | Y1 output channel |
| 10 | not used | |
| 11 | PL1 | Pen Lift 1 |
| 12 | 0VA | 0V analogue |
| 13 | +5V | +5V, 100mA max. |
| 14 | 0VL | 0V Logic |
| 15 | 0VL | 0V Logic |

Note: *The +5V output on this socket is for test purposes only. If it is used for any reason then the total current must not exceed 100mA.*

## Plotting

There are five methods of plotting captured traces from the 4070. These are: internal plotter; RS423; GPIB; single-channel analogue; and dual-channel analogue. All five types are initiated by pressing the **Plot** button. Normally, the 4070 will default to plotting with the internal plotter. To change to any other type, See Section 2.7. Once another type has been selected this will be the default setting on power-up.

**Plot** Pressing this button causes the chosen plotter to make a copy of the screen display.

**Abort** If Abort is pressed while a plot is in progress then the plot is terminated. The present character/line being drawn will be completed and then normal 'scope operation will be resumed.

**Note:** *It is possible for there to be a slight discrepancy between the position of the plotted trace with respect to the graticule (screen grid) and that of the displayed trace. This is due to the effects of time and temperature on the tube and its display driving circuits. These can cause small offsets to occur on the display, but will have no effect on the graticule, which is part of the display tube glassware.*

## The Internal Plotter

The internal plotter of the 4070 enables the user to take copies of the screen display. The plot output includes the graticule (screen grid), a border, all displayed traces and some alphanumerics.

The plotter has four pens: black, blue, green and red. The grid, border and on-screen alphanumerics are plotted in one colour. Each of the four traces has a separate colour of its own, and at the end of each trace an identifier line and label is drawn to distinuish it, see Figure 1.7.1.

To load paper or install pens see below.

In addition to its normal function, the **Abort** button will also feed enough paper to enable easy removal of the partially plotted picture.

## Paper Loading

Please use only Gould paper (Part No: – 04101165 for a pack of 8 rolls).

When loading the internal plotter please follow these steps:

1. With scissors, cut the end of the paper square.
2. Open the printer cover by depressing the catch and lifting the cover until it is fully open.
3. Remove the cardboard roll from the shaft (if the plotter has been used previously).
4. Insert the end of the paper into the slot in the bottom of the plotter.
5. Insert the shaft into the roll and place the roll of paper into paper compartment.

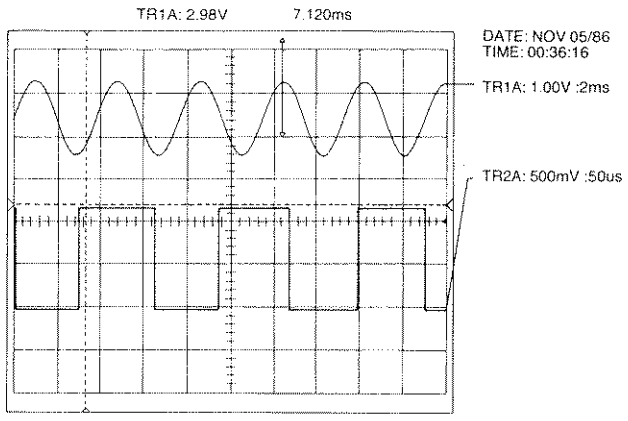



*Figure 1.7.1 Example of Plot Output.*

3. **Mixed A and B traces**
Each A trace is paired with its equivalent B trace; if an equivalent trace is not present, the trace is paired with itself, e.g. TRACE1A, TRACE3A, TRACE3B will generate the output sequence.
Y1 = TRACE1A, Y2 = TRACE1A
Y1 = TRACE3A, Y2 = TRACE3B
Y1 = TRACE2B, Y2 = TRACE2B.

## 4074 Plotting Order

When plotting a Y-T display in single pen analog mode, the eight traces will be output in the following sequence:–

TRACE1A, TRACE2A, TRACE3A, TRACE4A, TRACE1B, TRACE2B, TRACE 3B, TRACE 4B.

**Note:** the output trace plot will be available at both the Y1 and Y2 outputs.

When plotting an X-Y display in single pen analog mode, the sequence from Y1 will be the same as for Y-T mode, but the channel supplying the X signal will be available at both the X and Y2 outputs.

An X-Y display in dual pen analog mode behaves in the same way as the single analog plot.

When plotting a Y-T display in dual pen analog mode, there are three different sequences:–

1. **A traces only**
a) single trace displayed, output to Y1 and Y2
b) two traces displayed, "earlier" trace to Y1, other trace to Y2, e.g. for
TRACE2A and TRACE3A,
Y1 = TRACE2A, Y2 = TRACE3A
c) three traces displayed. The traces are paired as TRACE1A with TRACE3A and TRACE2A with TRACE4A; if a trace's pair is not present it is paired with itself. The "earlier" trace of the pair will be directed to Y1, e.g. TRACE1A, TRACE2A and TRACE4A will first output
Y1 = TRACE1A, Y2 = TRACE1A
and then output
Y1 = TRACE2A, Y2 = TRACE4A
d) four traces displayed. The traces are output as
Y1 = TRACE1A, Y2 = TRACE3A
followed by
Y1 = TRACE2A, Y2 = TRACE4A

2. **B traces only**
For B traces only the output sequence is the same as that for case 1., but using the B traces.

3. **Mixed A and B traces**
Each A trace is paired with its equivalent B trace; if an equivalent trace is not present, the trace is paired with itself, e.g. TRACE1A, TRACE3A, TRACE2B, TRACE3B will generate the output sequence.
Y1 = TRACE1A, Y2 = TRACE1A
Y1 = TRACE2B, Y2 = TRACE2B
Y1 = TRACE3A, Y2 = TRACE3B.

## RS423

RS423 is an upgrade from RS232. Provided cabling and handshaking are correctly set then there should be no problems interfacing the 4070 RS423 to any RS232 or RS423 equipment.

One difficulty that can be encountered in using RS423/RS232 is the direction of the data and handshake lines. This is usually overcome by making up special cableforms. On the 4070 it has been overcome by having all the lines internally settable.

The instrument is shipped from the factory with the following configuration:

*Table 1.7.3 The RS423 connector*

| Pin No. | Name | Description |
|---|---|---|
| 1 | 0VL | 0V Logic |
| 2 | TX | Transmit Data |
| 3 | RX | Receive Data |
| 4 | RTS | Request To Send |
| 5 | CTS | Clear To Send |
| 6 | DSR | Data Set Ready |
| 7 | 0VL | 0V Logic |
| 8 | DCD | Data Carrier Detect |
| 9 | True | RS423 Logic True |
| 14 | True | RS423 Logic True |
| 20 | DTR | Data Terminal Ready |

To re-set the connection order or to remove the handshaking it is necessary to gain access to the inside of the instrument.

## Changing the RS423 Connections

It is recommended that this operation be carried out by suitably qualified personnel.

**WARNING:** *Once the covers are removed from the instrument dangerous voltages are exposed. In particular, the area around the tube base will have voltages in excess of 2kV, which may be retained for several minutes after power down.*

1. Remove the mains connector.
2. Remove the top cover. Use the correct tools as damage to the screw heads could make the cover very difficult to remove.
3. Carefully examine the contents of the instrument. You will notice there are six cards in a rack (4074=7) to carry out this operation you will need to remove the Input/Output board. This is situated nearest to the display tube.
4. Remove the card retaining bar.
5. The I/O board is situated in the middle of the instrument,nearest to the display tube. It is also identifiable by the cableform entering it towards the rear.

## Strings

A string is the smallest complete message that can be sent over the bus.

e.g. "HSA=5E+3"

Commas may be used as separators within a string and semi-colons can be used to separate strings from each other.

e.g. "HSA=5E+3;ST1=1,2,3....."

A string may contain only ASCII characters, except binary blocks (see later). The space, character codes above 127 (decimal) and control codes other than line feed will be ignored.

## Numbers

Numbers that appear in commands must conform to certain conditions:

1. the number must contain less than 20 characters;
2. the mantissa must be an integer, i.e. it must not contain a decimal point;
3. the mantissa may contain a sign (+/−); + will be assumed if none is specified;
4. the exponent is optional; if included it must be preceeded by an 'E';
5. the exponent may contain a sign; if omitted + is assumed

## Blocks

The buffer of the 4070 is of limited size: when large data transfers are being carried out it is necessary to break them into smaller groups, or blocks. Differences arise here between RS423 and GPIB working. RS423 accepts ‹cr› and ‹lf› as terminators in different combinations. The GPIB port does the same, but in addition, the dedicated EOI (End Or Identify) bus line may be used. This line can be asserted with the final character of a transfer to signify end of transmission (as opposed to end of block). In the 4070 this is optional, the *command* EOI being used to enable or disable the use of this line. Block termination codes available for both ports are as follows (reference to EOI clearly relate only to GPIB working):

As separator between blocks:

1. ‹cr› ‹lf›
2. ‹lf› without EOI asserted.

As final block terminator:

3. ‹cr› ‹lf›, EOI asserted with ‹lf›.
4. ‹lf› with EOI (if EOI = ON has been set).
5. ‹lf› without EOI (if EOI = OFF has been set).

## Records

A record is a group of one or more command strings. The strings will be separated by semi-colons within the record. Records are separated in the same way as blocks and therefore the final record must be terminated by methods 3, 4 or 5 above.

The simplest form of record has a single string and is terminated by a ‹lf› with EOI.

e.g. "HSA=5E−3 ‹lf›" EOI asserted with ‹lf›

If a record (or a block) exceeds 82 characters, the command interpreter will process the record as far as it can.

Each complete command string within the 82 character group will be executed, though an error message may be returned if part of a further command string occurs at the end of the buffer. This command will however be correctly executed once it has been received complete.

## Command Types

There are three types of command:

**Interrogative** This is a request for information about instrument status or for the contents of a memory to be transmitted.

**Assertive** These commands request a change in one of the settings or memory of the instrument. They are only valid when in Remote or Local Lock Out mode. They have the form 'parameter=setting'.

**Direct Action Assertive** These commands have a direct action rather than changing a setting. They are only valid in Remote and Local Lock Out modes.

## Service Requests

Service requests are generated by the 4070 to inform the bus controller that some event or problem has occurred. These have no effect upon the instrument and may be ignored. In response to a serial poll or the **SRQV** command the 4070 will supply a number. This has the meaning given in Table 1.8.1.

*Table 1.8.1 Service Requests*

| SRQ No. | Meaning |
|---|---|
| 0 | Ok |
| 74 | Completed |
| 96 | Invalid command |
| 98 | SRQ stack overflow |
| 99 | Command buffer overflow |
| 100 | Selection failure |
| 101 | Not allowed when Local |
| 102 | Syntax error (parameter field) |
| 103 | Number out of range |
| 104 | Length error (bulk transmissions) |
| 105 | Checksum error |

## Sending and Receiving Stores

There are a few points to note when transferring data from the display trace stores and the reference memory stores. The data may exceed the host computers' buffer size, and may also require a considerable amount of time to transfer (particularly using RS423 at a low baud rate).

## Octal Data Transfers

Octal numbers are transmitted in ASCII coded Octal, the format is as folows:

1. The header is followed by 1008 three character octal numbers separated by commas or ‹cr›‹lf›.
2. The numbers are unsigned and in the range 000 to 377, with 000 corresponding to the bottom of the screen.
3. Leading zeros are transmitted but suppression is acceptable on the input.
4. Numbers 6 through 8 under the heading 'Decimal Data Transfers' also apply.

## Hexadecimal Data Transfers

Hexadecimal numbers are sent in ASCII as two Hex digits. The format is as follows:

1. The header followed by 1008 two character hexadecimal numbers separated by commas or ‹cr›‹lf›.
2. The numbers are unsigned and in the range 00 to FF with 00 corresponding to the bottom of the screen.
3. Leading zeros are transmitted but suppression is acceptable on the input.
4. Numbers 6 through 8 under the heading 'Decimal Data Transfers' also apply.

| | | | |
|---|---|---|---|
| HMOD | A<br>B<br>ALTB | Horizontal Mode | A,I |
| HOLD* | ON<br>OFF | Channel Hold | A,I |
| HS[A][B] | number | Horizontal Scaling | A,I |
| INT | DOT<br>DOTJ<br>LIN<br>SINE | Interpolation | A,I |
| INV* | ON<br>OFF | Channel Invert | A,I |
| LOCK | ON<br>OFF | Hold all Channels | A,I |
| MODE | ROLL<br>REFR<br>XY<br>PTR | Acquisition Mode | A,I |
| MSAV* | | Save Machine Setup | |
| MSTX* | data field | Transmit Machine Setup | A,I |
| NB | BIN<br>OCT<br>HEX<br>DEC | Number Base | A,I |
| PBG* | x1<br>x10<br>x100 | Probe Gain | A,I |
| PH− | | Phase Shift −ve | D |
| PH+ | | Phase Shift +ve | D |
| PLOT | | Start Plot | D |
| PLRT | 0.005<br>0.01<br>0.05<br>0.1<br>0.5<br>1<br>5<br>10<br>EXTERNAL | Plot Rate (DIVS/SEC) | A,I |
| PLTDST | GPIB<br>ANSGL<br>ANDL<br>PRNT<br>SRL | Plot Destination | A,I |
| PLTGT | ON<br>OFF | Plot Graticule | A,I |
| PLTMD | AUTO<br>SNGL | Plot Mode | A,I |
| PLTR | ON<br>OFF | Plot Traces Only | A,I |
| RCLMS* | | Recall Machine State | D |
| REFM* | mass transfer<br>TRC1A<br>TRC1B<br>TRC2A<br>TRC2B | Reference Store Transfer | A,I |
| REL | | Release | D |
| RM*HS | number | Reference Trace Hor. Scaling | A,I |
| RM*VS | [-][›]number[~] | Reference Trace Vert. Scaling | A,I |

**Function:** **Add Channels 1 and 2**

**Type:** Assertive, Interrogative

**Syntax:** ADD12
ADD12=[ON] or [OFF]

**Explanation:** This command causes input channels 1 and 2 to be added together before being digitised. The resulting trace is placed in the Channel 1 store.

**Examples:** ADD12
'ADD12=ON' (4070 response)
ADD12=OFF

**See also:** Section 2.4

**Function:** **Add Channels 3 and 3 (4074 only)**

**Type:** Assertive, Interrogative

**Syntax:** ADD34
ADD34 = (ON) or (OFF)

**Explanation:** This command input channels 3 and 4 to be added together before being digitised. The resulting trace is placed in the channel 3 store.

**Examples:** ADD34
'ADD34 = ON' (4074 response)
ADD34 = OFF

**See also:** Section 2.4.

**Function:** **Complete Machine Status**

**Type:** Interrogative

**Syntax:** ALL

**Explanation:** This causes the complete state of the instrument to be output as though the relevant interrogatives had been sent. Its response will be a number of strings each separated by ';', if the block length is non-zero then each block will be separated by ‹cr›‹lf› with EOI, if selected, set on the final ‹lf›.

**Example:** ALL
'ADD12=ON;.....;WIND=0,1007‹cr›‹lf›'

**See also:** HELP

**Function:** **Arm**

**Type:** Direct Action Assertive

**Syntax:** ARM

**Explanation:** This command produces the same effect as pressing the front panel **S/Shot** button.

Service request 74 will be generated when the trace has been stored. If, for some reason, the trace cannot be captured, service request 100 will be generated.

**Notes:** *It is not possible to arm the instrument with this command if:*

1. **LOCK** *is on;*
2. *All the traces are in hold;*
3. *The instrument is in* **LOCAL**;
4. *The instrument is in menu mode.*

**See also:** Section 1.5

**Function:** **Autocal**

**Type:** Assertive, Interrogative

**Syntax:** AUTCAL
AUTCAL = [ENABLE] or [DISABLE] or [FORCE]

**Explanation:** Autocal performs a regular adjustment cycle on the CCD in the acquisition system and also balances the Y-amplifier. This can be controlled remotely eg. to avoid the function coinciding with a timed measurement process. Note that if the function is removed for extended periods the trace may become noisy particularly on fast timebase speeds.

**Function:** **Averaging**

**Type:** Assertive, Interrogative

**Syntax:** AVRG
AVRG=number

**Explanation:** It is possible for the 4070 to continuously capture traces and the new trace is added to the old and the new trace is weighted by the factor. When AVRG is set to 1 then the feature is disabled. The allowable options are: OFF, 2, 4, 8, 16, 32, 64, 128 and 256.

**Examples:** AVRG
'AVRG=4' (4070 response)
AVRG=128

**Note:** *If this feature is used with Max-Min then the results can be unpredictable. When Roll is selected the first sample of each capture can be either a Max or a Min, but not neccessarily the same type on successive captures. This can cause Maxima to be averaged with Minima.*

**See also:** Section 2.4

**Function:** **Auto Setup**

**Type:** Direct Action Assertive

**Syntax:** AUTSET

**Explanation:** This command produces the same effect as pressing the **Auto Setup** button on the front panel.

**See also:** Section 1.1

**Function:** **Block Length**

**Type:** Assertive, Interrogative

**Syntax:** BL
BLL
BL=number
BLL=number

**Explanation:** This command defines the length of the blocks used during bulk transmissions. Its default state is zero, which selects infinite length blocks. Values from 0 to 256 may be used. Apart from zero these specify the maximum number of characters that will be sent before a ‹cr›‹lf›.

**Explanation:** In its assertive form this command moves the time datum cursor to the specified position on the screen. The range is 0 to +10.07, zero being the left-hand edge of the screen and 10.07 being the right-hand edge.

**Examples:** DATMH=9.4
DATMH
'DATMH=3.7' (4070 response)

**See also:** DATMV, CSRHP, CSRVP, Section 1.6

**Function:** **Voltage Datum Position**

**Type:** Assertive, Interrogative

**Syntax:** DATMV
DATMV=number

**Explanation:** In its assertive form this command moves the voltage datum cursor to the specified position on the screen. The range is +/−4.48, zero being the centre of the screen and +4 being the top of the grid.

**Examples:** DATMV =0.5
DATMV
'DATMV=1.35' (4070 response)

**See also:** DATMH, CSRHP, CSRVP, Section 1.6

**Function:** **Display Menus or Traces**

**Type:** Assertive, Interrogative

**Syntax:** DISPLAY
DISPLAY=[TRACE] or [MENU][number]

**Explanation:** This command controls whether traces or menus are displayed. If menus are chosen then this is accompanied by the menu number:

MENU0 - Master Menu
MENU1 - Status Menu
MENU2 - Trigger Menu
MENU3 - Display Menu
MENU4 - Help Menu
MENU5 - Save and Recall Setup Menu
MENU6 - Plot Menu
MENU7 - I/O Interfaces Menu
MENU8 - TV and Special Functions Menu

The trace display consists of those traces selected by CH* command.

**Examples:** DISPLAY=MENU4
DISPLAY
'DISPLAY=TRACE' (4070 response)

**See also:** CH*, Section 2.1

**Function:** **End or Identify**

**Type:** Assertive, Interrogative

**Syntax:** EOI
EOI=[ON] or [OFF]

**Explanation:** This command affects only the GPIB interface. When EOI is asserted this indicates the end of the present transmission. If EOI=OFF then EOI will be ignored if asserted. EOI = ON is the default at power on.
(See 'Blocks' Section 1.8).

**Examples:** EOI=OFF
EOI
'EOI=OFF' (4070 response)

**Function:** **Glitch Detect**

**Type:** Assertive, Interrogative

**Syntax:** GLDET
GLDET=[OFF] or [MAX] or [MIN]
or (MAXMIN]

**Explanation:** This command allows the glitch detector of the 4070 to be configured as if from the menu.

**Examples:** GLDET
'GLDET=OFF' (4070 response)
GLDET=MAXMIN

**See also:** Section 2.4.

**Function:** **Horizontal Expansion**

**Type:** Assertive, Interrogative

**Syntax:** HE
HE=[1], [2], [5], [10] or [20]

**Explanation:** This command allows the present X magnification to be interrogated or a new value set. This works in the same way as the front panel buttons X Mag ON and X Mag 2▶20, although this one command can perform both functions. There are five possible options, x1 or OFF, x2, x5, x10 and x20.

**Examples** HE=5
HE
'HE=1' (4070 response)

**Notes:** *In the same way as the front panel buttons, HE expands the trace around the present centre of the screen.*

**See also:** HSA, HSB, INT, Section 1.3

**Function:** **Hello Message**

**Type:** Interrogative

**Syntax:** HELLO

**Explanation:** This command returns the message 'Gould, 4072, Software issue no.' or 'Gould, 4074, Software issue no.'

**Function:** **Command List**

**Type:** Interrogative

**Syntax:** HELP

**Explanation:** When this command is issued the 4070 responds with a list of all the allowable command names.

**See also:** ALL

**Function:** **LOCK, Hold All Channels**

**Type:** Assertive, Interrogative

**Syntax:** LOCK=[ON] or [OFF]

**Explanation:** When LOCK is asserted all channel traces are held, even if part way through an acquisition. The action of this command is exactly the same as the Hold button on the front panel.

**Example:** LOCK=ON hold all traces

**See also:** HOLD, Section 1.5

**Function:** **Acquisition Mode**

**Type:** Assertive, Interrogative

**Syntax:** MODE
MODE=[ROLL], [REFR], [XY] or [PTR]

**Explanation:** There are four capture modes on the 4070:

1. ROLL Chart recorder mode: the data comes in from the right-hand side of the screen and travels to the left-hand side, even in the absence of a trigger. This is only valid at timebase ranges slower than 20ms/div. At faster ranges REFR and ROLL are indistinguishable.
2. REFR Refresh mode: data is plotted from left to right across the screen, after a valid trigger is received.
3. XY XY mode: Channel 1 is displayed as the X or horizontal part of the trace and Channel 2 as the Y or vertical part. In 4074, Channels 3 and 4 are also displayed as the vertical part.
4. PTR Pre-Trigger Roll: this mode is a combination of ROLL and REFR in that any part of the trace that was captured before the trigger point will behave like ROLL while the rest will be refreshed. In the same way as ROLL, this is only valid on timebase ranges slower than 20ms/div.

**Examples:** MODE=XY

MODE
'MODE=PTR' (4070 response)

**See also:** Section 2.4.

**Function:** **Save Machine Setup**

**Type:** Direct Action Assertive

**Syntax:** MSAV1
MSAV2
MSAV3
MSAV4

**Explanation:** This command provides the same function as the save part of the Save and Recall Setup Menu. When this command is asserted the present machine setup is saved into the specified backup memory.

**Example:** MSAV1

**See also:** MSTX*, RCLMS, Section 2.6

**Function:** **Transmit Machine Setup**

**Type:** Assertive, Interrogative

**Syntax:** MSTX1
MSTX2
MSTX3
MSTX4

**Explanation:** The data sent by this command is a series of numbers that have no decipherable meaning. They can be used to extend the number of saved machine setups. The format of the numbers is controlled by NB and BLL.

**Example:** MSTX3
'MSTX3= data field ‹cr›‹lf›'

**See also:** MSAV*, RCLMS, Section 4.6

**Function:** **Number Base**

**Type:** Assertive, Interrogative

**Syntax:** NB
NB=[BIN], [OCT], [HEX] or [DEC]

**Explanation:** This command specifies the number base used during bulk data transfers. There are four options:

1. BIN Binary: each byte transferred represents the data for one sample. This is the fastest transfer mode. The range is from 00000000B (bottom of the screen) to 11111111B (top of the screen); the centre is given by 10000000B. Not available via RS423.
2. OCT Octal: each data sample is sent as three unsigned octal (base 8) digits. The range is 000O (bottom of the screen) to 377O (top of the screen); the centre is given by 200O.
3. HEX Hexadecimal: each data sample is sent as two unsigned hex (base 16) digits. The range is 00H (bottom of the screen) to FFH (top of the screen); the centre is given by 80H.
4. DEC Decimal: each data sample is sent as a signed decimal number. The range is -128 (bottom of the screen) to +127 (top of the screen); the centre is given by 0. This is the slowest transfer mode.

**Examples:** NB=OCT

NB
'NB=DEC' (4070 response)

**Notes:** *The number base defaults to decimal (DEC) on power up and the selected number base is used for transmitted data, the numeric base for receive data is specified in the header of the bulk transfer. Any numbers received outside the range for the chosen number base will generate a service request 103.*

**See also:** BL, BLL, TRC*A, TRC*B, REFM*

**Function:** **Plot Mode**

**Type:** Assertive, Interrogative

**Syntax:** PLTMD
PLTMD=[AUTO] or [SNGL]

**Explanation:** On the 4070 there are two plot modes, Auto and Single. In single mode when plot is asserted, either by the front panel button or by the PLOT command, a hard copy of the screen display is made on the selected plotter. In auto mode when plot is asserted, a hard copy of the screen is made on the selected plotter, the instrument performs another capture, makes a further hard copy, etc.

**Examples:** PLTMD=AUTO

PLTMD
'PLTMD=SNGL' (4070 response)

**Note:** *There are only two ways to stop the instrument once AUTO mode is asserted: press Abort on the front panel; or send device clear.*

**See also:** Section 1.7

**Function:** **Plot Traces Only**

**Type:** Assertive, Interrogative

**Syntax:** PLTR
PLTR=[ON] or [OFF]

**Explanation:** On the internal plotter and in the two external digital plot modes it is possible to plot traces, the graticule and some alphanumerics. When PLTR=ON the graticule and alphanumerics will not be plotted, even if PLTGTON. In analog plot modes PLTR=OFF is an invalid selection. This command determines the format of the plot; it does not plot anything directly.

**Examples:** PLTR=ON

PLTR
'PLTR=OFF' (4070 response)

**See also:** PLTGT, Section 1.7

**Function:** **Recall Machine Setup**

**Type:** Direct Action Assertive

**Syntax:** RCLMS1
RCLMS2
RCLMS3
RCLMS4

**Explanation:** This command recalls one of the backed-up machine setups. These are setups for all the instrument's controls, i.e. attenuator settings, timebase ranges, trigger source and coupling, etc.

**Example:** RCLMS3

**See also:** Section 2.6

**Function:** **Reference Store Transfer**

**Type:** Assertive, Interrogative

**Syntax:** REFM1 REFM5
REFM2 REFM6
REFM3 REFM7
REFM4 REFM8
REFM*
REFM1=[Data Field], [TRC1A], [TRC2A], [TRC1B], [TRC2B], [TRC3A], [TRC3B], [TRC4A] or [TRC4B]
REFM2 to REFM8 are identical.

**Explanation:** The reference trace stores of the 4070 can be transfered to and from the host computer, or set equal to one of the display trace stores. Each store consists of 1008 data samples, the first data sample being from the left-hand edge of the screen and successive samples coming from one position further right each time.

The format of the data field is dependent on the specified block length. If BLL=0 then this will consist of 1008 numbers in the specified numeric base followed by ‹cr› ‹lf› with EOI on the ‹lf›, if asserted. If BLL is non-zero then the data field will consist of a number of blocks of data each separated by ‹cr› ‹lf› with EOI (if selected) on the last ‹lf›.The numeric base of the data is determined by the NB command.

The command REFM* can only be used interrogatively and has the same effect as issuing the commands REFM1 to REFM8 separately. The instrument responds by sending the contents of each store in the selected number base.

It is also possible to copy one of the screen traces into a reference store with this command. The screen traces are referred to as TRC1A, TRC1B, TRC2A to TRC4B.

**Examples:** REFM1=TRC1A

REFM2
'REFM2=3,25,89,2,..,123,-5,4,6'

**Notes:** *The format of the transmitted data is the same as the received data. Additional backup stores can be created in the host computer by retaining this data and transmitting it back to the instrument at a later date.*

**See also:** BL, BLL, NB, TRC*A, TRC*B

**Function:** **Release**

**Type:** Direct Action Assertive

**Syntax:** REL

**Explanation:** This command has the same effect as pressing the front panel button Continuous.

**Example:** REL

**See also:** ARM, Section 1.5

**Function:** **Service Request Value**

**Type:** Interrogative

**Syntax:** SRQV

**Explanation:** When an error is generated in the instrument, either through an invalid command being issued or for any other reason, a service request is generated. This command allows the user to ascertain what the error is and then determine its cause. The service requests are listed below:

| SRQ No. | Meaning |
|---|---|
| 0 | ok |
| 74 | completed |
| 96 | invalid command |
| 99 | command buffer overflow |
| 100 | selection failure |
| 101 | not allowed when local |
| 102 | syntax error in parameter field |
| 103 | number out of range |
| 104 | length error |
| 105 | checksum error |

**Example:** SRQV
'SRQV=74' (4070 response)

**Note:** *The last two service request numbers, 104 and 105, are only generated by errors in bulk transmissions.*

**See also:** Section 1.7

**Function:** **Acquisition Status**

**Type:** Interrogative

**Syntax:** STAT

**Explanation:** This command allows the user to determine which stage the instrument has reached in an acquisition. The three states are given below:

| Value | State |
|---|---|
| ARMD | Armed but not yet triggered |
| TRIGD | Triggered, acquisition in progress |
| STORD | Stored, trace acquisition complete. |

**Example:** STAT
'STAT=TRIGD' (4070 response)

**See also:** Section 1.5

**Function:** **Trigger Delay by Time**

**Type:** Assertive, Interrogative

**Syntax:** TDELA
TDELB
TDELA=number
TDELB=number

**Explanation:** This command allows the present value of the trigger 'delay by time' function for timebases A and B to be read or changed. The minimum time delay is minus 10.24 screen divisions, the maximum is given in the table below. Negative time delays capture events prior to the trigger point (this is called pre-trigger). The amount of pre-trigger is expressed as a percentage, i.e. -100.0 (100% pre-trigger) places the trigger point on the right-hand edge of the screen and 0.0 (0% pre-trigger) places it on the left-hand edge. Positive time delay settings capture events after the trigger point, and are expressed in seconds.

| Timebase range | Max. TDEL |
|---|---|
| 20s/div to 0.1ms/div | 99.9s |
| 50$\mu$s/div to 50ns/div | 0.99s |
| 20ns | 0.40s |

**Examples:** TDEL=-50
TDEL
'TEL=0.0' (4070 response)

**See also:** TEVNT, Section 1.4

**Function:** **Trigger Delay by Events**

**Type:** Assertive, Interrogative

**Syntax:** TEVNT
TEVNT=number

**Explanation:** On the 4070 it is possible to delay the start of acquisition from arm by a number of trigger events. The specified number of trigger events will be required before an acquisition can begin. The range is from 1 to 999999. The selected trigger mode must be: ADIVN, BDELN, BGATA–DELN or BGAT–ADIVN.

**Examples:** TEVNT=951
TEVNT
'TEVNT=3' (4070 response)

**Note:** *A trigger event is a valid trigger as determined by the trigger source, coupling, level and slope controls.*

**See also:** TDELA, TRGMDA, Section 1.4

**Function:** **Auto trigger mode on or off**

**Type:** Assertive, Interrogative

**Syntax:** TGAAUT
TGAAUT=[ON], [OFF]

**Explanation:** This command allows the auto-trigger circuit of timebase A to be turned on or off. Note that no auto-trigger circuit exists for timebase B.

**Examples:** TGAAUT=ON
TGAAUT
'TGAAUT=OFF' (4070 response)

**See also:** TRGMDA, TS*, TSL*, Section 1.4

The format of the data field is dependent on the specified block length. If BLL=0 then this will consist of 1008 numbers in the specified numeric base followed by ‹cr› ‹lf› with EOI on the ‹lf›. If BLL is non-zero then the data field will consist of a number of blocks each separated by ‹cr› ‹lf› with EOI on the last ‹lf›, if asserted.

The commands TRC*A and TRC*B can only be used interrogatively. These are equivalent to issuing the commands TRC1A, TRC2A and TRC1B, TRC2B respectively, the instrument responds with the data from each trace.

**Examples:** TRC1A=REFM2

TRC*B
'TRC1B=3,20,2,1,0,....,34;
TRC2B=3,50,1,2,....,45,6 ‹cr›‹lf›'

**See also:** EOI, REFM*, BL, BLL, NB, WIND

**Function:** **Horizontal Trace Scaling**

**Type:** Assertive, Interrogative

**Syntax:** TRHS1A TRHS3A
TRHS2A TRHS4A
TRHS*A TRHS3B
TRHS1B TRHS4B
TRHS2B
TRHS*B
TRHS1A=number
TRHS1B=number
TRHS2A=number
TRHS2B=number
**4074 only:**
TRHS3A=number
TRHS3B=number
TRHS4A=number
TRHS4B=number

**Explanation:** When a display trace is stored the horizontal scaling is also stored. This value can be changed or interrogated with this command. The range is 20ns per division to 20s per division in 1, 2, 5 steps. TRHS*A interrogates the scaling of both the A timebase traces and TRHS*B interrogates both the B traces.

**Examples:** TRHS1A=200E-3

TRHS2B
'TRHS2B=5E-9' (4070 response)

**Note:** *When the scaling has been changed the results of any cursor calculation will be based on the new value.*

**See also:** HSA, HSB, Section 1.3

**Function:** **Vertical Trace Scaling**

**Type:** Assertive, Interrogative

**Syntax:** TRVS1A
TRVS1B
TRVS2A
TRVS2B
TRVS1A=[-][›]number[~]
TRVS1B=[-][›]number[~]
TRVS2A=[-][›]number[~]
TRVS2B=[-][‹]number[~]
TRVS3A=[-][‹]number[~] (4074 only)
TRVS3B=[-][‹]number[~] (4074 only)
TRVS4A=[-][‹]number[~] (4074 only)
TRVS4B=[-][‹]number[~] (4074 only)

**Explanation:** When a display trace is stored the vertical scaling is also stored. This value can be changed or interrogated with this command. The range is 2mV per division to 5V per division in 1, 2, 5 steps. In addition to the scaling there are three other pieces of information that may be specified:

- `-` Trace invert
- `›` Uncalibrated
- `~` AC coupled

**Examples:** TRVS1A=5

TRVS2B
'TRVS2B=2E-3' (4070 response)

-0.5~ means the trace is AC coupled and invert is on.
›10 means the trace is uncalibrated and the sensitivity is greater the 10V per division.

**Note:** *When the scaling has been changed the results of any cursor calculation will be based on the new value.*

**See also:** VS*, Section 1.2

**Function:** **Trigger Source**

**Type:** Assertive, Interrogative

**Syntax:** TSA
TSB
TSA=[CH1], [CH2], [EXTA] or [LINE] (4072 only)
TSB=[CH1], [CH2], [EXTB] or [LINE] (4072 only)
TSA=[CH1], [CH3], [EXTA] or [LINE] (4074 only)
TSB=[CH1], [CH3], [EXTB] or [LINE] (4074 only)

**Explanation:** On the 4070 there are five different sources for the trigger channels, the two input channels, the two external inputs and LINE. Channel A cannot use EXTB as input and Channel B cannot use EXTA as input. The exception to this is where channel A takes EXTA as input and Channel B is using TV line coupling, TRGCB=TVL. In this case Channel B will be using the same source as Channel A.

If dual timebase mode is selected then both the A and B timebase traces will be shifted by this command.

VP* returns the values of the shift for all input channels.

**Examples:** VP1=7.65

VP2
'VP2=-4.67' (4070 response)

**See also:** VPS*, Section 1.2

**Function:** **Post Storage Shift**

**Type:** Assertive, Interrogative

**Syntax:**

| **4070** | **4074** |
|---|---|
| VPS1A | VPS3A |
| VPS1B | VPS3B |
| VPS2A | VPS4A |
| VPS2B | VPS4B |
| VPS*A | |
| VPS*B | |
| VPS1A=number | VPS3A=number |
| VPS1B=number | VPS3B=number |
| VPS2A=number | VPS4A=number |
| VPS2B=number | VPS4B=number |

**Explanation:** The vertical position of traces on the instrument can be controlled in two ways: pre-storage shift and post-storage shift. This command controls post-storage shift; see VS* for pre-storage shift. The input range is +/- 4.48 screen divisions, where zero is nominally the centre of the screen.

**Examples:** VPS2B=-3.8

VPS1A
'VPS1A=4.2' (4070 response)

**See also:** VP, Section 1.2

**Function:** **Vertical Scaling**

**Type:** Assertive, Interrogative

**Syntax:**

| **4070** | **4074** |
|---|---|
| VS1 | VS3 |
| VS2 | VS4 |
| VS* | |
| VS1=[-][›]number[~] | VS3[-][›]number[~] |
| VS2=[-][›]number[~] | VS4[-][‹]number[~] |

**Explanation:** This command allows the attenuator settings of the input channels to be interrogated or set. The range of inputs is 2mV per division to 5V per division in 1, 2, 5 steps.In addition to the attenuator settings there are three other pieces of information that may be specified:

- `-` Trace invert
- `›` Uncalibrated
- `~` AC coupled

**Examples:** VS1=5

VS2
'VS2=2E-3' (4070 response)

-0.5~ means the trace is AC coupled and invert is on.
›5 means the trace is un-calibrated and the sensitivity is greater than 5V per division.

**See also:** TRVS*A, TRVS*B, Section 1.2

**Function:** **Trace Window**

**Type:** Assertive, Interrogative

**Syntax:** WIND
WIND=number1, number2

**Explanation:** This command is used in conjunction with the block transfer commands. It specifies a window on the trace that will be transmitted next time a block transfer is requested. The range for number1 is 0 to 1006 and for number2 is 1 to 1007, number2 must always be greater than number1. Only the data samples between the two numbers will be transferred, inclusive.

**Examples:** WIND=1,58

WIND
'WIND=0,1007' (4070 response)

**See also:** REFM*, TRC*A, TRC*B

**Trigger** This consists of a 'graphical' menu which controls the 4070 trigger system and allows easy setting of the trigger processor.

**Display** This menu controls how the traces are acquired and in what format they are subsequently displayed.

**Help** A brief menu giving some information on various aspects of the instrument's operation.

**Save and Recall Setup** Up to four control setups on the 4070 can be retained in the backup memory for future recall. These save and recall features can be accessed with this menu. The status menu allows the saved setups to be viewed, see above.

**Plot** The various methods of plotting captured traces can be set using this menu. Once set up, simply press the Plot button on the front panel to produce a hard copy.

**I/O Interfaces** This menu allows the controllable features of the GPIB and RS423 interfaces to be set. These include such things as the GPIB address and RS423 baud rate.

**TV and Special Functions** The additional trigger couplings, TV line and TV frame, can be selected through this menu. In addition, the time and date may also be set for use on the plot outputs.

### Controlling the Menus

The menus consist of a number of rows of text each of which is in line with one of the numeric buttons at the side of the display. On some of the lines you will notice there are characters in inverse video, these show which option has been chosen. In some cases, where the number of options is large, only the selected one is shown. Again, you will notice that some of the inverse characters are flashing, this indicates the active line. The entry on this line may be changed by the the relevant numeric button or the vertical datum paddle.

**Horizontal Datum** can be used to select the active line in the current menu. This is in addition to using the numeric buttons at the side of the display.

**Vertical Datum** can be used to select options on the active line or skip over digits in number entry mode (see later).

## 2.2 STATUS MENU

This menu allows the horizontal, vertical and trigger settings of the instrument to be viewed. A typical display is shown in Figure 2.2.1.

**VIEW SETUP** There are five possible setups on the 4070, the four held in the backup store (see Section 2.6) and the current setup obtained from the front panel buttons and paddles. The setup presently being displayed is indicated by the inverse video characters after the words 'VIEW SETUP'.

*Examples:*

| | |
|---|---|
| VIEW SETUP CURRENT | The status menu is showing the present instrument setup. |
| VIEW SETUP 4 | The setup in memory number 4 is being displayed. |

To view a different setup simply press button number **1.** Each press steps through the five options: CURRENT, 1, 2, 3, and 4. After 4 has been selected a further press will return the choice to CURRENT.

**Mode:** There are four display modes: Roll, Refreshed, Pre-Trigger Roll and XY. The mode in the displayed setup is indicated by the abbreviations given below:

| | |
|---|---|
| Roll | Roll |
| Refreshed | Refr |
| Pre-Trigger Roll | Pretrig Roll |
| XY | X-Y |

The four modes and how they operate are described under the display menu, Section 2.4.

### Channel Sensitivity

The input sensitivity of the input channels is shown in volts per division. The range is 2mV to 5V per division. If add mode is selected, as in the example in Fig 2.2.1, a 'plus' sign is shown after the attenuator range for channel 1. If invert is selected a 'minus' sign is shown before the attenuator range.

### Timebases

The sweep rate of the two timebases, TBA and TBB, is shown in s, ms, $\mu$s or ns per division. Following this is the trigger 'delay by time' setting. If the time delay is positive this is given in s, ms, $\mu$s or ns as appropriate. With negative time delays the figure is given as a percentage of pre-trigger: 0% places the trigger point at the left hand edge of the screen, 50% in the middle and 100% at the right hand edge.

### Triggering

Under each timebase line is a short description of how the sweep is started. This is a representation of the trigger configuration diagram in words, see Section 2.3 for more details.

The bottom two lines show the two trigger channels' source, coupling and trigger level settings. The choices of source and coupling are detailed in Section 1.4.

*Note: The trigger level cannot be directly related to a position on the screen, so the figure shown is only representative of the trigger level compared with its settable range.*

## 2.3 TRIGGER MENU

The trigger system on the 4070 is particularly versatile, a graphical representation is used to facilitate ease of setup.

The menu shows two triggers entering at the top, A trig and B trig. These represent the A and B trigger source and coupling combinations. The menu shows how these are processed to initiate the two sweeps, i.e. the A sweep and the B sweep.

The six functions that can be introduced in the trigger paths are described below. At the end of this section is a description of how they may be combined to provide complex trigger functions.

### Number Entry in Menu Mode

Certain functions on the trigger menu require numbers to be entered. This is done as follows:

1. The digits are entered one at a time, starting with the most significant one, i.e. the left-hand digit.
2. The digit currently being entered is shown in flashing inverse video.
3. After each digit is entered the next one to the right begins to flash.
4. After all digits have been entered the front panel buttons return to their usual menu control functions.

As an alternative, while the flashing numeral is indicating an 'active' numeric field for delay or events, the appropriate Trigger Delay paddle can be used to alter the value. Once set, Datum should be used to leave the active field.

If **Abort** is pressed at any time during input, number entry is terminated and the feature is de-selected. The last used value is retained, and recalled if the feature is selected again.

### A Divided by N

This feature is shown on the menu by the letters:

A ÷ N

The text is in line with the front panel button **2**. If function is already selected then pressing this button de-selects it. When it is not selected the first press of this button selects 'divide by N', the last used value is displayed.The second press puts the menu into number entry mode, see above. The numeric buttons are now used to enter the number N. The range of numbers is 1 to 999999. The value 1 is equivalent to not having the function selected.

In addition, pressing the Trigger Events paddle while in numeric entry mode increases or decreases this number.

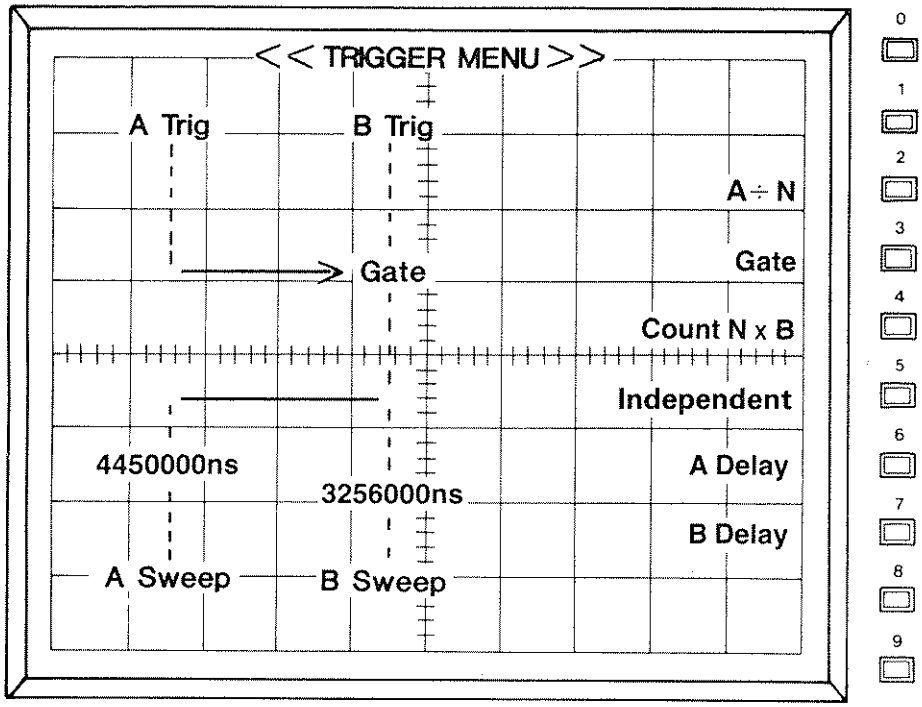



*Figure 2.3.1 The Graphical Trigger Menu (4070)*

The A sweep is unaffected, and a capture is initiated by a valid A trigger after an arm. The B sweep, however, can only begin a capture on the 20th valid B trigger after arm.

**Note:** *If 'A divided by N' is selected then 'B delay by N' cannot be used, and vice-versa.*
*In addition, 'A divided by N' cannot be used with 'Independent' (see below).*

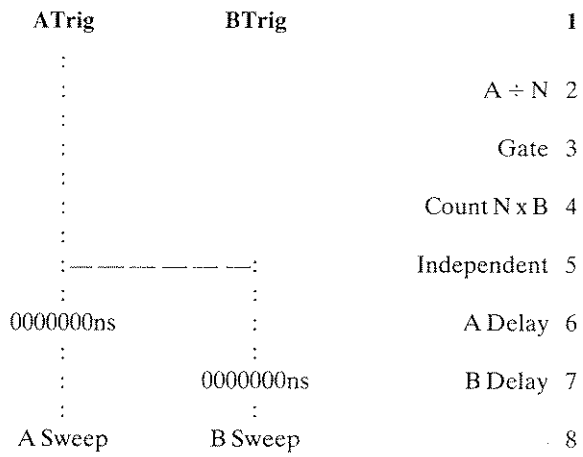
## Independent

This feature is shown on the menu by the letters:

Independent

The text is in line with the front panel button 5. Pressing this button selects 'dependent', a further press 'Independent'.

*Example:* select dependent




The A sweep is unaffected, and a capture is initiated by a valid A trigger after arm. The B sweep does not use B triggers at all, but will begin the sweep with the same A trigger that started the A sweep.

## A Delay by Time

This feature is shown on the menu by the letters:

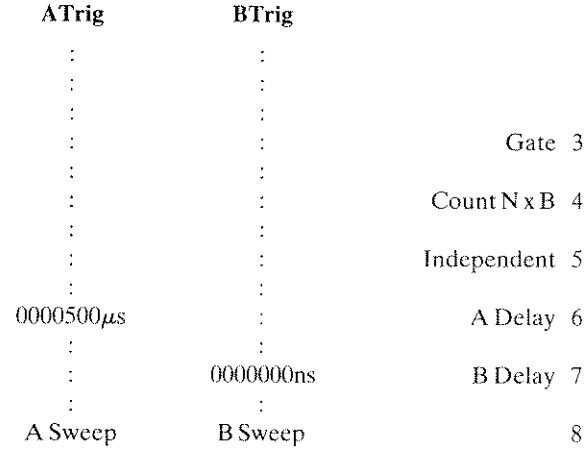
A Delay

The text is in line with the front panel button 6. If the function is already selected pressing this button switches it off. When not selected the first press selects 'A delay by time'. The display now subtly changes: on the line level with button 4 the units field appears. There are five choices, the selection of which is made by repeated pressing of button 4 . These are:

| | |
|---|---|
| % | for pre-trigger; |
| ns | nano-seconds; |
| μs | micro-seconds; |
| ms | milli-seconds; |
| s | seconds. |

When the correct units are displayed press button 6 again, this puts the menu in number entry mode, see above. The numeric buttons are now used to enter the delay time. In addition, this number can be entered by the 'Time Delay' paddle: pushing to the left decreases the delay and pushing to the right increases it. See also Section 1.4.

*Example:* select A delay by time with a delay of 0.5ms




The B sweep is unaffected and a capture is initiated by a valid B trigger after arm. The A sweep begins its capture 500μs (0.5ms) after the receipt of a valid A trigger after arm. Negative time delays allow capture of events prior to the trigger point. See Section 1.4 for more details.

## B Delay by Time

This feature is shown on the menu by the letters:

B Delay

The text is in line with the front panel button 7. If the function is already selected pressing this button switches it off. When not selected the first press selects 'B delay by time'. The display now subtly changes, on the line level with button 4 the units field appears. There are five choices, the selection of which is made by repeated pressing of button 4. These are:

| | |
|---|---|
| % | for pre-trigger; |
| ns | nano-seconds; |
| μs | micro-seconds; |
| ms | milli-seconds; |
| s | seconds. |

When the correct units are displayed press button 7 again; this puts the menu in number entry mode, see above. The numeric buttons are now used to enter the delay time. In addition, this number can be entered by the 'Time Delay' paddle: pushing to the left decreases the delay and pushing to the right increases it. See also Section 1.4.

## 2.4 THE DISPLAY MENU

This menu can be used to control some of the more advanced features of the oscilloscope, including its 'glitch' or transient detection facilities, and its sophisticated interpolation capabilities.

### Timebase Mode

The captures on the 4070 can be realised in a number of different ways. The options available are:

**Roll** This mode is like a chart recorder: the display scrolls from right to left until a trace has been acquired. This scrolling effect operates on the slower timebase ranges, upto 50ms/div. On the faster ranges there is no discernable difference between Roll and Refreshed.

**Refresh** This is the more usual oscilloscope mode, imitating the normal timebase of a real-time 'scope. The display is plotted from left to right as it is acquired.

**PreTrig Roll** This mode is a mixture of the previous two modes. If there is zero time delay or a positive time delay set, this mode acts in the same way as Refresh. Only when there is negative time delay, when we are viewing events prior to the trigger point, does this mode appear different.

All points to the left of the trigger point (i.e. prior to it) will roll from right to left as described above under Roll.They will continue to roll until a trigger is received, at which time the portion of the trace to the right of the trigger point will be refreshed as above, under Refresh.

*Example:*

TBA = 100ms Pre trig = 30%

The A timebase is set to 100 milliseconds per division and there is minus 300 milliseconds delay, or 30% pre-trigger. This places the trigger point three divisions from the left-hand edge of the screen. All points to the left are pre-trigger and all points to the right are post trigger. If we perform a capture in PreTrig Roll, the first three screen divisions will be seen to scroll until a trigger is received then the right-hand seven divisions will be refreshed. This mode is particularly useful on very slow timebase ranges where the operator can view the 'filling' operation of the pre-trigger stores.

**XY** In this mode Channel 1 is plotted against Channel 2. Channel 1 takes the X, or horizontal component, and Channel 2 takes the Y, or vertical component. The timebase rate at which the channels are acquired is selectable in the normal manner. (Section 1.3).

**Note:** The XY display mode is only a display of the captured waveform. The waveform can be viewed in the normal YT mode by selecting refresh.

The various choices of timebase mode are made by repeated pressing of the number 1 button, the present selection being indicated by the inverse video characters.

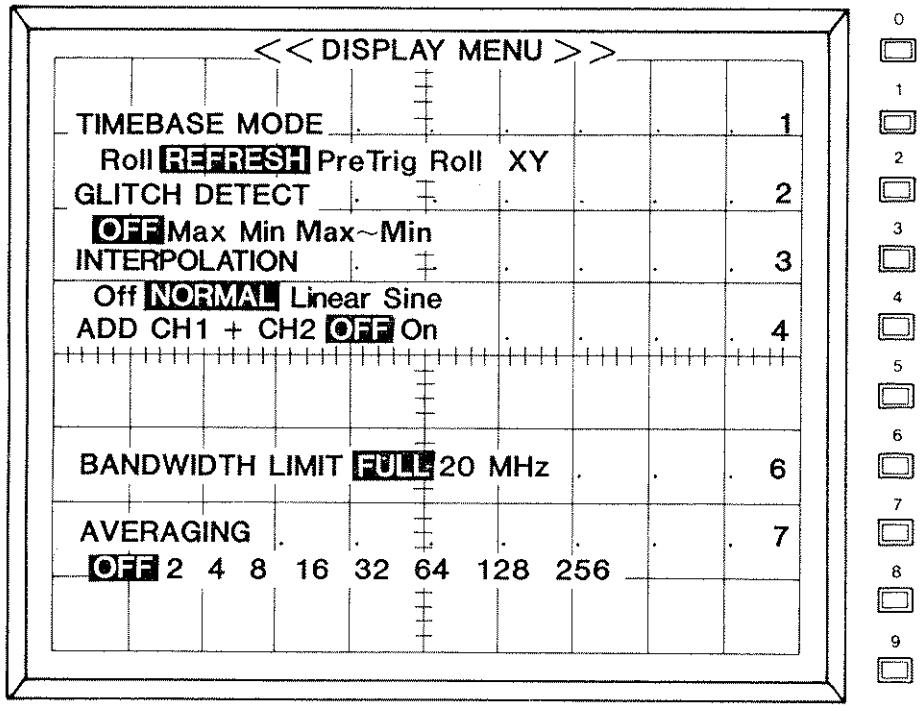



*Figure 2.4.1 The Display Menu (4072 shown, 4074 is similar)*

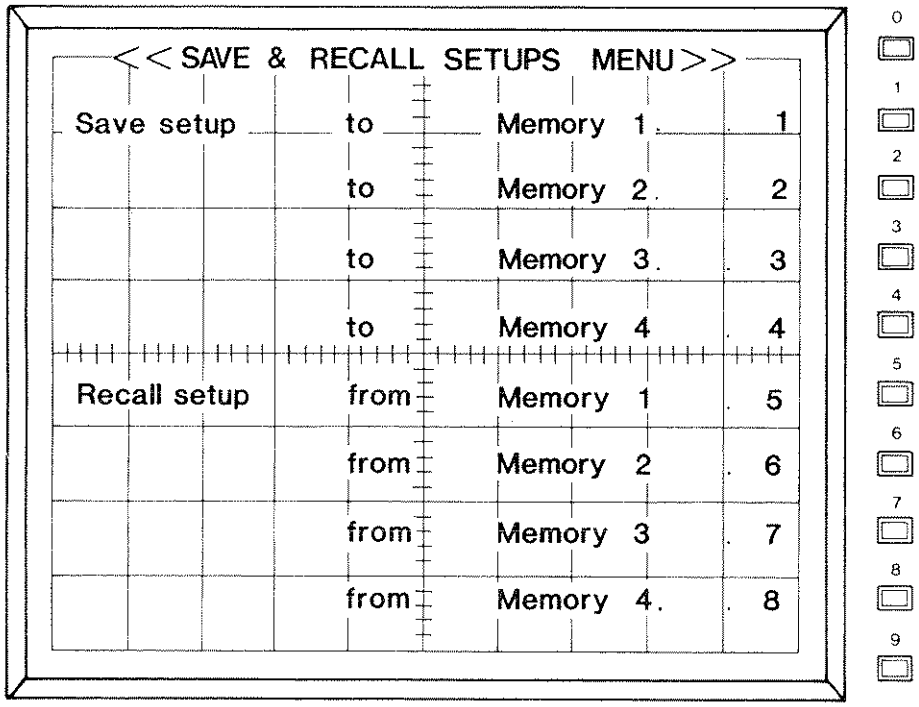



*Figure 2.6.1 The Save and Recall Setup Menu (4070)*

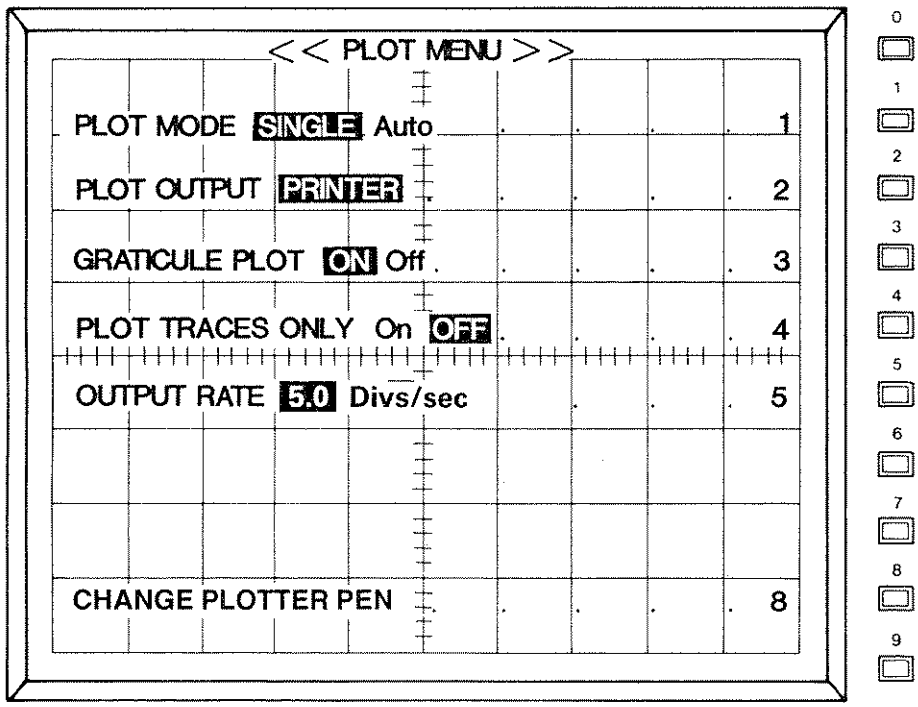



*Figure 2.7.1 The Plot Menu (4070)*

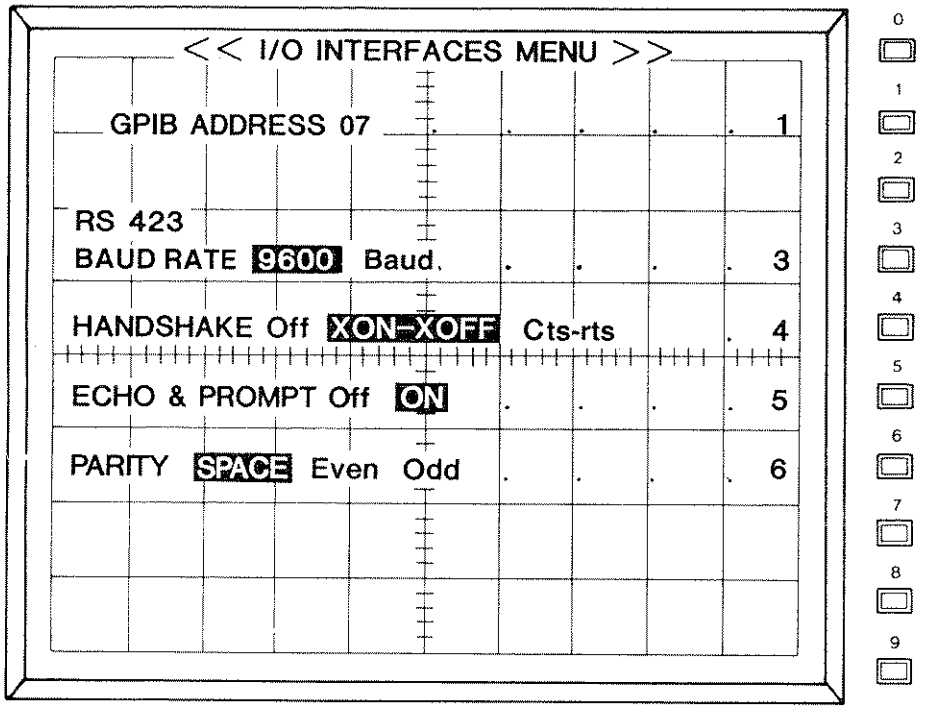



*Figure 2.8.1 The I/O Interfaces Menu (4070)*

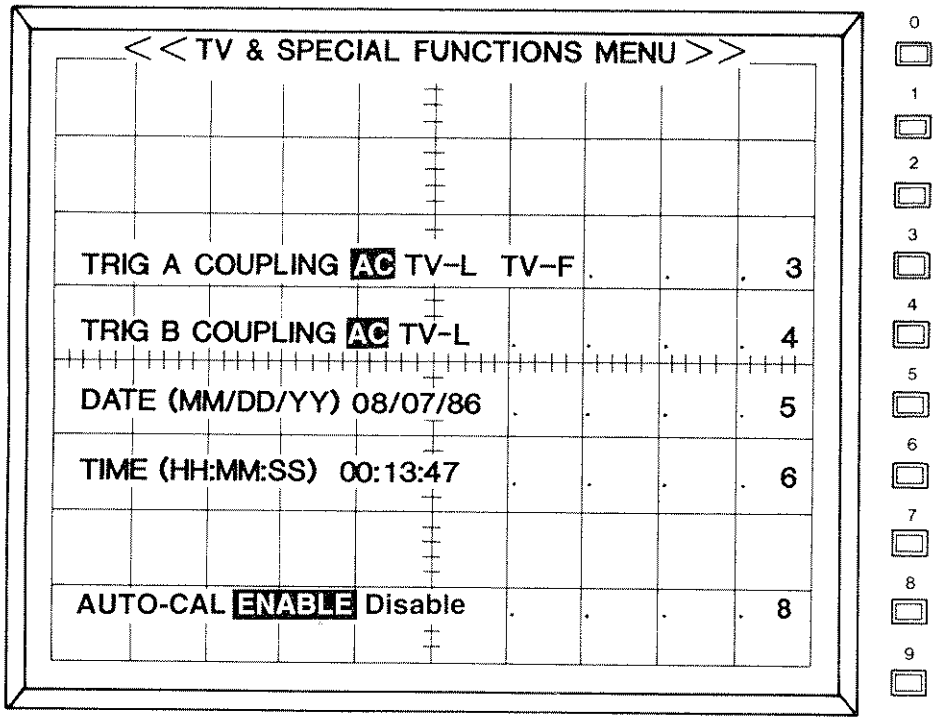



*Figure 2.9.1 A TV & Special Functions Menu (4070)*

## 3. PERFORMANCE CHECKING

The aim of this section is to allow the user of a 4070 to verify the major analog 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.

### Risetime

Equipment required:

Fast edge generator <1ns: Bradley oscilloscope calibrator type 192 or Tektronix PG506 or similar;
50 Ohm precision coaxial cable;
50 Ohm precision terminator.

Connect the edge generator to a channel input through the coax cable and the terminator, which should be at the 4070 end of the cable.

1. Select 50mV per division on the input channel and set the timebase to 1$\mu$s per division.
2. Set the generator to give 300mV peak to peak at a repetition rate of 1MHz and adjust the trigger level to give a stable trace. Adjust the pre-trigger setting to view the leading edge.
3. Select the cursors and change the timebase to 20ns per division.
4. Apply x20 trace magnification using the X Mag On and X Mag 2›20 buttons, to give 2ns per division, and adjust the horizontal Position paddle to centre the fast edge.
5. Position the cursors on the edge such that the minor cursor is 30mV below the high level and the datum cursors cross 30mV above the low level.

The risetime can now be read from the cursor line on the bottom row of text. This figure should not be greater than 3.6ns.

### 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 4070 end of the cable.

1. Select 50mV per division on the input channel and set the timebase to 50$\mu$s 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 250ns 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 100MHz if bandwidth limit is not selected and approximately 20MHz if it is selected.

### 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 4070 end of the cable.

1. Select 50mV per division on the input channel and set the timebase to 50$\mu$s per division.
2. Select Auto trigger.
3. Set the signal generator to 50kHz or similar reference frequency and adjust the amplitude to give three major divisions peak to peak. Then reduce the signal by 10:1 to give a signal of about one and a half minor divisions.
4. Select AC **Coupling** and **Norm** on the trigger controls.

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

### 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 4070 end of the cable.

1. Select 50mV per division on the input channel and set the timebase to 250ns per division.
2. Select AC **Coupling** and **Norm** on the trigger controls.
3. Set the signal generator to give one major division at 100kHz input frequency.
4. Without adjusting the amplitude set the signal generator to 100MHz.
5. Change the timebase to 250ns per division.

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

### Timebase Calibration

Equipment required:

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

## 4. ALPHABETICAL SUMMARY OF THE CONTROLS

**Abort** Terminates plotting at the end of the current line or character; terminates I/O communications via GPIB/RS423; allows escape from Save, Recall and Clear Trace menus.

**A/B TRIGGER** This button determines which trigger channel's status is viewed on the LED display and which one is controlled by the source, coupling and other controls in this light area patching of the front panel. The light above the button shows which channel is currently being displayed. When selected in this way the source and coupling buttons will change the setup of the channel.

**AC/Gnd/DC** These are the available ways an input signal may be coupled into the 4070.

**AC** This channel input coupling selection is used for rapidly varying input signals. Low frequency and DC components will be removed. Suitable input signals are from 10Hz to 100MHz with a x1 probe and 1Hz to 100MHz with a x10 probe.

**Gnd** The input signal is not coupled into the instrument. A 0V reference signal is displayed.

**DC** The input signal is directly coupled into the instrument so all frequency components of the input signal will be displayed. The bandwidth is from 0Hz(DC) to 100MHz (see 'Bandwidth Limit' in Section 2.4).

**Alpha Intensity** This is used to control the brightness of the characters displayed on the screen.

**Arm'd** This light illuminates after the **S/Shot** button has been pressed; it will stay lit until either a valid trigger has been received or until the **Continuous** button is pressed.

**Auto/Norm** In normal mode, trace captures can only occur when a valid trigger input has been received. When Auto is selected, if no valid trigger has been received for some time (about 40ms) the instrument will generate its own trigger and initiate a capture.

**Auto Setup** This will attempt to arrange the display so that two to five complete cycles of the input signal appear, with the amplitude set so that the height of the trace is roughly two to five divisions. Also, it selects auto trigger to ensure the screen is frequently updated.

**A TIME/DIV** This is a five position paddle which controls the sweep rate of the A traces. A gentle push causes a small change in the sweep rate, whilst a firmer push will cause a large change in the sweep rate.

**B TIME/DIV** This is a five position paddle which controls the sweep rate of the B traces. A gentle push causes a small change in the sweep rate, whilst a firmer push will cause a large change in the sweep rate.

**Cal** The **VOLTS/DIV** paddle steps the attenuator through the discrete calibrated ranges from 2mV 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 input. See also **Uncal.**

**Continuous** This button puts the 4070 in continuous capture mode (i.e. its default state). The sequence **Arm'd,** triggered, **Stor'd** and displayed is carried out and repeated automatically.

**Coupling** Steps through the available options of trigger coupling. These are AC, ACHP(AC High Pass), ACLP(AC Low Pass),DC, & DCLP(DC Low Pass). After DC has been selected, a further press of the button returns the selection to AC. All the couplings can be used with CH1, CH2 and EXT sources. On line, the input coupling is not selectable.

**Cursor** One press of this button brings up the cursors on the A trace. Another press moves them to the B trace. A third press of the button switches the cursors off. If only one trace is displayed, the cursors will be called up onto that trace; a further press of the button will de-select the cursors.

**CURSOR** This paddle moves the minor cursor along the trace - i.e. the minor cursor, when moved horizontally, automatically follows the trace up and down as well.

**DATUM** The left-hand paddle moves the horizontal (voltage) datum cursor vertically, while the right-hand paddle moves the vertical (time) datum cursor horizontally.

**DC** The input signal is directly coupled to the instrument so all frequency components of the input signal will be displayed. The bandwidth is from 0Hz(DC) to 100MHz (see 'Bandwidth Limit' in Section 2.4).

**Events** This paddle controls the 'divide by N' and 'Count N x B' trigger function. i.e. it sets the number of triggers (events) required before a capture is initiated. A gentle push to the left decreases the number of events, a firmer push to the left decreases the number of events at a faster rate. A gentle push to the right increases the number of events, a firmer push increases the number more quickly.

**EXTERNAL A** This input can only be used as a trigger source for the A trigger channel.

**EXTERNAL B** This input can only be used as a trigger source for the B trigger channel. When TVLN is selected for B, the B trigger source is the external A trigger input.

**Focus** Controls the focus of the CRT display.

**Gnd** The input signal is not coupled to the instrument. A 0V reference signal is displayed.

**A B** A and B alternately (i.e. 'dual timebase mode'). Any active channel will produce two traces: one on the A timebase setting and one on the B timebase setting.

**Time** This paddle controls the 'delay by time' trigger function. Negative times enable pre-trigger events to be captured, positive times allow events after the trigger point to be viewed. A gentle push to the left decreases the time delay; a firmer push causes the delay to decrease at a faster rate. A gentle push to the right increases the time delay; a firmer press increases it at a faster rate. If the delay changes to zero, there will be a long pause before the change continues.

**TIME/DIV** The two timebases which are available for each input signal are set by the **A** and **B 'TIME/DIV'** paddles. The range is 20s/div to 20ns/div.

**Trace Intensity** This controls the brightness of the trace. The brightness of the cursors and the trigger level indicator are also adjusted by this control.

**Trace on/off** Pressing this button calls up the 'Trace on/off' menu. Through this it is possible to remove or display traces on the screen.

**Trace Rotate** If the trace is not properly horizontal relative to the grid, then adjustment of this control with a small screwdriver should remedy the situation.

**Trig'd** This lights up when the 4070 is receiving valid A trigger signals at a rate of greater than every 40ms.

**TRIGGER DELAY** These paddles allow the trigger delay conditions to be set; trace acquisition will only begin after these conditions have been met:

**Time** This paddle controls the 'delay by time' trigger function. Negative times enable pre-trigger events to be captured, positive times allow events after the trigger point to be viewed. A gentle push to the left decreases the time delay; a firmer push causes the delay to decrease at a faster rate. A gentle push to the right increases the time delay; a firmer press increases it at a faster rate. If the delay changes to zero, there will be a long pause before the change continues.

**Events** This paddle controls the 'divide by N' trigger function on the A timebase and the number of delayed triggers on the B timebase (as selected by the **A/B** switch). A gentle push to the left decreases the number of events at a faster rate. A gentle push to the right increases the number of events, a firmer push increases the number more quickly.

**TRIG LEVEL** This paddle controls the trigger level setting.

**Uncal** The coarse setting of the attenuator is unchanged, but a variable gain is applied by the **VOLTS/DIV** paddle to the input signal. This has a range of 1 to about 0.4. Thus, with an initial setting of 1V per division, the actual sensitivity of the channel could be set anywhere between 1V and 2.5V per division.

**VOLTS/DIV** This adjusts the volts per division. Pushing the paddle upwards will adjust the sensitivity as far as 5V/div. In the other direction, sensitivity can be increased as far as 2mV per division.

**X mag On** This button selects X (horizontal) magnification; if it is already selected, pressing again switches it off.

**X Mag 2>20** Selects the amount of horizontal expansion applied to the trace. Each press of the button steps the magnification through the settings x2, x5, x10 and x20. After x20, a further press returns the setting to x2. The new timebase setting is displayed each time the button is pressed.

**x1** The external trigger signal is coupled directly into the trigger circuitry at the specified 500mV sensitivity (see also x10).

**x10** The external trigger signal is increased by a factor of 10 before it enters the trigger circuitry - i.e. a signal ten times smaller will be required to produce the same effect as on the x1 setting (i.e. 50mV sensitivity).

**+/-** This button selects positive or negative slope triggers. The current selection is indicated by the light above the button. If negative slopes are selected then a single press will select positive slopes and a further press reverts to the negative slopes.

**0-9** These buttons are used to select options from the various menus and enter numbers when required. See Section 2 for details.

## HORIZONTAL DEFLECTION

**Horizontal Display Modes**
A, A alt B with A intensified by B, B only, X-Y, Refresh, Roll, Pre-Trigger Roll.

**Horizontal Display Accuracy**
±3%.

**A and B Delayed Sweep Range**
20ns/div to 20s/div in 1-2-5 sequence. Sweep speeds faster than 250ns/div use equivalent time sampling (ETS). ETS uses random sampling to achieve pre-trigger.

**Horizontal Expansion**
The Expansion from x2 to x20 times (in a 1-2-5 sequence) is available on all timebase ranges (except x2 to x10 on 20ns/div). This gives a fastest timebase rate of 2ns/div.

**Timebase Sample Accuracy**
±0.01%.

**Timebase Jitter**
Less than ±200ps

**Trigger Jitter**
Less than ±500ps.

**Trigger Delay**
The A or B sweep start can be delayed from either Trigger A or Trigger B respectively. The delay can be either negative (pre-trigger), or positive (post-trigger).

**Trigger Range**
Pre-Trigger -0 to 100% with 0.1% resolution.
Post Trigger –

| TIMEBASE RANGE | MAX DELAY |
|---|---|
| 20s to 0.1ms/div | 99.9s |
| 50μs to 50ns/div | 0.99s |
| 20ns/div | 0.4s |

**Trigger Delay Accuracy**
±0.001% delay
±0.1% of timebase range
±1ns

**Delay by Events**
This will allow the B sweep to be delayed from the A sweep by up to 999,999 events with a maximum trigger frequency of 100MHz

## TRIGGER

There are two trigger systems, A and B. Each system has similar specifications.

**Trigger A:**

**Source**
4072: CH1, CH2, EXT A. LINE,
4074: CH1, CH3, EXT A, LINE.

**Couplings**
AC, DC, ACHP, ACLP, DCLP.
TV Line, TV Field 2.
DCLP, ACLP -(‹15kHz)
ACHP -(›15kHz).

**Trigger B**

**Source**
As Trigger A except use EXT B.

**Couplings**
As Trigger A. TV Line taken from A Source.

**Slope**
Selectable +ve, −ve

**Sensitivity**

| | | |
|---|---|---|
| Internal: | DC-10MHz | ‹0.3 div. |
| | 10MHz-100MHz | ‹1.0 div. |
| External: | DC-10MHz | ‹ 50mV p-p (x10) |
| | | ‹500mV p-p (x1) |
| | 10MHz-100MHz | ‹100mV p-p (x10) |
| | | ‹1V p-p (x1) |

**Trigger Level**
Variable over greater than ±4 divisions.
Level indicated on screen with marker.

**External Input Impedance**
1MΩ/20pF

**External Input Protection**
200V DC or pk AC

**Trigger Combinations**
A and B Timebase can be triggered independently or in any combination of the following:

'A' Trigger only
Trigger after every Nth A event
Triggered on B after every Nth A event
'B' Trigger only
'A' Trigger then after N x 'B' trigger events

## CURSOR MEASUREMENTS

There is an on-screen measurement cursor which can be allocated to any trace plus horizontal and vertical datum cursors which can be moved to any screen position.

The voltage and time differences between the measurement and datum cursors are automatically displayed.

**Time Accuracy**
As horizontal specification ± sample interval

**Voltage Accuracy**
As vertical specification ± 1 least significant digit (LSD)

## IEEE-488 INTERFACE

**Read and Write Functions**
All front panel controls are fully programmable, except:
Trace Intensity Power on/off
Alpha-Numeric Intensity
Scale Illumination

## MISCELLANEOUS

**Calibrator**

1V pk-pk ±1% at 50Hz to 50kHz depending on A Timebase Range. Time accuracy as for timebase range.

**Probe Power**

Power connector mounted on the front panel for Gould 10-TC-02 logic probe

## POWER REQUIREMENTS

**Voltage**

90V-260V AC. No switching required between voltage ranges

**Frequency**

48-440Hz

**Power**

200W max.

## DIMENSIONS

See Figure 5.1 – -mm (approx)

## WEIGHT

**Net Weight**

4072: 11.4kg (25lbs) approx.
4074: 12.3kg (27lbs) approx.

**Shipping Weight**

4072: 15.9kg (35lbs) approx.
4074: 16.8kg (37lbs) approx.

## ACCESSORIES SUPPLIED

Operating Handbook
Front Panel Cover
Pack of 4 plotter pens
2 rolls of plotter paper
Line Cord
4072: 2-off PB36 Probes
4074: 4-off PB36 Probes

## OPTIONAL ACCESSORIES

**Rack Mount Tray with Slides** PN 04094732

**Cart** TR7 General-Purpose Cart

**Protective Carrying Case**

PN 04101172 – a strong padded case enclosing the oscilloscope with three thicknesses of material covering the front panel

## ENVIRONMENTAL

**Temperature**

**Operating**

0°C to 50°C

**Specified**

15°C to 35°C

**Humidity**

Tested to IEC 68-2-Ca operating 45°C at 95% RH
Tested to IEC-2-Dd cycling non-operating.
25°C-45°C, 95% RH cycles (144 hours).

**Safety**

Complies with IEC-348 Cat 1 Standards.

**Electromagnetic Interference (EMI)**

meets VDE 0871 category A.

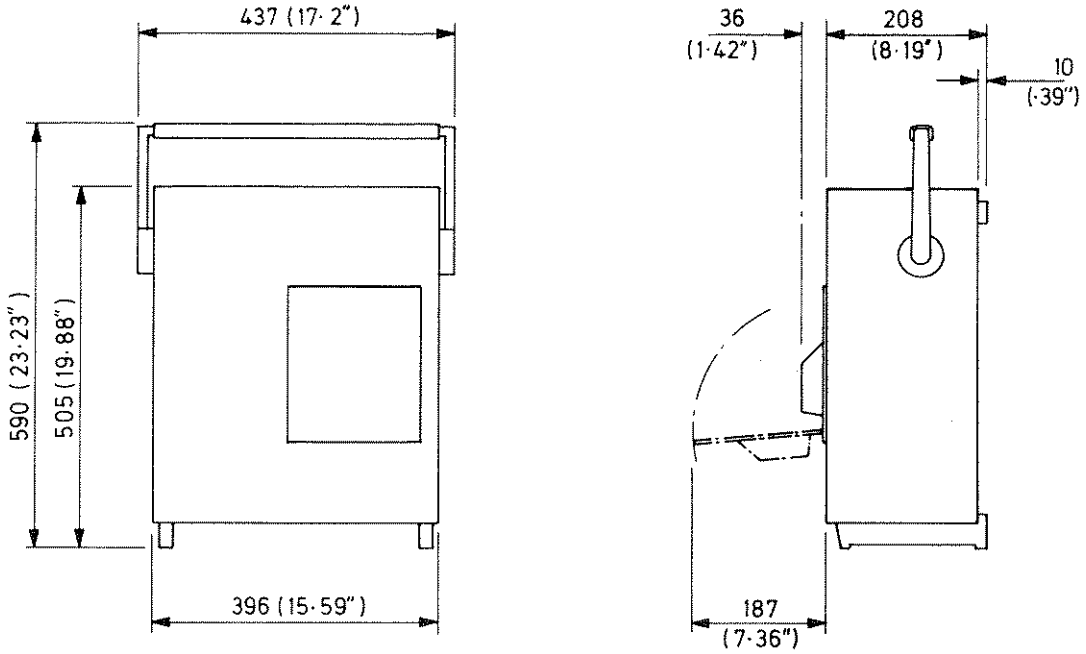



*Figure 5.1 Dimensions in mm (in)*

# Appendix 1

## BRIEF IEEE-488 BUS DISCUSSION

The IEEE-488 bus specification describes an asynchronous byte-serial digital bus sufficiently general to allow instruments with greatly varying capabilities to communicate with each other. Table A1.1 lists the required signals and the assigned connector pins.

In a typical small system, a controller would direct the data transfer and individual operation of a few bussed instruments; for example a 4070 together with printer, and a floppy disc unit, all IEEE-488 compatible. Each of the three instruments would be assigned a unique primary address from 0 to 30. More specific selection of functions within a particular instrument is possible by assigning a unique secondary address to each such function; for example, an 8 channel analog to digital converter might have primary address 5. Each channel could have a separate secondary address from 0 to 7. The instrument (for example the A to D converter) must have been designed to use secondary addressing and the controller must have been programmed to correctly address each instrument and function according to the manufacturer's data before the system can function. Table A1.2 lists all valid IEEE Bus message codes.

All instruments, and the controller(s), in a system are interconnected by a standard connector shown in Fig. A1.3. Commercial examples are the Amphenol series 57 connector or the AMP 'Champ' series.

All bytes of information exchanged on the bus are 'handshakes'. See Fig. A1.1. The sender of a message via the bus is conventionally called the 'talker', and those devices receiving the message are called 'listeners'. The talker (there must only be one at a time) sets DAV LO (data is now valid), the listeners (there may be many) each first set NRFD LO (not ready for more data) and then set NDAC HI (this data byte accepted). After the current byte has been accepted by all listeners, the Talker will reset DAV HI and the listeners will all first return NDAC LO and the NRFD HI, readying the bus for the next byte transfer.

| PIN | SIGNAL | | DESCRIPTION |
|---|---|---|---|
| 1 | D101 | | |
| 2 | D102 | | |
| 3 | D103 | | |
| 4 | D104 | Data Input/ | Carry bi-directional, asynchronous byte serial data, addresses |
| 13 | D105 | Output lines | or commands |
| 14 | D106 | | |
| 15 | D107 | | |
| 16 | D108 | | |
| 5 | EOI | | End or Identify. Transmitted by talker at end of multi-byte data record. Used with ATN for parallel poll. |
| 17 | REN | | Remote Enable. Asserted by controller. Transfers control for each instrument to the bus instead of their front panels. |
| 9 | IFC | Interface | Interface Clear. System controller returns all active devices on bus to |
| | | Management | idle states and takes control of bus. |
| 10 | SRQ | Lines | Service Request. Line used by device on bus to indicate its need for service from the system controller. |
| 11 | ATN | | Attention. Asserted by Controller. When true, D101-D108 carry addresses or commands. When false, data. |
| 6 | DAV | Handshake | Data Valid |
| 7 | NRFD | Lines | Not Ready For Data |
| 8 | NDAC | (see Fig. 3.3) | Not Data Accepted |
| 18 | (DAV) | | |
| 19 | (NRFD) | | |
| 20 | (NDAC) | Return | Twisted with (line) |
| 21 | (IFC) | Lines | |
| 22 | (SRQ) | | |
| 23 | (ATN) | | |
| 12 | Shield | | Braid around entire cable, continued through connector shells. |
| 24 | Logic Ground | | Connects together 0V's of all instruments on bus. |

*Table A1.1 IEEE Bus Signal Definitions*

# Appendix 1

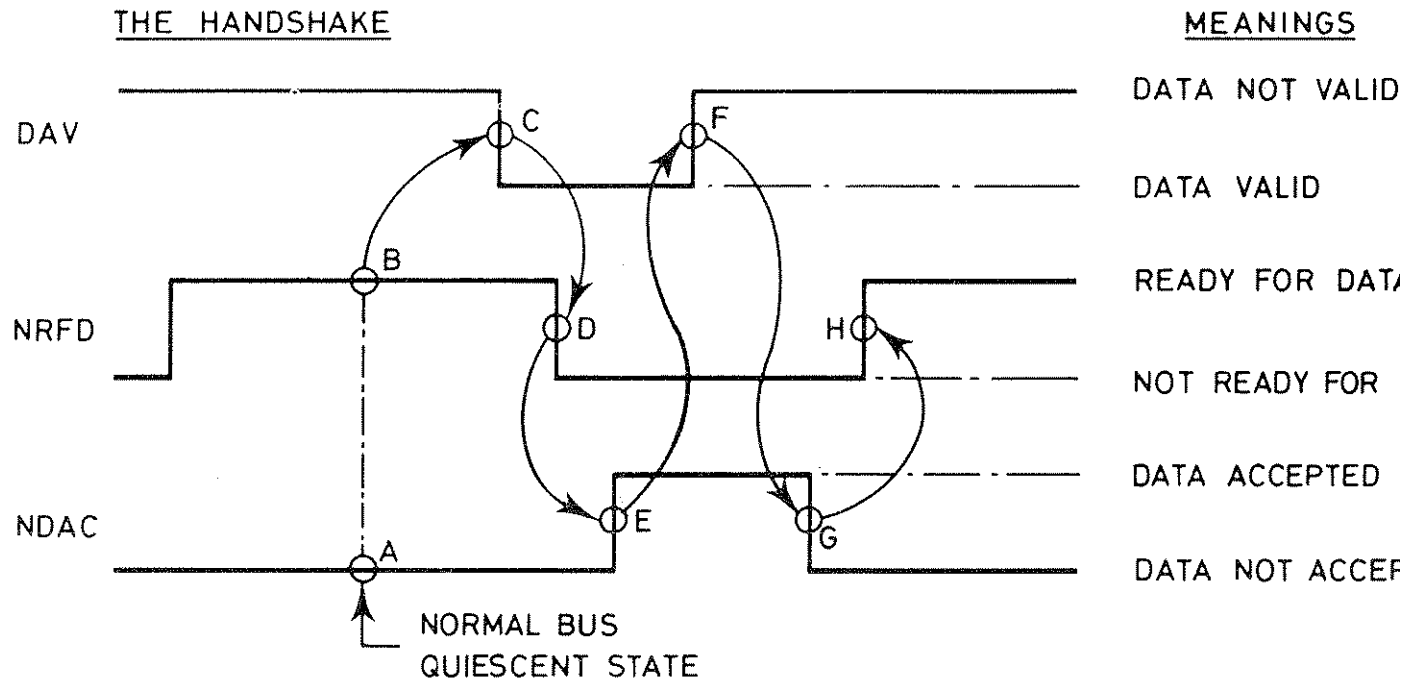



*Fig. A1.1 The Handshake*

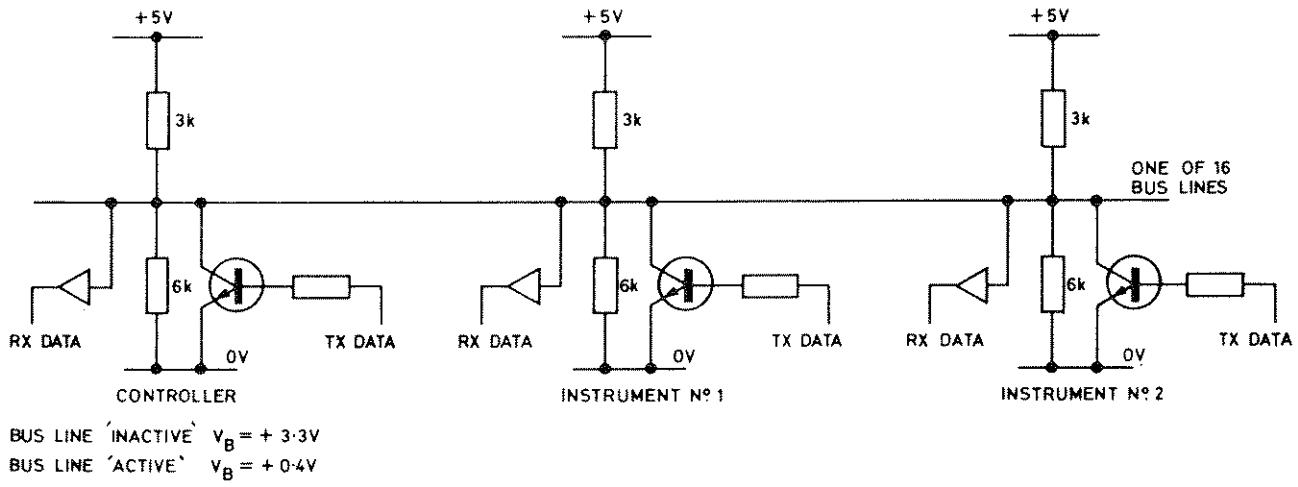



*Fig. A1.2 IEEE-488 Bus Lines*

# Appendix 1

**FURTHER IEEE-488 INFORMATION:**

1. The definitive specification is the IEEE STD 488-1975, Digital Interface for Programmable Instrumentation. Available from:

   IEEE
   345 East 47th Street,
   New York, N.Y. 10017 or,

   American National Standards Institute,
   1430 Broadway,
   New York, N.Y. 10018

2. The corresponding IEC standard is very similar, but specifies a 'D' range connector instead of the 'Amphenol 57' type IEEE connector.

3. A basic discussion of the IEEE-488 bus and an implementation of the standard using the MC68488/MC3448A integrated circuits.

   "Getting Aboard the 488-1975 Bus"
   Available from Motorola Semiconductor Products, Inc.

# Index

# Service Facilities

## GUARANTEE AND SERVICE FACILITIES

### SERVICE FACILITIES

Gould and its distributors and agents maintain comprehensive after sales facilities and, whether or not it is still under guarantee, this instrument should be returned to the factory or to the local distributor or agent 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 instrument was supplied and shipped, with transportation charges prepaid. We accept no responsibility for instruments arriving damaged.

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