Gould Classic 5000/6000/9000 and DataSYS 7000 Series Digital Storage Oscilloscopes Operator Manual

Figure List

CE

1996

GOULD
Instrument Systems

Manufacturer's Declaration of Conformity

We declare that the product(s) listed below meet the safety requirements of the European Commision Directive 73/23/EEC.

Product(s)	Classic 5000, 6000, 6100, 6500, and 9500 DSOs DataSYS 7100 & 7200 DSOs

Products manufactured after 15th June 1996 meet or exceed the protection requirements of:

EN61010–1:1993 (AMD A2:1995), Safety requirements for electrical equipment for measurement, control and laboratory use,

for class 1 (earthed) equipment when installed and used in accordance with the instructions in the operator's manual.

This equipment is not suitable for use in explosive atmospheres or as a component in a life support system.

Quality Manager

for and on behalf of

Gould Instrument Systems
Roebuck Road, Hainault, Ilford, Essex IG6 3UE, UK

CERTIFICATE No. FM 20892
BS EN ISO 9001: 1994

CE

1995

GOULD
Instrument Systems

Manufacturer's Declaration of Conformity

We declare that the product(s) listed below meet the intent of the Electromagnetic Compatibility directive 89/336/EEC, for measuring equipment in a laboratory or light industrial environment, when installed and used in accordance with the operator's manual.

Product(s)	Classic 5000, 6000, 6100, 6500, and 9500 DSOs DataSYS 7100 & 7200 DSOs

This declaration is made for products manufactured after 15th June 1996 with respect to testing done to the relevant parts of:

EN50081-1:1992 Generic emission std; residential, commercial and light industry,
EN50082-1:1992 Generic immunity std; residential, commercial and light industry.

This equipment is not intended for use in high electric or magnetic fields. Intense fields will degrade measurement performance by an amount related to the nature of the field and the interconnection method used to make the measurements.

For the purpose of electromagnetic compatibility, RS423 and IEEE–488 leads need to be high quality, screened leads less than 3 m long with ferrite absorbers fitted close to the oscilloscope. (For Gould part numbers see manual.)

Note that an oscilloscope is a sensitive wideband receiver and its immunity to conducted and radiated signals is critically dependant on how it is used. Optimum grounding and orientation of input and output leads with respect to local interfering sources will improve its performance.

Quality Manager
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Introduction

WARNING Read section 1.1 Safety and Power requirements before installing or operating this instrument.

About the Classic Series of Digital Storage Oscilloscopes

Gould has developed a series of Classic and DataSYS Digital Storage Oscilloscopes suitable for a wide range of applications. Incorporating state of the art integrated electronic components and using the latest manufacturing techniques, high performance and ease of use ensures excellent value.

This manual includes information on the following products.

Classic 9500

500 MHz bandwidth- 2 GS/s sample rate for high speed transient and repetitive signal capture. Memory lengths of 50 k, 200 k, or 1 MByte.

Classic 6500

200 MHz bandwidth - 1 GS/s Sample Rate for medium speed electronic and electrical signals with high speed transients. Memory 50 k, 200 k or 1 MByte.

Classic 6100

200 MHz bandwidth - 100 MS/s, 8 bit or 25 MS/s, 12 bit for mixed electrical/electronic and lower high resolution transducer signals. Memory 50 k or 200 kBytes.

Classic 6000

200 MHz bandwidth - 200 MS/s for medium to fast electrical/electronic signals. Memory 50 k or 200 kBytes.

Classic 5000

200 MHz bandwidth - 100 MS/s has the same basic performance as the Classic 6000 but uses a monochrome display. Memory 50 k.

DataSYS 7100 Power Analyzer

200 MHz bandwidth - 100 MS/s acquisition performance plus a power analyzer feature for testing power consumption, power factor and harmonic content to EN 61000-3-2 (IEC 1000-3-2) Required for CE Conformance. Memory 50 k or 200 kBytes.

DataSYS 7200 Fast Recording Scope

200 MHz bandwidth - 100 MS/s, 8 bit or, 25 MS/s, 12 bit for medium to high speed electrical/electronic plus direct recording to disk in 8 or 12 bit mode. Memory 50 k or 200 kBytes plus 500 MByte hard disk.

All the above models have extensive features available as standard or options to provide complete solutions for signal testing and evaluation.

Probe gain: To scale inputs so that measurements are scaled to voltages at the probe tip.

Scaling: This function caters for transduced inputs such as a current probe with mA/Volt. The scaling also allows for transducers with live zeros.

Offsets: When looking for small signal changes offsetting the input will allow the sensitivity to be maximized.

Averaging: This function removes noise aberrations from the signal and increases the vertical resolution depending on the weighting factor.

X-Y: Displays channel 1 against all or any other input to measure phase for example differences or generate constellation diagrams.

Triggering: Obtaining the signal of interest is the most important function. Trigger Tools provide a wide range of facilities to identify amplitude, pulse width, period and frequency changes. TV standards, counting gating and additional features cater for more complex signal capture.

Mass Storage: Keeping records of tests and producing reports is often mandatory when evaluating new designs or processes. The Classic and DataSYS instruments can provide hard copy paper to internal or external printers via any one of the interfaces. Data can be stored on the internal hard disk, ram disk or the floppy disk in data format for further analysis or picture format suitable for importing into applications on a PC to easily produce reports.

Measurements: A list of standard measurements are available and are easily selected and assigned to any trace. Far more complex measurements and computations, Custom Measurements are available which can be configured to provide and display live measurements in the required units.

Analysis: Waveform analysis incorporates filtering to remove noise on repetitive single shot captures, FFT to provide information in the frequency domain and maths to compute waveforms such as power waveforms. Integration can be used to provide a measure of energy and differentiation to find the maximum rate of rise. Measurement analysis is made using graphing or histograms of specified measurement. Graphing will show trends and histograms will provide a summary of the number of occurrences in preset bands.

Sequencing: Baby-sit routines are preprogrammed to provide unattended capture and storage and/or a printout if required. The full sequence feature caters for customizing the instrument by assigning a single control function to a front panel soft key or generating a full ATE program with decision making on measurements without reference to a manual.

Limits Testing: A limits mask can be generated from a standard input or masks loaded from a disk designed for specific tests.

Persistence: This function captures waveforms over time showing variations or jitter in a different color.

Glitch Detection: Captures fast aberrations at high speed even if the oscilloscope timebase is set to a slow speed. Glitch detection prevents missing data.

Transfer Data: When interfacing to a PC Transition2 operates with either the serial RS423 or the parallel IEEE.488 interfaces. Please ask your local distributor for further information visit the Gould Website: http://www.gould.co.uk or contact Gould UK via email: helpline@gould.co.uk

Operating philosophy

Fast display update of the acquired waveforms on a high brightness, color screen creates a very responsive instrument with clear differentiation among traces. The wide choice of display modes — Refresh, Persistence, Roll, X–Y, with pre– or post–trigger viewing and live zoom — together with advanced trigger facilities and TruTrace ®, make for quick and precise acquisition and display of the signal characteristics.

Dedicated front panel controls to position and scale traces quickly coupled with user–defined soft keys for regularly used functions ensure that the Classic range is easy to use. Analyze signals further, make specific measurements or archive waveforms for later reference: Classic DSOs provide complete application solutions.

TruTrace ®

The Gould Classic range not only provides today's solution oriented features in a very cost effective instrument, it also addresses the display of acquired signals and derived traces in a new and innovative way: *TruTrace*. For the first time, the effect of all the data points within a complex waveform — even 200 k in length — can be seen in a compressed raster–scan overview. *TruTrace* accomplishes this by displaying compressed traces as grey–scale images; traces very similar to those which an analog, real–time oscilloscope would produce from the same signals. This means that anomalies in complex, switching power supply start–up waveforms, for example can be recognized readily, without time–consuming windowing and zooming.

Alternatively, because the acquired data is always accessible, any displayed trace can be examined in more detail should it be necessary. In this case, the independent, per–channel control of Y–zoom and Y–position provided in the Classic series allows personalised display formatting to suit the application.

TruTrace can be used to display any trace or combination of up to eight traces, – transients, zoom traces, derived traces which result from analysis operations or recalled traces.

TruTrace performs an intelligent compression of acquired data in which each data point contributes to the displayed waveform and intensity variations are produced, allowing the display of far more information about an acquired signal than available with conventional DSOs. Intensity variation is also used to highlight areas where traces overlap making it impossible to "lose" a trace entirely behind another.

About this Manual

This manual contains information on the operational features and detailed explanations of all front panel controls and menu items of the Classic Series instruments.

The manual is split into sections that allow both the novice and advanced user to find basic and more advanced operating information.

Section 1.1, Safety and Power requirements, must be read and note taken of its contents before using the oscilloscope.

Section 1 contains basic information on standard operating features using the front panel controls and section 2 details how to perform more advanced DSO functions using both the front panel controls and the menu system. Section 3 explains the menu features.

Section 4 provides instructions for basic performance checking, and section 5 is a summary of all the front panel controls.

Numbers shown in brackets in the text refer to the controls shown on the fold out front panel picture in appendix 6.

For details of the RS423 and GPIB interfaces and the remote command set see the Classic Series programming manual.

1.1 Safety and Power Requirements

1.1.1 Symbols and Terms

This symbol is used to denote the measurement ground connection. This point is not a safety ground.

This symbol is used to denote a safety ground connection.

Where caution is required, this symbol refers the user to the operator manual for further information. See section 1.1 to section 1.1.8.

This symbol warns the user that high voltages are present close to this symbol.

This symbol shows that the switch is a standby switch. When it is pressed the instrument state toggles between operating and stand by mode. In stand by mode some power will be consumed and the instrument is NOT disconnected from the AC supply.

WARNING statements identify conditions or practices that could be dangerous or fatal to personnel.

CAUTION statements identify conditions that could cause damage to the instrument or other property.

400 V peak (≤100 V CAT I) This statement shows that the instrument's signal inputs may be connected to CAT I supplies whose peak voltage is not likely to exceed 400 V. CAT I supplies are signal level supplies typically found within equipment on the secondary side of an AC supply transformer.

1.1.2 International Safety Warnings

Danish

SIKKERHEDSADVARSEL

Dette instrument skal anvendes med en beskyttelsesjordforbindelse via netkablets jordledning til jordforbindelsen i instrumentets apparatkontakt eller – hvis instrumentet er forsynet dermed – via sikkerhedsjordklemmen. Enhver afbrydelse af sikkerhedsjordforbindelsen vil formentlig gøre instrumentet berøringsfarligt. Bevidst afbrydelse er forbudt. Hvis et indgangssignal overstiger 40 V spidsværdi, skal en ekstra signal jord forbindes.

Dækslerne må ikke fjernes.

Afbryd instrumentet fra lysnettet ved at fjerne IEC-stikket fra bagpanelet. Dette instruments AC netafbryder er kun beregnet til funktionelle formål. Den er hverken beregnet til eller egnet til afbrydelse af lysnettet.

Nederlands

VEILIGHEIDSWAARSCHUWING

Dit instrument mag uitsluitend worden gebruikt als een beschermende massa (aarde) is aangesloten via de beschermende massageleider van de voedingskabel, of – indien het instrument daarvan is voorzien – via de veiligheids-massa-aansluiting. Als de beschermende massa, binnen of buiten het instrument, wordt onderbroken, dan kan dat hierdoor uitermate gevaarlijk worden. Het opzettelijk onderbreken van de massa, is verboden. Indien er een signaal wordt aangeboden van meer dan 40 V (top-top) dan dient eveneens de signaal aarde aangesloten te zijn.

De deksels nooit verwijderen.

Als de IEC-aansluiting op het achterpaneel uit het stopcontact wordt verwijderd, zal het instrument niet langer zijn aangesloten op de wisselstroom-voeding. De wisselstroom-voedingsschakelaar op dit instrument is uitsluitend bestemd voor functionele doeleinden. Die schakelaar mag nooit worden gebruikt om het instrument aan of af te zetten.

Suomi

TURVAOHJEITA

Tätä laitetta käytettäessä sen tulee olla suojamaadoitettu joko verkkojohdon suojajohtimen tai erillisen suojamaadoitusliitännän kautta, mikäli laitteeseen on sellainen asennettu. Suojamaadoituksen katkaiseminen laitteen sisä-tai ulkopuolelta tekevät siitä vaarallisen. Tahallinen katkaisu on kiellettyä. Lisäksi, jos jokin tulosignaaleista ylittää 40 V peak, on signaalimaa kytkettävä.

Älä poista suojakansia.

Erottaaksesi tämän laitteen käyttöjännitteestä irrota takapaneelissa oleva IEC-liitin. Tämän laitteen verkkokytkimellä on ainoastaan toiminnallinen tarkoitus. Sitä ei ole tarkoitettu, eikä se sovellu laitteen erottamiseen käyttöjännitteestä.

Français

ATTENTION - DANGER!

Cet appareil doit impérativement être mis à la masse par le conducteur de terre du câble d'alimentation ou, si l'instrument en comporte une, par la borne de terre. Il peut être dangereux en cas de coupure du circuit de terre, que ce soit à l'intérieur ou à l'extérieur de l'instrument. Il est formellement interdit de couper intentionnellement le circuit de terre. De plus, une masse signal doit être connectée si l'un quelconque des signaux d'entrée dépasse 40 V crête.

Ne pas déposer les panneaux de protection.

Pour couper l'alimentation secteur de cet instrument, débrancher le cordon secteur monté à l'arrière. L'interrupteur d'alimentation est purement secteur fonctionnel. Il ne s'agit pas d'un dispositif de coupure du courant, et n'est pas conçu pour cette fonction.

Deutsch

WARNHINWEIS!

Dieses Gerät muß mit einer Schutzerde betrieben werden, die über den Schutzleiter des Speisekabels oder über die Erdungsklemme des Gerätes (falls vorhanden) anzuschließen ist. Bei einer Unterbrechung der Schutzerde außerhalb oder innerhalb des Gerätes kann eine Gefahr am Gerät entstehen! Eine beabsichtigte Unterbrechung ist nicht zulässig. Achtung! Bei Signalspannungen über 40 V muß die Signalmasse angeschlossen sein.

Die Schutzabdeckung nicht entfernen.

Zum Trennen des Gerätes von der Wechselstromversorgung den IEC-Stecker von der Rückwand abziehen. Der Wechselstromversorgungs-Schalter dient bei diesem Gerät nur für Funktionszwecke. Er ist nicht als Trennvorrichtung bestimmt bzw. geeignet!

Italiano

AVVISO DI SICUREZZA

Questo strumento deve esser utilizzato con un collegamento protettivo di messa a terra tramite il filo di messa a terra del cavo di alimentazione o tramite il terminale di messa a terra in sicurezza, nel caso in cui lo strumento ne sia dotato. Qualsiasi interruzione della massa a terra protettiva, sia all'interno che all'esterno dello strumento, lo renderà pericoloso. E'vietata qualsiasi interruzione causata intenzionalmente. Inoltre, la connessione di terra deve essere collegata se ad uno qualsiasi degli ingressi viene applicato un segnale superiore a 40 V di picco.

Non aprire lo strumento.

Per disinnestare questo strumento dall'alimentazione a corrente alternata, levare il connettore IEC che si trova sul pannello posteriore. L'interruttore dell'alimentazione a corrente alternata di questo strumento viene fornito esclusivamente per scopi operativi e non viene inteso, né è adatto, per essere utilizzato come dispositivo di disinnesto.

Αγγλικά

ΠΡΟΕΙΔΟΠΟΙΗΣΗ ΑΣΦΑΛΕΙΑΣ

Το όργανο αυτό πρέπει να λειτουργεί με το προστατευτικό γείωσης (γείωση) να έχει συνδεθεί μέσω του προστατευτικού αγωγού γείωσης του καλωδίου που χορηγείται ή με τον ακροδέκτη ασφαλείας που είναι για τη γείωση, εάν υπάρχει τοποθετημένος στο όργανο τέτοιος ακροδέκτης. Διακοπή της προστατευτικής γείωσης, εσωτερικά ή εξωτερικά του οργάνου ενδεχομένως να κάνει το όργανο επικίνδυνο. Διακοπή εκ προθέσεως απαγορεύεται.

Μην αφαιρείτε τα καπάκια.

Για ν'απσυνδέσετε το όργανο από την ηλεκτρική παροχή, τραβηξτε να βγει ο συνδετηρας IEC από το πίσω ταμπλω. Η ηλεκτρικός διακόπτης που υπαρχει σ'αυτό το όργανο είναι μόνο για λειτουργικές ανάγκες. Δεν προτίθεται, ή δεν είναι κατάλληλος, σαν μέσο αποσύνδεσης.

Norsk

ADVARSEL!

Dette instrumentet må bare anvendes så lenge det er jordet via den beskyttende jordlederen i strømkabelen, eller via jordingsklemmen, hvis instrumentet har en. Eventuelle forstyrrelser i den beskyttende jordingen, inne i eller utenfor instrumentet, vil sannsynligvis gjøre instrumentet farlig. Forsettlig forstyrrelse er forbudt. I tillegg, signal jord må tilkobles dersom inngangs signalet overstiger 40 V spissverdi.

Ikke fjern dekslene

Skal instrumentet koples fra vekselstrømtilførselen, kopler man ut IEC-koplingen bak på panelet. Vekselstrømbryteren på dette instrumente tjener kun en funksjonell hensikt. Den er ikke egnet, og må ikke brukes, som skillebryter.

Português

Aviso de segurança

Este aparelho deve ser operado com uma ligação terra ligado por um conductor trifásico do cabo principal ou, se o instrumento já tiver um, via um terminal de segurança. Qualquer interrupção do trifásico, dentro ou fora do aparelho, pode tornar o aparelho perigoso. É proibida a interrupção intencional. Nota: O terminal de terra deve ser ligado se o sinal de entrada a medir for superior a 40 V de pico.

Não retire o invólucro/capas.

Para desconectar este aparelho da fonte AC, retire o conector IEC do painel trazeiro. Neste aparelho, o interruptor da fonte AC existe sómente por razões funcionais. Não deve ser usado e nem é apropriado como dispositivo de desconexão.

Español

ADVERTENCIA SOBRE SEGURIDAD

Este instrumento debe utilizarse conectado a tierra a través del conductor de puesta a tierra del cable de alimentación o de la borna de seguridad, si dicho instrumento estuviera equipado con ella. Cualquier interrupción de esta puesta a tierra, dentro o fuera del instrumento, hará que el manejo del mismo resulte peligroso. Queda terminantemente prohibido dejar en circuito abierto dicha puesta a tierra. Además, debe conectarse una señal de tierra si cualquier señal de entrade sobrepasa los 40 V de pico.

No quite las tapas.

Para desconectar este instrumento de la red, desenchufe el conector IEC del panel trasero. El interruptor de entrada de CA (encendido) se incluye solo para fines funcionales. No está pensado para utilizarse como medio de desconexión, ni tampoco es adecuado para ello.

Svenska

SÄKERHETSVARNING

Detta instrument måste drivas med en skyddande jordledning ansluten via den skyddande jordledaren på matarkabeln eller, om instrumentet har sådan monterad, via det jordade uttaget. Om jordanslutningen störs, inuti eller utanför instrumentet, är det troligt att instrumentet kommer att utgöra en fara. Avsiktlig störning är förbjuden. Dessutom måste en signaljord anslutas om någon av ingångssignalerna överstiger 40 V topp.

Tag ej bort skydden.

För att koppla bort instrumentet från växelströmstillförseln, tag ut IEC-anslutningen på bakpanelen. Strömställaren för växelströmstillförsel på detta instrument är enbart till för funktionerliga ändamål. Den är inte avsedd som, eller lämplig som, en bortkopplingsanordning.

English

SAFETY WARNING

This instrument must be operated with a protective ground (earth) connected via the protective ground conductor of the supply cable or, if the instrument is fitted with one, via the safety ground terminal. Any interruption of the protective ground, inside or outside the instrument, is likely to make the instrument dangerous. Intentional interruption is prohibited. In addition, a signal ground must be connected if any input signal exceeds 40 V peak.

Do not remove the covers.

To disconnect this instrument from the AC supply, unplug the IEC connector on the rear panel. The standby switch on this instrument is provided for functional purposes only. It is not intended as, or suitable as, a disconnecting device.

GÜVENLİK UYARISI

Bu cihaz, koruma topraklaması besleme kablosunun topraklama iletkeni yoluyla ya da eğer varsa cihazın koruma topraklama terminali yoluyla bağlanmış olarak çalıştırılmalıdır. Koruma topraklamasının cihaz içinde veya dışında kesintiye uğraması cihazın tehlikeli hale gelmesine yol açar. Bağlantıyı bilerek kesintiye uğratmak yasaktır. Buna ilaveten, herhangi bir giriş sinyali 40 V tepe değerini geçerse giriş sinyali toprağı bağlanmalidir.

Kapakları çıkarmayınız.

Bu cihazı AC kaynağından ayırmak için arka paneldeki IEC konektörünü yuvasından çıkarınız. Bu cihaz üzerindeki AC güç şalteri sadece işlevsel nedenlerle sağlanmıştır. Cihazı elektrik kaynağından ayırma amacını taşımaz ve bu amaçla kullanılmaya uygun değildir.

1.1.3 Safety Statement

The design of this instrument has been checked to EN 61010 for class 1 (grounded) use.

This manual contains information and warnings that must be observed to keep the instrument in a safe condition. The instrument should not be switched on if it is damaged and it should not be used under wet conditions.

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

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

This instrument must not be used in life support roles.

1.1.4 Grounding

The instrument must be operated with a protective ground connected via the yellow/green conductor of the supply cable.

This is connected to the instrument before the line and neutral connections when the supply plug is inserted into the socket on the back of the instrument. If the final connection to the supply is made elsewhere, ensure that the ground connection is made before line and neutral.

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

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

WARNING: It is recommended that signal grounds are always connected to a local ground. For safety, it is essential that a signal earth is connected whenever voltages greater than 40 V peak are connected. This is to prevent the instrument's case becoming live in the event of a safety ground interruption which could occur if the supply connector is accidentally disconnected from the rear of the instrument.

It is the responsibility of the user to ensure the safety of any accessories, such as probes, used with the instrument.

CAUTION: Even low voltage inputs may contain high voltage fast transients (spikes) which could damage the input. For this reason it is not safe, for instance, to make direct connections to an AC line supply.

CAUTION: The outers of the input BNCs are connected to the oscilloscope's chassis and therefore to the safety ground.

Note: In order to verify the continued safety of this equipment, it is necessary to routinely check the earth bonding and insulation resistance. This should be done by a suitably qualified person.

1.1.5 Live Parts

The covers protect the user from live parts and they should be removed only by suitably qualified personnel for maintenance and repair purposes.

The instrument must not be operated with covers removed.

1.1.6 Environment

The instrument should preferably be operated in a clean, dry environment with an ambient temperature of between 0 °C and +50 °C. (+35 °C for thermal plotter).

The instrument is specified for use in a Pollution Category II environment, which is normally non–conductive with temporary light condensation, but it must not be operated while condensation is present. It should not be used in more hostile, dusty or wet conditions.

The instrument will operate with full, specified accuracy between +15 °C and +35 °C.

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

The instrument relies on forced air cooling via a fan and ventilation slots. Adequate ventilation can usually be achieved by leaving a 75 mm (3" gap) around the instrument. Care should be taken to avoid restricting the airflow around the fan holes at the side of the instrument.

To clean the DSO, disconnect all power sources and then wipe the surfaces lightly with a clean, soft cloth dampened with water.

1.1.7 Power and Frequency Requirements

The instrument uses less than 250 W/350 V·A and operates from line voltages of 90–132 V at 45–400 Hz and 180–264 V at 45–65 Hz to Installation Category II, local level supplies distributed within a building. Under the extreme conditions of 90 V and 45 Hz, the instrument will still operate correctly even if there is a half cycle dropout in the line supply.

The power connection is via a standard IEC, CEE 22 connector. Before connecting the instrument to the supply, ensure that the rear panel AC supply voltage selector is set to the appropriate voltage, either 115 V or 230 V.

The AC supply fuse must be changed to suit the supply voltage as shown in table 1.1.9. Access to the AC supply fuse can only be made if the AC supply connector is removed.

To disconnect this instrument from the AC supply, unplug the IEC connector on the rear panel. The instrument should be positioned to allow access to the AC connector. The standby switch on this instrument is not a disconnecting device. When the instrument is in standby mode some power will still be consumed.

1.1.8 EMC

EMC stands for Electro-Magnetic Compatibility. The overall intention is that electronic equipment must be able to co-exist with other electronic equipment in its immediate vicinity and neither emit large amounts of electromagnetic energy nor be susceptible to the prevailing electromagnetic energy. Thus there are two distinct requirements for electromagnetic compatibility; Emission and Immunity.

This instrument generates, accepts and can radiate radio frequency energy and, if not installed and used in accordance with the operator manual, may cause harmful interference to other equipment. However, there is no guarantee that interference will not occur in a particular installation.

Immunity tests: All immunity tests are done with the failure criterion being a change of the instrument's control settings. Any of these tests may produce a spurious trigger. Measurements are not valid during and immediately after the immunity tests.

In demanding applications, if this instrument does cause minor harmful interference to other equipment, which can be determined by turning this instrument off and on, the user is encouraged to try to reduce the interference by one or more of the following measures:

- Re-orient or relocate the affected equipment.
- Increase the separation between the instrument and the affected equipment.
- Re-orient or relocate RS423 and/or IEEE-488 interface cables.
- Connect the instrument to an outlet on a different supply circuit to the affected equipment.

Supply cables, interface cables and probes should be kept as short as practical, preferably a maximum of 1 m. Interface cables should be screened and interface cables longer than 3 m are not acceptable in terms of interface port immunity.

1.1.9 Fuse Requirements

The fuse arrangement shown in table 1.1.9 must be followed, and additionally in the UK, a 3 A fuse should be fitted in the line supply plug. The fuses should be slow blow (T) types. For 100/120 V use, CSA approved fuses should be fitted.

Supply Voltage	Slow Blow (T) Fuse Rating IEC (UL/CSA)	Gould Part No.	Suggested types. Manufacturer/ Type No.
230 V	2 A (2.5 A) HBC	461887	Bussman/S505, Littlefuse/215002., Schurter/SPT0001,2507 Wickman/19181
115 V	4 A (5 A)	457456	Bussman/GMC,

Table 1.1.9 Fuse ratings

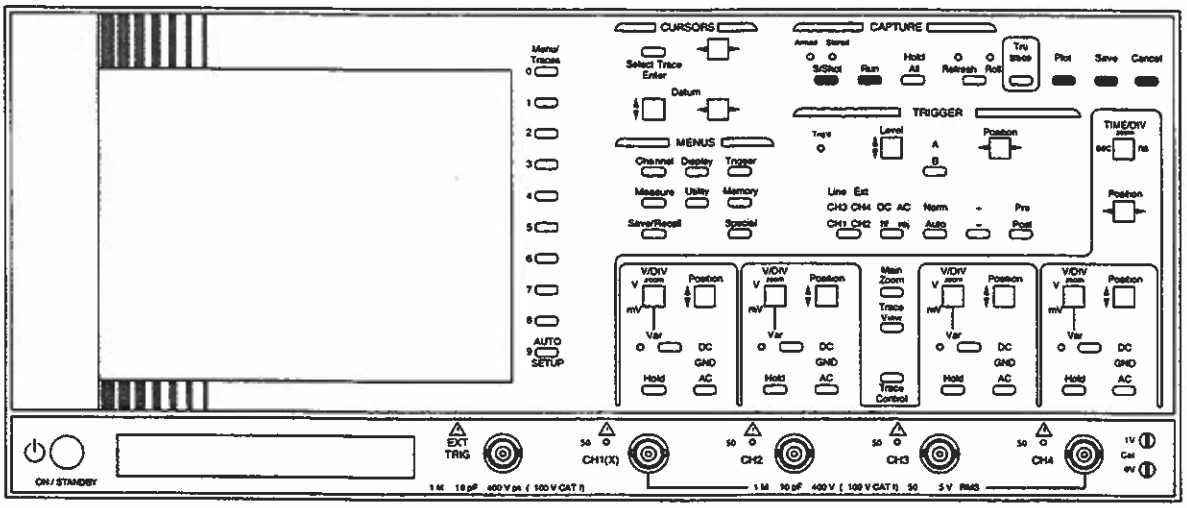


Figure 1.2a Single Function Buttons

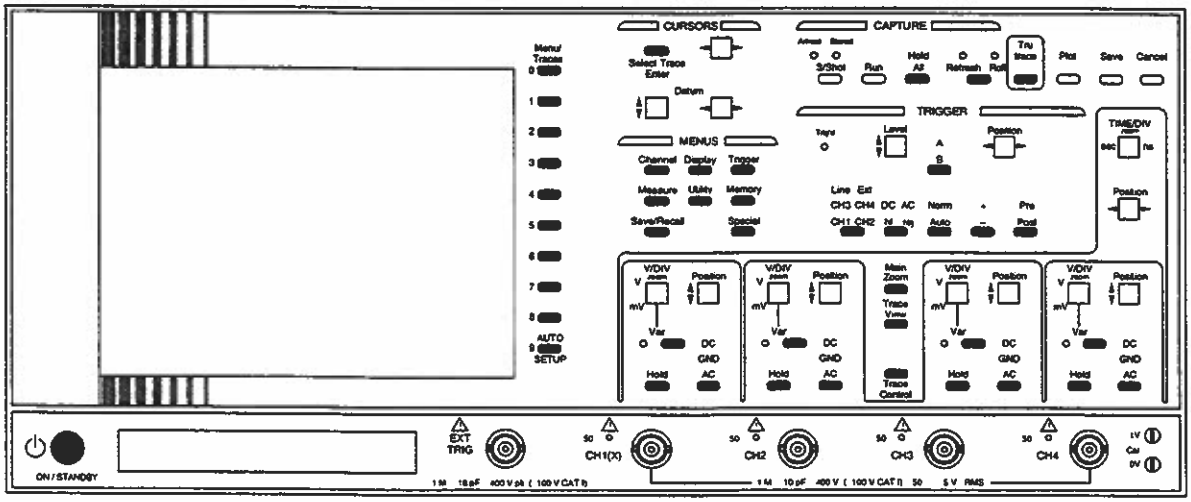


Figure 1.2b The Toggles

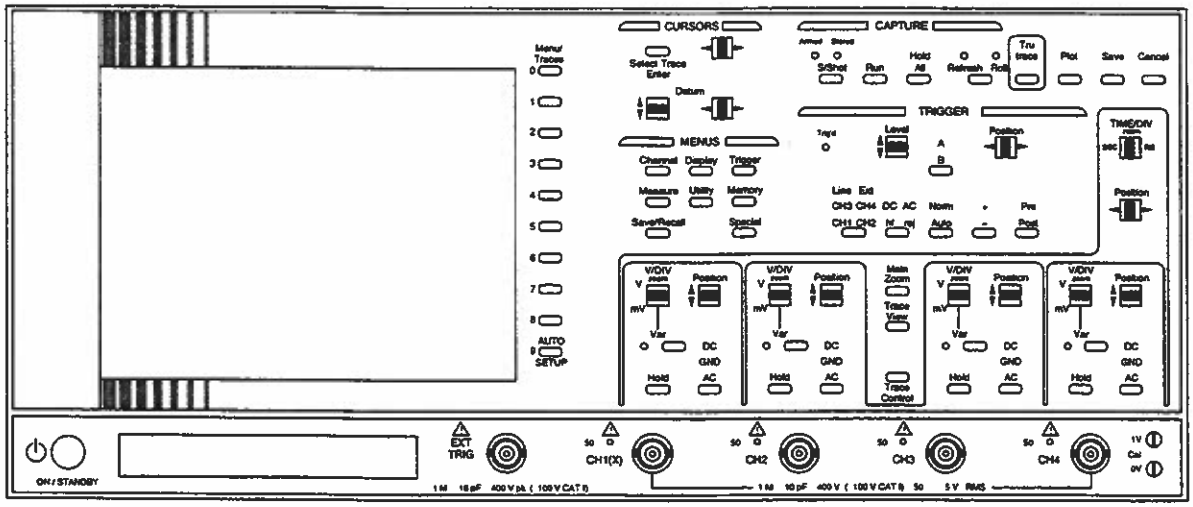


Figure 1.2c The Paddles

1.2 Using the Buttons

Numbers shown in brackets in the text refer to the controls shown on the fold out front panel picture in appendix 6.

There are three types of buttons on the instrument. The first type usually have only one function: when pressed, that one function will be activated e.g. **Run** (11). See figure 1.2a.

The second type are toggles: each press of the button either switches something on or off e.g. **Hold** (35), or selects the next item in a sequence e.g. **DC/GND/AC** (33). See figure 1.2b.

The third type are five position controls the effect caused depends upon how far the paddle is pressed. For example a gentle push of a **Position** paddle (30), up or down, will move the trace slowly. If the paddle is pushed further, the trace will move more quickly. See figure 1.2c.

1.3 Start-Up Display

When first switched from standby mode using the standby button (47), the instrument will display an information page for approximately 5 seconds and then display information similar to that shown in Figure 1.3.

The information page shows the instrument's bandwidth, maximum sample rate, samples per channel and software version number.

	2V	OFF		OFF		OFF		50µs	

Figure 1.3 Start-Up Display

The trace is visible across the center of the screen. At the top will be the sensitivities of the input channels and the timebase speed. If any channel is inactive, information for that channel will not be displayed. If the unit has previously been used, the trace may not be visible as the instrument will remember and return to the previous setup.

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

1.4 Obtaining a Trace

Whenever the DSO is switched on, the control settings at power down will be used. These may not suit the current input signals. The instrument can be set to suit new signals either manually or, automatically using the Auto Setup feature.

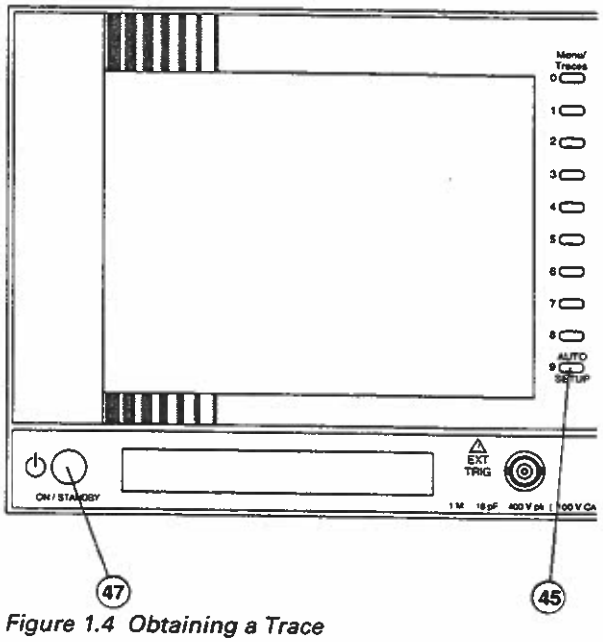


Figure 1.4 Obtaining a Trace

1.4.1 AUTO SETUP

To display an input signal, connect it via any of the channel input sockets (36), (38), (42) or (44) and press **AUTO SETUP** (45).

The instrument will respond with the message:

PRESS AGAIN TO AUTOSETUP

To proceed with the autosetup, press button (44) again. Pressing any other button will prevent auto setup from occurring.

CAUTION: Signals connected to the input socket should not be more than ± 400 V peak. Larger signals could cause damage to the internal circuitry.

Assuming a regular signal has been applied, say a 2 kHz sinewave with an amplitude of perhaps 5 V peak to peak, Autosetup will set the instrument to show the sinewave on the display. An example is shown in figure 1.4.1.

AUTO SETUP will attempt to arrange the display so that two to five complete cycles appear, with the amplitude set so that the height of the trace is between two and five screen divisions.

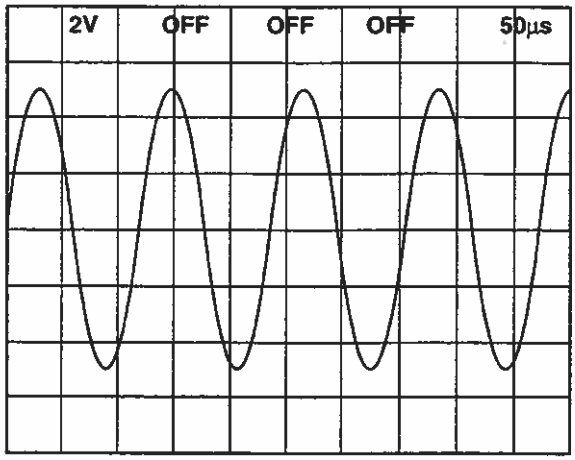


Figure 1.4.1 An AUTO SETUP Display

The lowest channel number with a valid input signal will take priority for triggering and timebase selection.

Some input signals are unsuitable for use with the Autosetup routines, see section 1.10.7. If Autosetup is unable to set the instrument to suit the input signal it may display the message:

NO VALID INPUT

This message tells the user that the input signal is not repetitive, has a frequency which would require a slower timebase outside the Autosetup range, has too large an amplitude or is not suitable for another reason.

Auto Setup will not alter any channel input impedance settings (50 Ω or 1 MΩ), the trigger slope or Bandwidth Limit settings.

1.4.2 Manually Obtaining a Trace

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

Later sections of the manual may need to be consulted as not all of the operating features have yet been described.

1. Decide to which channel the input signal is to be applied. - CH1, CH2, CH3 or CH4.

CAUTION: Signals connected to the input socket should not be more than ± 400 V peak. Larger signals could cause damage to the internal circuitry.

2. Ensure that the chosen channel will be displayed by setting the appropriate trace to match the channel using the trace view menu (40) .
3. Set the **AC/Gnd/DC** button (33) for the chosen channel to Gnd.
4. If necessary, turn that channel's **Uncal** light out by pressing **Var** once (37).
5. Ensure that both **Trace Hold** (35) and **Hold All** (13) are off.
6. Set the main/zoom button (41) to **Main**.
7. Adjust the **TIME/DIV** paddle (23) to give a timebase of 100 ms.
8. Set the display mode (16) to **Refr**.
9. Set the trigger control (14) to A and the trigger **Auto/Norm** (29) to Auto.
10. Use the trigger source button (24) to select the required source for the trigger signals.
11. Set the trigger coupling with button (25) and ensure that trigger delays (or pretrigger) are set to zero using paddle (22)
12. Select **Run** (11).
13. If necessary, adjust the position of the trace using the **Position** buttons (30) and (26) so that the trace is in a convenient position on the display.
14. Apply the signal through a BNC connector to the chosen channels input socket. (36), (38), (42) or (44).
15. Set the **AC/Gnd/DC** button (33) to either AC or DC as appropriate.
16. Adjust the gain of the chosen channel using the **V/DIV** paddle (31).
17. Adjust the timebase setting using the **TIME/DIV** paddle (23).
18. If the display is unstable, adjust the trigger **Level** paddle (12) for a stable trigger, indicated by the Trig'd light.

1.5 Channel Controls

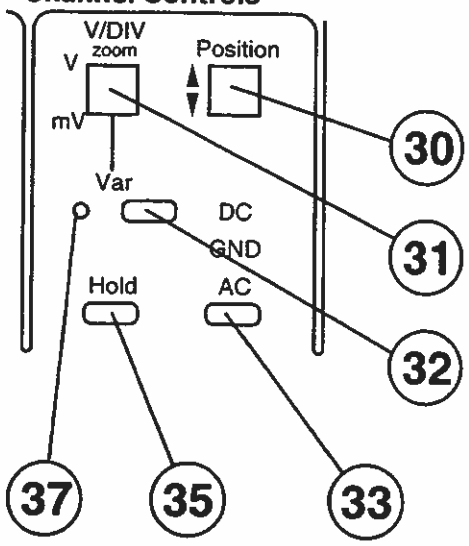


Figure 1.5 Channel Controls

1.5.1 Channels and Traces

On the Classic series of instruments there are 4 input CHANNELS and up to 8 display TRACES.

The traces are displayed objects and the channels are acquired objects. The instrument always acquires all four input channels although they are not necessarily displayed.

Each trace may have two views, a MAIN view and a ZOOM view.

A trace may display either a live channel, a recalled trace or a manipulated channel or trace, e.g. trace 5 could be a live FFT of channel 3.

The choice of the content of each trace, which traces are displayed and the zoom/main settings are controlled by the Trace View Menu, the Trace Analysis Menu and button (40) and the Main/Zoom Select button (41). In addition, the position and amplitude of each of the eight traces on the display can be individually controlled using the 4 sets of controls on the front panel control together with the trace control button (39).

1.5.1 Coupling (AC/Gnd/DC) (33)

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

The channel input impedance is normally 1 MΩ in parallel with a capacitance of 10 pF unless it has been set to 50 Ω using the menu system. See section 3.3.

AC This is used to remove any DC component from input signals. Suitable input signals are from 4 Hz to 200 MHz. AC coupled 50 Ω still presents a 50 Ω load to the input signal.

Gnd The input signal is internally disconnected from the inputs and the input amplifier grounded. A 0 V reference signal is displayed.

DC The input signal is directly coupled to the instrument so that all frequency components of the input signal will be displayed. The bandwidth will be from DC to 200 MHz.

1.6 Horizontal Adjustments

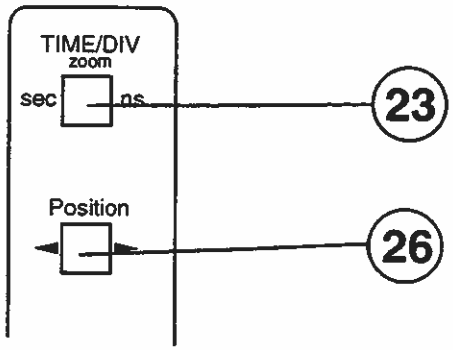


Figure 1.6a Horizontal Controls

The DSO's timebase is controlled by the TIME/DIV paddle (23).

Each trace can be displayed as a main and/or a zoom trace. To display zoom traces, press the Main/Zoom Button (41) so that Main and Zoom or just Zoom is illuminated.

Main: Main only. Each trace will be the acquired, recalled or manipultaed signal suitably compressed to display the complete waveform.

Main & Zoom: Two traces will be displayed, a main trace and a zoomed trace: The main trace is the complete signal and the zoom trace is a zoomed picture of the main display at the current Zoom factor setting.

Zoom: Zoom Only. A zoomed picture of the main trace will be displayed at the current Zoom setting.

Both Main and Zoom display traces are derived from the same single acquisition. The Main and Zoom traces may appear superimposed on the display. They can be separated using the channel position paddle (30) as described in section 1.7.6.

Note: *Zoom traces are a "Window" onto a bigger trace and cannot exist without the original trace. If the acquired store is overwritten or modified, then the zoom trace will also be modified.*

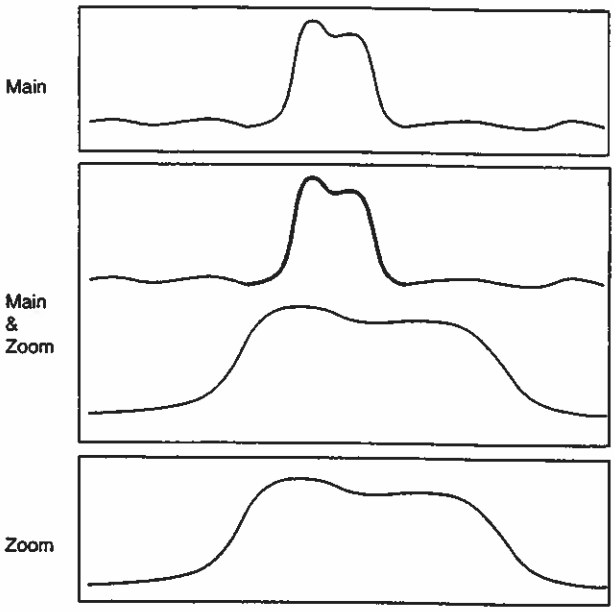


Figure 1.6b Zoom Windows

1.6.1 TIME/DIVISION

Paddle (23) controls the acquisition sweep rate of the traces. Pushing the paddle towards 'ns' decreases the time/div, and towards 'sec' increases the time/div.

The timebase selected is shown at the top right–hand corner of the display - e.g. 250 ns.

The slowest timebase rate is 200 s/division. Attempting a further decrease in sweep rate will result in an external clock signal being selected. See section 1.6.5.

The maximum timebase rate available depends upon the model and store length selected as shown in the table below:

Ranges of 200 ns and faster (only available in 500 sample mode) are Equivalent Time Sampling (ETS) ranges. When an ETS timebase is selected, the letters Ets appear on the second line towards the left–hand side of the display.

Equivalent Time Sampling

The fastest ranges are produced by Equivalent Time Sampling. This is a technique whereby a complete trace is built up by sampling a number of acquisitions at various times relative to the trigger point. Clearly for this scheme to produce meaningful traces the input signal must be repetitive and have a stable trigger.

The number of acquisitions required to build up a trace is variable, but in general the faster timebases require more captures.

The fastest timebase, is equivalent to a sampling rate of 5 GS/s, giving 50 samples per cycle on a 100 MHz input signal.

The use of ETS allows captures with pre–trigger. See section 1.9.1.

In 500 sample mode, the timebase sequence is:

200 s to 500 ns.	Transient capture
200 ns to 1 ns	ETS repetitive sampling

ETS ranges should only be used to capture and display repeating waveforms.

Transient Capture Ranges

Transient capture ranges are used to capture and display single or non repetitive events as well as repeating waveforms.

Store Length		Maximum Timebase /div					
		6000 6100 7200	6100 Hi Res Mode	6500	7200 Record 8 bit mode	7200 Record Hi Res Mode	9500
500 samples	Transient	500 ns	2 µs	50 ns	5 ms	5 ms	25 ns
	Repetitive	10 ns	N/A	10 ns	N/A	N/A	10ns
5 k samples	Transient	5 µs	20 µs	500 ns	5 ms	10 ms	250 ns
	Repetitive	100 ns	N/A	100 ns	N/A	N/A	100 ns
10 k samples	Transient	10 µs	100 µs	1 µs	5 ms	200 ms	2.5 µs
	Repetitive	200 µs	N/A	200 ns	N/A	N/A	1 µs
50k samples	Transient	50 µs	200 µs	5 µs	5 ms	N/A	500 ns
	Repetitive	1 µs	N/A	1 µs	N/A	N/A	200 ns
200k samples	Transient	200 µs	N/A	20 µs	N/A	N/A	10 µs
	Repetitive	N/A	N/A	50 µs	N/A	N/A	50 µs
1 M samples	Transient	N/A	N/A	100 µs	N/A	N/A	50 µs
	Repetitive	N/A	N/A	200 µs	N/A	N/A	200 µs

On the 6500 and 9500, as the timebase is increased the channels available become restricted to provide for the increase in transient sample rate. On a 6500 this provides 1 GS/s on channels 1 and 2 and on a 9500, 2 GS/s on channel 1 and 1 GS/s on channels 1 and 2.

Memory Length & Sample Rate

The instrument displays 501 points per horizontal sweep: therefore there are 50 points per display division.

For the Main trace in with a store length of 500 points, all sample points are displayed but for greater storelengths (i.e 5 k, 50 k, 200 k & 1 M) with glitch detection and Max min both off, every tenth, hundredth etc. sample is displayed. To view the captured trace in greater detail and examine all the acquired sample points the zoom trace feature should be used, see sections 1.6 and 1.6.4. For further details of Memory length and Multishot see section 3.32.

1.6.2 Aliases

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

An alias is a false image. The instrument is a digital oscilloscope and so takes frequent samples of the input signal in order to update the trace. If the signal frequency is higher than the sample frequency, one sample will be taken from a particular point on the waveform and the next sample may be taken from a point slightly further along on a subsequent cycle. It will then display the wave as being much slower than it really is. See figure 1.6.2. This effect will occur if the sample rate is less than twice the frequency of the input signal.

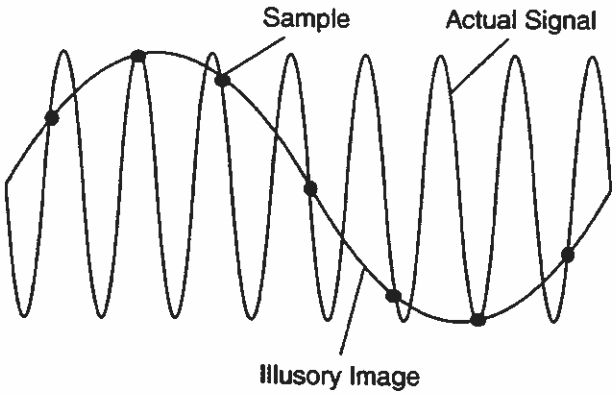


Figure 1.6.2 Alias Generation

There is a Max/Min glitch detection feature which can be used to detect aliases. With dot join on, this usually results in a filled-in wave envelope being seen on the screen, indicating a high frequency. See section 3.2.1

1.6.3 Position (horizontal)

The function of the position paddle (30) changes according to the Main/Zoom display mode selected.

If the instrument is in Main only, the paddle is used to move all the traces to the left or right relative to the graticule.

When the instrument is in Main and Zoom, the paddle moves the brightup left or right along the main trace selecting the portion of the trace to be zoomed. As the brightup moves, the zoom trace display also moves such that the zoom trace is always that portion of the main trace that is highlighted.

When the instrument is in Zoom only mode, the paddle has the same effect on the zoom traces as when the instrument is in main and zoom. The paddle selects the part of the main trace that is zoomed and displayed.

The position of the cursor (section 2.3) is fixed in relation to the sample points so it will move with the traces. With some displays, such as zoomed traces (section 1.6.4), the cursor can be off the part of the trace displayed on the screen. To bring it back into view use the cursor paddle (6) or the position paddle (26).

1.6.4 Zoom (horizontal)

When in Zoom or Main and Zoom mode, the TIME/DIV paddle (23) switches the zoom factors through a sequence. The expansion factors available vary depending upon the store length in use;

Store Zoom factors available

1 M	×2, ×5, ×10, ×20, ×50, ×100, ×200, ×500, ×1000, ×2000, ×4000
200 k	×2, ×5, ×10, ×20, ×50, ×100, ×200, ×500, ×1000, ×2000, ×4000
50 k	×2, ×5, ×10, ×20, ×50, ×100, ×200, ×500, ×1000
5 k	×2, ×5, ×10, ×20, ×50, ×100
0.5 k	×2, ×5, ×10

When active, the selected zoom factor is applied to all displayed zoom traces which then expand the brightup segment of the main trace display.

If the cursor is on, changing zoom may cause the cursor to move off the screen. It can be brought back into view using the cursor paddle (6) or the position paddle (26).

The instrument displays 50 dots (samples) per screen division, each displayed dot value being obtained from the acquisition memory. With a 50 k acquisition and a zoom of ×100, there are, therefore, 50 acquired dots per division displayed, i.e. every acquired sample is displayed.

If the zoom factor is increased, extra, interpolated, samples are displayed. The table below shows the interpolated zoom factors.

Store	Zoom factors
1 M	×500,×1000, ×2000, ×4000
200 k	×500,×1000, ×2000, ×4000
50 k	×200, ×500, ×1000
5 k	×20, ×50, ×100
0.5 k	×2, ×5, ×10

1.6.5 External Clock

To use an external clock as the timebase, use the TIME/DIV paddle (23) to step through the timebase ranges towards 'sec' and EXT will appear on the display after 200 s/div.

The external clock TTL input is on the rear panel D–type connector. The input should be correctly driven as described in appendix 5.

CAUTION: Signals connected to the external clock input should be TTL level signals. RMS voltages greater than 20 V could cause damage to the internal circuitry.

When using external clock, the signal is re–clocked by the oscilloscope at 30 MHz to synchronize the clock with the internal clocks. One sample will be taken for each positive edge of the external clock signal but due to the re–clocking, will not necessarily be exactly on the positive edge.

In roll mode, the maximum frequency of the external clock is 100 kHz.

In Refresh mode, the maximum frequency of the external clock is 5 MHz. At slow clock rates the screen will update as data is acquired. As the clock rate increases, a complete store will be acquired before the data is transferred to the screen.

The frequency of the external clock signal should remain constant during an acquisition.

1.7 Vertical Adjustments

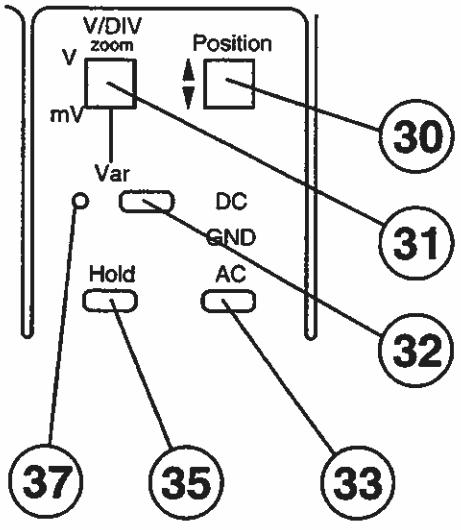


Figure 1.7 Vertical Controls

There are 4 sets of vertical controls and 8 display traces. The vertical controls either control traces 1 to 4 or 5 to 8 as set by the Trace Contol button (39). Press the Trace Control button once to change to the other set of controls.

1.7.1 VOLTS/DIVISION

Paddle (31) adjusts the vertical sensitivity of the appropriate trace over discrete calibrated steps from 2 mV to 5 V per screen division in 1, 2, 5 steps. With probes other than ×1 the probe tip ranges are shown in table 1.7. See also section 3.4.

Probe	Range		
×1	2 mV	to	5 V/div
×10	20 mV	to	50 V/div
×100	200 mV	to	500 V/div
×1000	2 V	to	5000 V/div

Table 1.7 Probe Tip Voltage Ranges

If **Zoom** or **Main and Zoom** mode is selected (41), then the **V/DIV** paddle (31) varies the Y–zoom factor of the acquired signal. See section 1.7.3.

1.7.2 Position (vertical)

The position paddles (30) move their respective traces up and down the display relative to the graticule. This control moves both main and zoom traces at the same time.

If **Hold Trace** (35), or **Hold All** (13) is on or a single shot capture has been made - see section 2.1 - and a trace subsequently shifted vertically, any part of the trace that was captured off the top or bottom of the screen will be shown by a horizontal line.

When the trace is stored as described above, the position control becomes a post storage shift control. When traces are once more live, any previously applied post storage shift will be remembered and added as a pre store offset. The overall effect of this is transparent to the user so the control appears to work at all times as a vertical position control.

1.7.3 Variable/Uncalibrated

When the **Var** button (32) is set to 'Uncal', the coarse setting of the vertical attenuator is unchanged but a continuously variable attenuation is applied to the input signal in the range of 1 to 0.4. Thus with an initial setting of 1 V, the actual sensitivity of the channel could be set by this control to anywhere between 1 V and approximately 2.5 V per division. The **V/DIV** (31)paddle is used to vary the uncalibrated sensitivity.

In order to change the coarse setting of the V/DIV, Uncal should be turned off. The range can then be changed using the V/DIV paddle (31). When the required coarse setting has been obtained, turn Uncal back on again and the V/DIV paddle reverts to the variable sensitivity control.

When a channel Uncal is selected, the relevant Uncal light (37) illuminates and the channel alphanumeric display changes from, for example 20 mV to >20 mV.

This feature can be used to calibrate an input signal to be a certain number of divisions e.g. the output from a sensor can be set to give a full scale trace for 100% input.

1.7.4 Zoom (vertical)

When the **Zoom** button (41) is set to **Zoom** or **Main and Zoom**, the coarse setting of the vertical attenuator is unchanged but a zoom factor is applied to the input signal in the range of ×1/4 to ×32. Thus with an initial setting of 1 V, the actual sensitivity of the channel could be set by this control between 0.25 V and 32 V per division. The **V/DIV** paddle is used to vary the zoom factor doubling the factor with each press.

In order to change the coarse setting of the V/DIV, Zoom should be turned off. The range can then be changed using the V/DIV paddle (31). When the required coarse setting has been obtained, turn Zoom back on again and the V/DIV paddle reverts to the Zoom control.

When a channel Zoom is on, the Zoom light illuminates and the Trace alphanumeric display changes to show the new sensitivity per division. The Channel alphanumeric display is unchanged. See section 3.8.5.

1.7.5 Trace Separation

To vertically separate Main and Zoom traces (see section 1.6 and 1.6.4), use the **position paddle** (30). This will move the selected trace's Zoom trace relative to its Main trace.

1.8 Trigger Control

The DSO has very comprehensive trigger facilities; those discussed here are available directly from the front panel. For the more comprehensive menu driven features see section 3.6 (Standard and TV trigger, and trigger tools).

There are two trigger systems on the instrument: A and B. Each trigger system has its own source, coupling, level, slope and delay settings.

Assuming that the selected trigger system is **not** set to A gate B, then a valid trigger signal will start channel sweeps and is a single event. The trigger controls determine when an event is recognized as a valid trigger. For further details of the trigger system, see the Trigger Setup Menu, section 3.6.

When the instrument receives a valid trigger, the trigger light (7) briefly illuminates to indicate that the instrument is triggered (Trig'd). When a continuous sequence of valid triggers are received, the trigger lamp is continuously illuminated.

The trigger point is indicated at the bottom of the display; the trigger point of the Main trace by a 'M' and the trigger point of the Zoom trace by a 'Z'. If either trigger point moves off the display the symbol will become ←M, M→, ←Z or Z→ as appropriate.

When the instrument is turned off, the current trigger settings are retained and will be used on power up.

The choice between selecting and adjusting the A or B trigger is made with the Trigger control button (14).

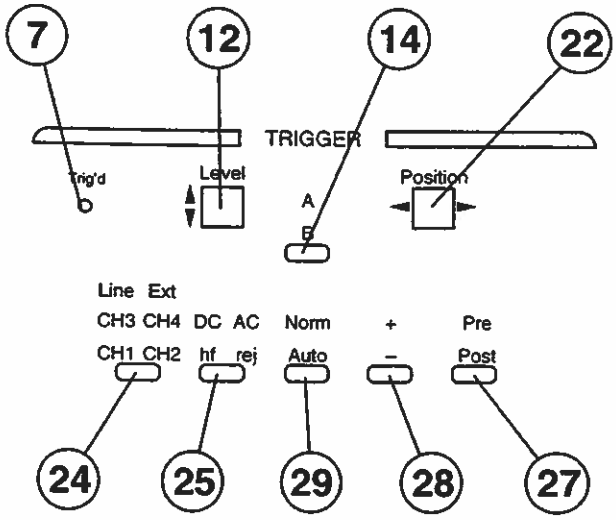


Figure 1.8 Trigger Controls

1.8.1 Selecting Trigger Source

Button (24) determines the source from which the trigger circuit takes its input. Only one of the LEDs above the source buttons will be illuminated to indicate the trigger source.

The trigger source can be any of the instrument's input channels, the AC line signal or an external signal.

If **Line** is selected, the trigger circuitry synchronizes to the line supply.

The external trigger signal should be connected to the front panel EXT TRIG BNC.

When External trigger is selected, the trigger level is referenced to the center of the screen. i.e. if the coupling is DC

then the trigger is referenced to ground and if the coupling is AC then the trigger is referenced to the center of the signal.

1.8.2 Trigger coupling

Button (25) selects the coupling used for the trigger signal. Each press of the button moves the selection on one step through the sequence: AC, AC hf rej (high frequency reject), DC, DC hf rej, etc.

The high frequency reject option switches in a low pass filter set to 15 kHz. Using this filter is helpful in stabilizing the trigger point on noisy input signals, although it may reduce the accuracy of the trigger point indicator at high timebase rates.

1.8.3 Trigger level

The trigger level is set by the **LEVEL** paddle (12). This is a continuously variable control. An indication of the trigger level relative to the displayed trace is shown by two small horizontal bars one at each side of the display, or if the trigger level is off the screen, by two arrows indicating the relevant direction.

The trigger level bars give an approximation of the trigger level and should only be used as a guide to the trigger point. They are meaningful, with respect to the trace, unless the channel is DC coupled with AC coupled triggering.

When the level control has been set so that valid trigger signals are being detected, the appropriate **Trig'd** LED lights up.

1.8.4 Trigger Slope (+/–)

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

The trigger point can be selected to be on either the positive going edge (+) or the negative going edge (–) by selecting the required option using button (28). Each successive press of this button toggles between + and –.

1.8.5 Trigger mode (Auto/Norm)

The trigger system can operate in two modes; Auto or Normal as selected by button (29).

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

In Auto mode, if no valid trigger signal has been received within 50 ms, the instrument will automatically produce its own trigger signal and initiate a capture. This ensures that the screen is constantly updated regardless of the input signal.

If valid triggers are received at a rate of approximately 25 Hz or more, they will be used to start all captures and the instrument will not generate its own triggers.

1.8.6 Trigger Output

A TTL trigger output signal is provided on the rear panel D–type connector.

This signal is a qualified trigger such that with trigger delay, the signal will indicate the start of the display sweep, i.e. the left hand edge of the screen and with pre–trigger it will indicate the trigger point. This trigger signal is shown in figure 1.9b.

1.9 Trigger delay

The acquired data position before, after and delayed from the trigger point is controlled using the delay paddle (22). See figure 1.9a. The amount of pre trigger or delay is shown at the bottom of the trace display when the delay paddle is pressed.

Either Pre or Post trigger delay is chosen using button (27). Any Pre or Post Trigger delay set is remembered by the instrument even when it is no longer selected. When either Pre or Post is re–selected, the previously remembered value will be restored.

Post trigger delay is the time between a trigger event being detected and the first sample acquired.

Note: *If the trace has been X shifted or zoomed, the first point on the display is not necessarily the first sample point of the acquisition.*

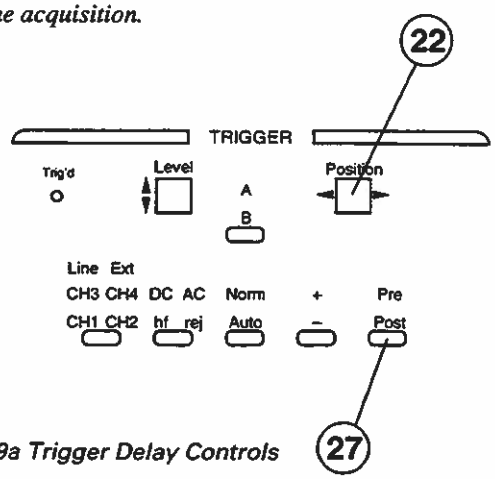


Fig 1.9a Trigger Delay Controls

1.9.1 Pre Trigger

Pre trigger is the ability to capture and display waveforms that occur partly or wholly prior to the trigger point.

To select Pre Trigger, press the Pre Post button (27) until the Pre lamp is lit.

Pre trigger is given as a percentage of screen width and can be set from 0% to 100% in 0.2% steps. While adjusting the percentage, the adjustment briefly pauses at 10% and 50%. With 0% pre trigger and no X–shift, the trigger point is at the left hand edge of the screen and 100% pre trigger puts the trigger point at the right hand edge of the screen.

The current amount is shown at the bottom of the screen while being adjusted with the delay paddle (22), and can also be viewed on the Status Menu (section 3.13) and also altered on the Trigger Setup Menu (section 3.6).

1.9.2 Delay by time

This is set by the Delay paddle (22) when the trigger mode is set to **Post** by button (27). The delay time can be set to a resolution of 5 ns, but the size of steps by which the delay can be increased or decreased using the paddle is dependent on the current timebase setting. Once set the delay time remains the same regardless of the selected timebase range.

Using the trigger menu, the delay can be set to any value directly, irrespective of the current timebase range.

The minimum delay is zero when the trigger point will be at the left hand edge of the screen. The maximum delay is 1000 s – 5 ns.

The current trigger delay setting is shown on the screen when the delay paddle (21) is adjusted. The delay setting can also be viewed on the Status menu (section 3.13) and altered on the Trigger Setup Menu (section 3.6).

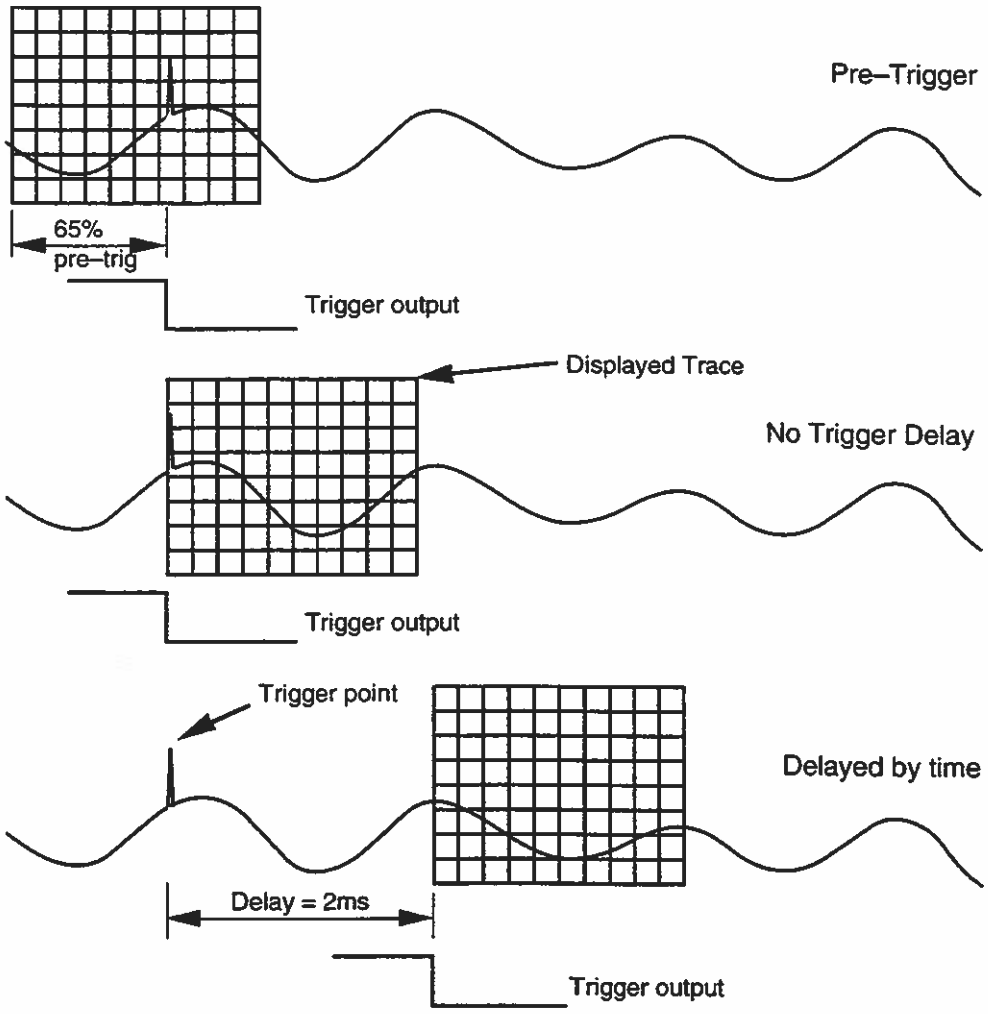


Fig 1.9b Trace capture with delay

1.10 Operating Hints

This section explains how to perform a system reset and gives some of the more commonly met problems in operating digital oscilloscopes, how to correct them, and a brief explanation of what was wrong. Later sections of the manual may need to be consulted as some of the operating features have not yet been discussed.

1.10.1 System Reset

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

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

To perform a system reset, switch the instrument off, press and hold the **Hold All** button. Keep the **Hold All** button pressed and turn the instrument on using the **Standby** button. When a short beep is heard, the HOLD all button should be released. The instrument will then start up in its reset condition.

1.10.2 Problem: Traces and alphanumerics very dim or completely disappeared.

Intensities too low

- Use the **Display Intensity Menu** or **Display Color Menu** as appropriate (section 3.10) to adjust the various intensities.
- Use the **Autosetup** (monochrome instruments only) to reset the intensities to their default levels.

1.10.3 Problem: Trace off the top or bottom of the screen.

Too much vertical shift

- Correct with that channel's **Position** button (30).

Input has large DC Offset

- AC couple the input signal using button (33).
- Correct using **Position** paddle (30).
- Use a less sensitive vertical range, button (31).

1.10.4 Problem: Trace not being acquired.

Instrument in single capture mode.

- Press **Run** (11).

Trigger level incorrect.

- Select **Auto** and **DC** trigger, buttons (29) and (25), then adjust the level control until the trigger level indicator bars are lined up with the center of the trace.

Trigger Source on the wrong input.

- Change the trigger source using button (24).

Trigger coupling on an unsuitable setting.

- Change trigger coupling using button (25).

Long trigger delay set.

- Either wait for delay to end, or shorten trigger delay. **Note:** *During long delays a countdown is displayed near the bottom of the screen.*

Channel **Hold** or **Hold All** on.

- Release Hold using button (13) or (35).

Timebase on very slow acquisition.

- Adjust horizontal **Time/Div** (23).

1.10.5 Problem: Trace is unstable even when triggered.

Alias.

- Check for alias by selecting a faster timebase range and checking whether or not the display changes as expected.

Noisy input.

- Select **Hf rej** triggering (25).
- Adjust trigger level (12).

Trigger on Auto.

- With very low frequency inputs (below 20 Hz), **Auto** trigger will initiate triggers in addition to any input triggers. Select **Norm** trigger (29).

1.10.6 Problem: Trace has very flat top or bottom.

Trace captured when off screen vertically and **position** shift has been used.

- Use less sensitive **V/Div** range when acquiring trace (31).
- Re–position trace prior to capture.

1.10.7 Problem: Auto Setup fails.

If Auto Setup fails it is most likely that the signal connected to the instrument is unsuitable for the automatic setup system for one or more of the following reasons.

Signal not repetitive.

- Auto Setup only works on repetitive signals

Signal amplitude too small or too large.

- Instrument cannot select a suitable V/div range. Use a suitable probe, i.e. ×1, ×10, ×100 or ×1000 to obtain a signal level between 5 mV and 400 V

Signal frequency too slow or too fast.

- The signal frequency is outside the range of Auto Setup.

Signal not constant.

- Amplitude and or frequency variations during the Auto Setup routine may interfere with its correct operation.

High frequency noise on signal.

- The noise may be interpreted as a high frequency signal instead of being ignored as noise on a lower frequency signal.

1.10.8 Problem: Cursor measurements apparently incorrect.

Wrong probe gain selected.

- Select correct probe gain to suit probe in use. See section 3.4.

Datum not set correctly.

- Re–position datum on trace (4).

Cursors on wrong channel trace.

- Position cursors on trace of interest (5).

1.10.9 Problem: Single Shot acquisition takes longer than expected.

Averaging or persistence modes selected.

- Turn off both averaging and persistence.

An ETS timebase is in use with infrequent triggers.

- Use the TIME/DIV paddle to change to a non ETS timebase.

An ETS timebase is in use with non repetitive or non triggered signal.

- Change to a non ETS timebase.
- Adjust the trigger controls to obtain a trigger signal.

1.10.10 Problem: Pressing the Volts/Div or position paddles does not seem to have any effect on the traces shown on the screen

Trace View is set to wrong channels.

- Check that the indicator below the Trace View button is indicating the correct set of trace numbers, i.e. 1-4 for traces 1 through 4 and 5-8 for traces 5 through 8. To move the signal being shown on trace 7, for example, the indicator should be showing 5-8. Now move the position paddle which is above the BNC input for channel 3. Trace 7 should move.

  To set the indicator and the controls to the other four traces, press the Trace View button once. Remember, when the indicator shows 5-8 the controls will affect the traces 5 through 8 and will not necessarily correspond to the signal being input in the BNC below that control.

1.10.11 Problem: Cannot turn traces on and off, there do not appear to be any buttons for this purpose on front panel.

The controls for turning traces on and off are not front panel controls but are menu controlled items.

- To bring up the traces menu press the button marked Trace Control once and then press the soft key next to the specific trace to turn it on or off - if either Main Only mode or Zoom Only mode is selected. In Main and Zoom mode then pressing the soft key for that trace will toggle through the choice of Main (M), Zoom (Z), Main & Zoom (M Z), or OFF. Main shows only the main trace; the position and Volts/Div paddles affect the input range of the input amplifiers. Zoom shows only the zoom trace; the position and Volts/Div paddles affect only the position and zoom factor of the screen image (i.e. not the input range of the amplifiers). Main and Zoom shows both the main and zoomed views of the input signal but the position and Volts/Div paddles operate in the same way as they do in Zoom mode.

  In Zoom mode, if the input signal is within the range of the input amplifiers currently set but the zoom factor applied means that the signal goes off the display then amplitude measurements will still measure correctly.

  However, if the signal goes off the screen in Main mode (or the input signal is above the input range of the amplifiers currently set) then the waveform will be chopped by the input amplifier and any amplitude measurements may not be correct.

2. DSO FEATURES

This section of the operators manual explains in detail how to use the various acquisition and display modes and the plot output features of the instrument.

2.1 TruTrace ®

TruTrace is a patented trace display technique that uses a spatial transformation to produce a display compressing the acquired data points into a trace that appears the same as the signal that would appear on an analog oscilloscope. Each group of acquired data points are converted into a vertical line whose brightness varies along its length according to the number of data points at any particular position.

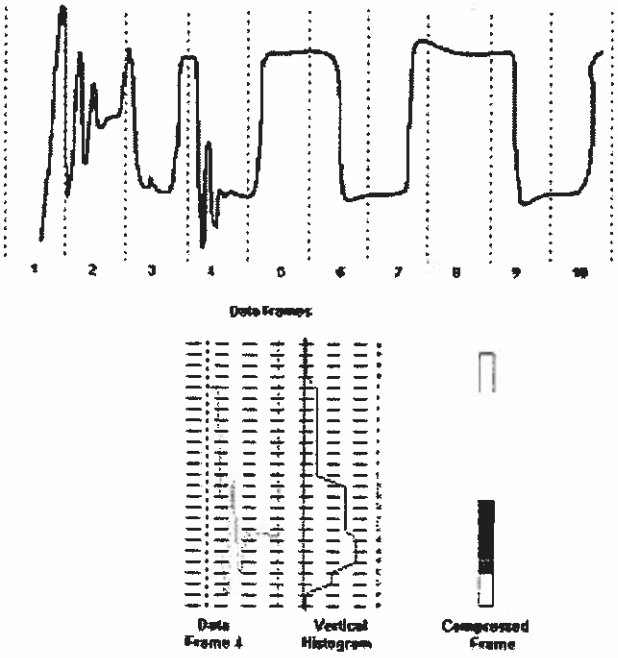


Figure 2.1 TruTrace display construction

For a 10, 000 point acquisition each group of 20 data points create one vertical line to produce the complete 500 line display.

Using TruTrace, detail that would appear as a solid color band on a conventional DSO is revealed allowing the user to see what is really going on in the signal.

TruTrace does not change the acquired data so that simply by pressing the TruTrace button (18) a standard DSO display is once more seen and zoom can be used to examine part of the signal in detail.

NOTE Because TruTrace is a compression technique, the instrument must be set to a memory length of more than 500 points so that there is data to compress down to the 500 point display.

2.2 Capture Facilities

The capture facilities allow the traces on the display to be frozen.

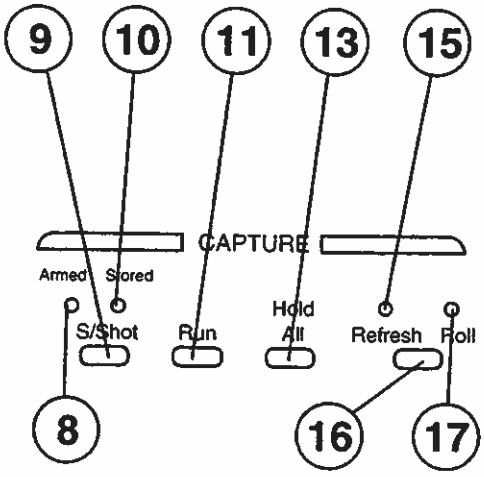


Figure 2.2 The Capture Controls

2.2.1 Trace Hold

There are three ways to hold or freeze the trace displays:

1) a single–shot capture whereby a full trace is acquired then frozen, section 2.2.2,

2) by pressing the **Hold All** button or

3) by pressing one of the individual channel **Hold** buttons.

Individual channels can be immediately frozen irrespective of the stage of any active acquisition by pressing the relevant channel **Hold** buttons (35). The associated Hold lamps light to show which channels have been held. To release a trace the **Hold** button should be pressed a second time and the hold lamp will go out. If Add is on when a channel is held then the other channel of the channel pair is also held.

Pressing the **Hold All** button (13) freezes all the displayed traces immediately regardless of the state of any on-going acquisition. The Hold All lamp lights to show that all traces have been held. A second press of this button releases all the traces and turns off the Hold All lamp.

To hold more than one trace at the same instant, press the **Hold All** button (13) then press the **Hold** buttons on the traces that you require. The individual channel hold lamps will illuminate. When all the required channels have been selected, press the **Hold All** button a second time. The selected channels will remain held while the others will be released. To release the held traces, press the relevant channel hold buttons.

If a trace is held during a slow refresh or slow roll acquisition, the display will stop updating but the acquisition will continue in the background. If hold is then de–selected, the display will instantly update to the point that the acquisition has reached. If however, hold is left on until the acquisition continues to a stored condition (see 2.1.2), de–selecting hold will have no effect on the screen display.

2.2.2 S/Shot and Run

These two buttons (9) and (11) are used to set the instrument into either a single shot capture–and–freeze mode (**S/Shot**), or a free running continuous capture and re-capture mode (**Run**).

S/Shot (9) Arms the instrument for a Single Shot triggered acquisition. The armed light will be illuminated to show that the button has been pressed. If it is required that the instrument should remain in this state waiting for a trigger for more than 40 ms, then Normal mode – section 1.8.6 – should be selected to prevent Auto triggers being generated.

Pressing S/Shot during a slow timebase capture (whilst in continuous mode) will freeze that capture upon "stored". Pressing S/Shot twice during a slow capture or during a slow Single Shot will rearm the scope immediately for a S/Shot capture.

Armed (8) Illuminates after the **S/Shot** button has been pressed; it will stay lit until either a valid trigger has been accepted or until the **Run** button is pressed.

Stored (10) Illuminated on completion of a single–shot acquisition. This is after the instrument has been armed, triggered and a complete trace acquired. The light will stay on until the instrument is rearmed by pressing either **S/Shot** again or **Run**.

2.3 Display Modes (see also 2.1 TruTrace)

There are five display modes on the instrument: Refresh, Roll, Persistence, XY and TruTrace. The first three of these are mutually exclusive. XY can only be applied to refresh modes. TruTrace can be applied to any display mode except XY. Roll, Refresh and TruTrace are available directly from the front panel using buttons (16) and (18). See Section 2.1 TruTrace.

2.3.1 Refresh

The instrument will imitate the style of a conventional real-time oscilloscope and the display is plotted from left to right as it is acquired, overwriting existing data. In refresh with pretrigger, the display does not update until the pretrigger information has been acquired. This is only noticeable on slow timebases.

2.3.2 Roll

This mode is like a chart recorder. The display scrolls from right to left until a trace has been acquired. New data is written on the right–hand side of the display.

The scrolling effect is most noticeable on the slower timebase ranges. The rolling display is frozen by the trigger in S/Shot mode but is unaffected by the trigger in Run.

Roll is only available on timebases of 50 ms/div and slower. If the timebase is faster than 50 ms/div, the display and trigger systems behave as in refresh mode.

2.3.3 X–Y

This mode allows the CH1 input to control the X (horizontal) component of the trace, and the other channel inputs to control the Y (vertical) component of the trace display. X–Y is turned on and off from the Display Master Menu. See section 3.8.1.

The display will show an X-Y display of the data captured by the timebase and trigger systems. Main trace 1 will be mapped against Main trace 2, 3 & 4 and Zoom trace 1 will be mapped against Zoom trace 2, 3 & 4. Which X–Y maps are actually displayed is determined by the display mode set with the Main/Zoom button (28), the traces that are On and the settings in the Trace View Menu. See section 3.37.

X–Y is available on all timebase ranges but the timebase should be set slow enough to capture the whole of the signal of interest. This mode is useful for showing Lissajous' figures.

2.3.4 Persistence

This is a refresh mode in which successive acquisitions are added to the current display. The number of acquisitions or the time before clearing the display is set in the Persistence menu accessed from the Display Menu. The latest acquisition is shown brighter than the persisted acquisitions. See section 3.11.

On color instruments, there are two styles of persistance, either monochrome or color. In monochrome, persisted traces are displayed in the one persistance color set in the Display Color menu. In color, persisted traces are displayed in their own trace color.

2.4 Cursors

The instrument allows you to take direct measurements from the screen display, using the datum and cursor lines. The required measurements must be selected in the Measurement Menu. See section 3.15. Measurements will be made with respect to ground or to the horizontal datum depending upon the measurement parameters selected . See section 3.15.1.

2.4.1 Cursor and Datum Selection

The cursor and datum lines are switched on or off using the Select Trace button (5). Successive presses of this button places the cursor and datum lines on to the displayed traces in turn. i.e. Trace1Main (TR1M), Trace1Zoom (TR1Z), Trace2Main, Trace2Zoom, ...Trace4Zoom, Off, Trace1Main etc. If any of the traces are not in use, the lines skip to the next valid selection.

Note: *If zoom, X shift, or other trace manipulation feature has been used, the cursor and datum lines may not be visible on the screen. To bring them back into view use the datum and cursor paddles as described below.*

2.4.2 The Cursor and Datum Lines

Once activated using the select trace button, 3 lines appear on the trace as shown in figure 2.4.2 below. Both the datum lines extend the full width or height of the display and the cursor is a short line that can be moved along the trace from sample to sample.

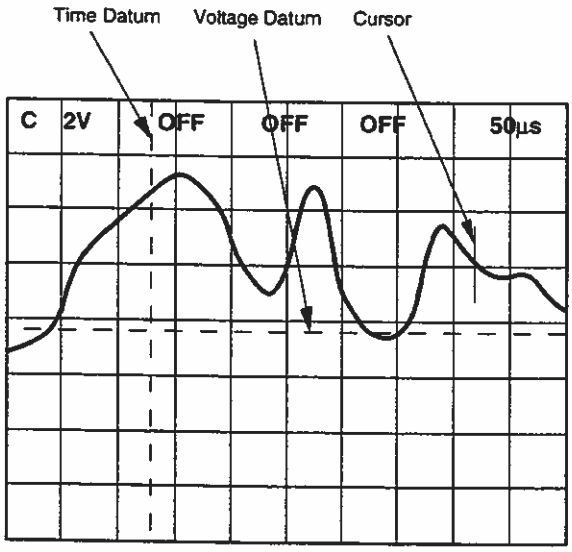


Figure 2.4.2 The Cursor and Datum Lines

Movement of these lines is achieved using the datum and cursor paddles (4) and (6). All three of these paddles are 5–position controls.

Paddle 4 (left–hand) moves the Voltage datum line up and down. See making measurements in section 2.4.3.

Paddle 4 (right–hand) moves the Time datum line left and right and,

Paddle 6 moves the Cursor line left and right along the selected trace.

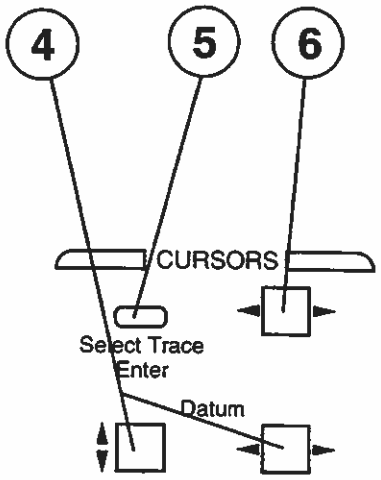


Figure 2.4.3 The Cursor and Datum Line Controls

2.4.3 Making Measurements

When using the cursors, the instrument displays, at the bottom of the screen, time and voltage or other special measurements as selected in the Measurements Menu, see section 3.15, 3.16 and 3.17.

The time and voltage shown is the difference between the trace intersections of the horizontal and vertical datum lines and the cursor.

Note: *Each channel's ground position may be in a different position on the screen.*

Placement of the cursor and datum lines at the desired positions is easier for the user at those points where the slope of the waveform is at its steepest. For example, on a standard sinewave, the easiest points to place the measurement lines to measure the wavelength are two 0 V crossing points or points of inflection. If a trace is zoomed then the cursor can be set more precisely and placed on the required sample.

2.5 Plot

A plot of the screen display and annotation can be obtained at any time by pressing the Plot button (18). Menus can also be plotted. The plot can be sent to the internal thermal plotter if one is fitted, or it can be sent to an external HPGL plotter via the centronic (parallel) RS423 or GPIB interface.

When sending plots to an external plotter, µ will be converted to u and any other special characters such as Ω will be converted to a question mark (?).

The plot destination and parameters are set via the menu system. See section 3.26.

Dot Join The plotter will plot the dot joined image as it appears on the screen. If dot join is not required it should be turned off using the Dot join On/Off feature in the menu system. See section 3.8.2.

Date and Time The original date and time of the trace acquisitions (including recalled traces) and the current date and time will be plotted.

2.5.1 Internal Thermal plotter

The thermal plotter option is a fast, high quality plotter, which provides hard copies of displayed or stored data in the form of single, or repetitive screen dumps. It can also plot menus. All plot parameters are user selectable through the instrument's menu system. See section 3.17.

Note: *The head should be lifted whenever the plotter is not in use to prevent flat spots forming on the pressure roller.*

When using the internal thermal plotter background plotting is provided as described below.

When the plot button is pressed, both the **Plot** and **Hold All** lamps light. After about 1 second the Hold All lamp goes out indicating that the plot data has been transferred to the plot buffer and that the instrument can be used again. The Plot lamp will remain lit until the plot is complete when it will go out. Further presses of the Plot button during a plot are ignored. If a plot of more than 1 screen width is being plotted, the Hold All lamp will remain lit until the last screen has been plotted.

To stop a plot while the Plot lamp is on, press the **Cancel** button (20), the plot, possibly after a short delay will be aborted. Any changes to the instrument status during a plot will have no effect on the plot as the data has already been transferred and stored in the plot buffer. If a calibration occurs during a plot, the plot may slow down but there is no change to the stored data.

Plots of persisted displays may take longer than normal due to the number of traces that have to be plotted.

Thermal Plotter Paper

Action The thermal image is formed by a chemical reaction between a dye precursor and acceptor coated on the paper and stimulated by the application of heat. As with any chemical reaction the operating conditions should be tightly controlled for consistent results.

Selection Only the recommended paper as detailed in the specification/order details section should be used with the thermal plotter. The paper is matched to the print head characteristics and has been selected for sensitivity, definition and non–abrasiveness. Variations in these qualities affect print quality and head life. Low definition label grade papers are not suitable. A paper with different coating or thickness could lead to abnormal head deterioration, poor image definition and inaccurate print registration.

Any damage or wear caused by the use of inappropriate papers will invalidate the warranty.

Feed The paper is automatically advanced at the start and finish of each plot. Further paper can be fed through the mechanism by pressing the manual feed button. This blue button is situated in a recess in the plotter assembly.

Note: *Paper is fed while the button is pressed even if a plot is in progress.*

Loading

1. Remove and discard the first complete layer of paper from the roll, because it is sticky in order to hold the roll together and the glue can block up the plotter mechanism. With scissors, cut the end of the paper square.
2. Open the plotter by depressing the cover catch and removing the cover.
3. Remove the shaft from the paper cradle and if the plotter has been used previously remove the plastic tube from the shaft.
4. Insert the shaft through the paper roll and fit the roll into the paper cradle so that the paper feeds from the underside of the roll as shown in figure 2.6.1 below.
5. Pull the head lift lever forward (toward the side of the instrument) and insert the end of the paper into the plotter mechanism behind the pressure roller and push it through until the end of the paper reappears at the front.
6. Pull enough paper through to pass through the top cover, ensure that it is running around the plotter mechanism smoothly and that it is straight, then lower the head by pushing the head lift lever towards the rear of the plotter.
7. Close the plotter cover and ensure that it latches shut.

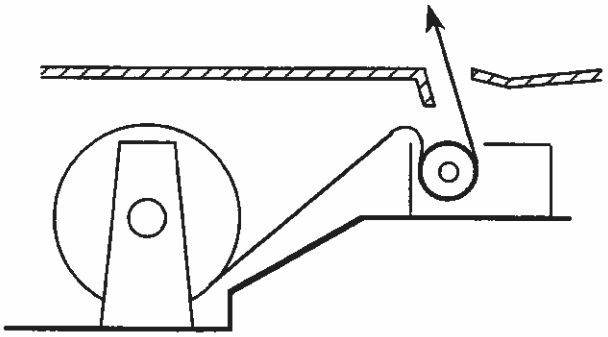


Figure 2.5.1 Thermal Plotter Paper Loading

Paper Storage For best results the thermal paper should be stored to avoid direct sunlight, moisture and fingerprints. The paper is desensitized by certain amines and esters.

Printed Image Archiving If the printed thermal image is stored in an ordinary manila file folder in the absence of light below 25 °C (77 °F) and with an average relative humidity of 65%, it will remain legible for a minimum of five years, provided that there is no contact with adhesive, solvent, or plasticizer bearing materials or vapors.

In general usage, degradation of the thermal image is caused by exposure to sunlight, moisture, adhesive tape, PVC folders or fingerprints, but it is tolerant enough to survive in a general "lab book" type environment below 54 °C (130 °F) with a relative humidity below 80%.

Plot Cancel A plot can be stopped by pressing the **Cancel** button (20).

Error Messages Under certain conditions, an error message relating to the thermal plotter will be displayed on the oscilloscope's screen. If a plot is in progress when an error condition occurs it will be aborted and any plots requested will be refused. The possible messages are:

PLOTTER OUT OF PAPER

PLOTTER HEAD RAISED

PLOTTER HOT ALLOW TO COOL

PLOTTER OUT OF PAPER is displayed if there is no paper in the plotter. Inserting more paper will remove this error.

PLOTTER HEAD RAISED appears if the plotter printing head lever is in the forward position with the head away from the pressure roller. Moving the head to the plotting position clears this condition.

2.6 Recorder Mode (7200 Only)

Recordings are made using the Roll mode where the display rolls from right to left. At the same time waveform data is be recorded to the internal Hard disk (500 Megabytes) or direct to paper. While in roll mode the Save/Recall Menu shown below displays the recording selections.

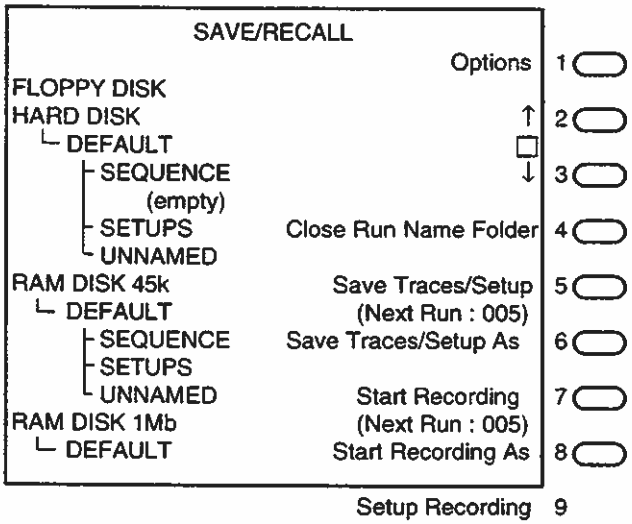


Figure 2.6 A Typical expanded Save/Recall Menu

2.6.1 Record To Disk

Using the up-down buttons 2 and 3 select an appropriate 'RUN NAME' below a user as shown in Fig 2.6. If a new user or run name is required, it can be entered below a user in the same way as other Classic instruments. See section 3.31.

2.6.2 Set Up Recording

Select 'Setup Recording' using Button 9 in the Save/Recall menu. This will change the display to the Recorder Menu as shown below in figure 2.6.2.

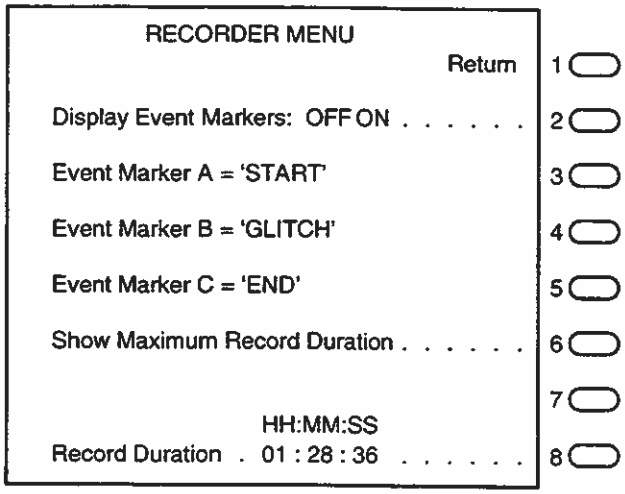


Figure 2.6.2 A Typical Recorder Menu

This menu has event markers and record duration selections.

Return Returns from the recorder menu to the Save/Recall menu

Display Event Markers Turns event markers on and off. During record these will appear on the display against soft keys 2, 3 and 4. The markers are entered manually using the soft keys while recording to disk or paper.

Event Marker A, B or C Allows labels with up to 19 characters to be entered against each marker from an alpha numeric display pad

Show Maximun Record Duration This function will display temporarily the length of recording possible with the current selected timebase taking into account the number of channels turned on and the remaining space on the hard disk. The display is expressed in hours, minutes and seconds.

Record Duration By selecting this function the required recording duration can be set in hours, minutes and seconds. 1 second is the minimum setting.

2.6.3 Start Recording

Return from the Recorder Menu or select the Save/Recall directly from the front panel menu control, Fig. 1.

Button 7, labelled 'Start Recording', will prepare the disk for recording.

The disk will be prepared and the display will return to rolling traces.

To start recording, press 'SAVE' on the front panel.

If the markers are turned on, they will appear against the soft keys 2, 3 and 4 and each time one is pressed the marker position will be recorded.

2.6.4 Replay

First select Save/Recall menu shown in Fig 2.6.2. Using the up and down buttons 2 and 3 in conjunction with button 4 to open Users and Run names select the appropriate run number to be replayed as shown in Fig 2.6.4a with the inverse video cursor.

By opening the folder detail of the stored data can be displayed and checked to ensure it is recorded data indicated by the file extension. e.g. REC. For full file details press the Options button 1 from the Save/Recall menu.

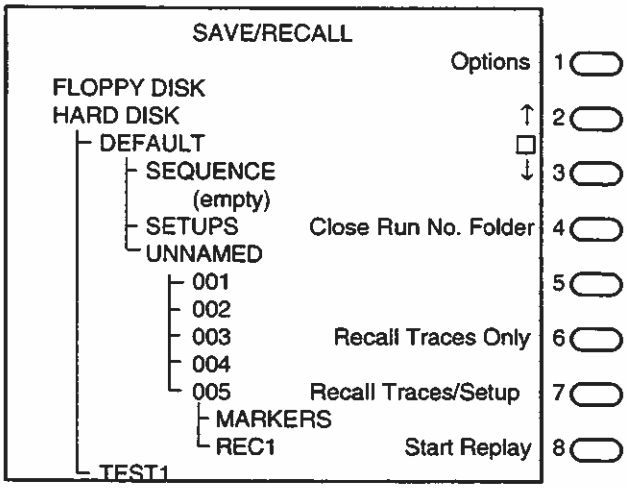


Figure 2.6.4a A Typical expanded Save/Recall Menu

By pressing button 8, Start Replay, the traces will be replayed in conjunction with a Replay Control menu as shown in Fig 2.6.4b.

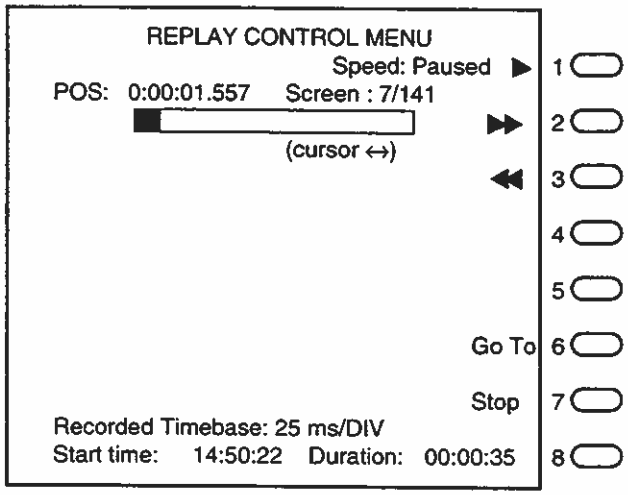


Figure 2.6.4b A Typical Replay control Menu

▶ Toggles between replay and pause.

▶▶ Starts fast forward.

◀◀ Starts fast reverse.

Button 4 If pressed while replaying will speed up the replay.

Button 5 If pressed while replaying will slow down the replay.

Go To will access a range of controls to move forward and backwards to stored markers. There is a choice to step through in order or choose any marker number from the 3 available.

When moving to a marker, the display will position the marker point in the centre of the screen. The cursor position is an additional control to move in either direction through the recorded data at the same time indicating the time and number of screens from the start.

2.6.5 Record To Paper

Continuous recording to paper is made using the ROLL mode. The other important parameters are timebase settings and the record duration.

Set to Roll mode

Set the timebase to 200 ms/div or slower. (max speed to paper is equivalent to 50 mm/s.

Set the record time to the required length from the the menu shown in Fig 2 in the same way as the record to disk. The record length at 200 ms/div for one screen is 2 s. When recording to paper up to 60% of the screen will be recorded to paper as pretrigger information and there will be additional recording after the preset recording is reached to ensure data is captured each side of the point of interest.

3. The Menus

Many of the advanced features of the instrument are accessed through the menu system. The menu structure is summarized in figure 3.0. The numbers 1 to 9 refer to the numeric buttons used to select the particular menu or menu items, see section 2.1.1. All the front panel controls remain live when menus are displayed, allowing the control status to be changed at any time using either the front panel controls or the menu buttons.

The menus consist of rows of text each of which is in line with one of the numeric buttons. On some of the lines there are characters in inverse video, these show which option has been chosen. In some cases, when there are a large number of options, only the selected one is shown.

Definitions

Button 1: in the menus may have different label or names but is essentially a "Do It" control which will cause the selected action to happen and will in many cases return the display to the previous menu or trace display.

Cancel: Returns to the previous menu with the selections unchanged.

Clear: Clears the complete selection line.

Delete: Deletes the last character in an entry pad or deletes the whole selected item.

Insert: Puts the highlighted character into the character string on an entry panel.

↑ Moves the highlight up a list

↓ Moves the highlight down a list

▭ Indicates approximately how far through a list the highlighted item is.

3.1.1 Entry Pads

Many operations require a user specified name or number and these are entered using entry pads. Each entry pad contains the characters appropriate to the item being named or numbered and all entry pads work in the same way.

The highlight is moved through the characters using buttons 2 and 3 until the required character is reached. Button 8 is used to insert the highlighted character into the character string at the bottom of the entry pad. When the character string is complete, the information is put into the menu system by pressing button 1 which also returns the display to the menus.

The highlight may also be moved around the characters by using the datum keys. The horizontal datum moves the highlight horizontally and the vertical datum moves the highlight vertically.

3.1.2 Menus

There are 8 Menu buttons and two other buttons which each select a menu to replace the current display. The menu buttons are **Channel**, **Display**, **Trigger**, **Measure**, **Utility**, **Memory**, **Save/Recall**, and **Special**. The additional buttons are **Trace View** (40), and the **Trace Control** button (39).

3.1.3 The Numeric Buttons

The buttons **1** to **8** (1) and **9** (45) are used in conjunction with the menu system to provide a large number of extra functions not otherwise available directly from the front panel. Pressing these buttons when the menus are displayed operates the menu functions described in sections 3.2 to 3.38.

3.1.4 Menu/Traces

The **Menu/Traces** button (2) toggles the display between the traces and the last menu used.

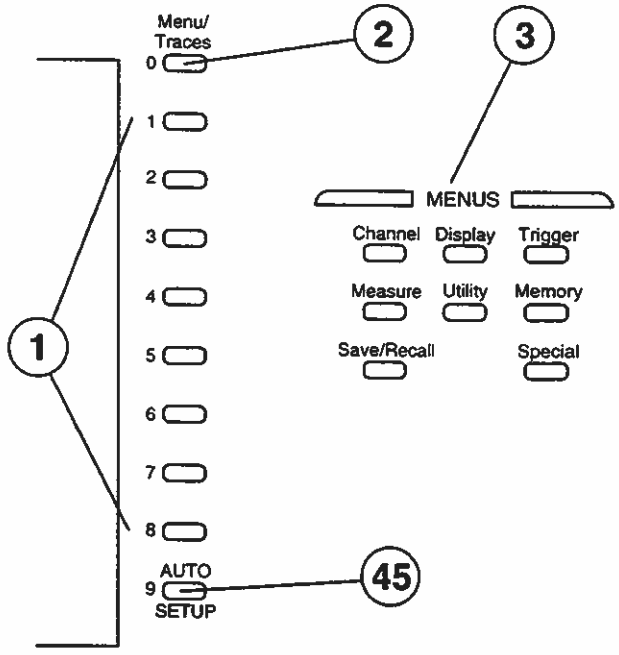


Figure 3.1 The Menu Operation Buttons

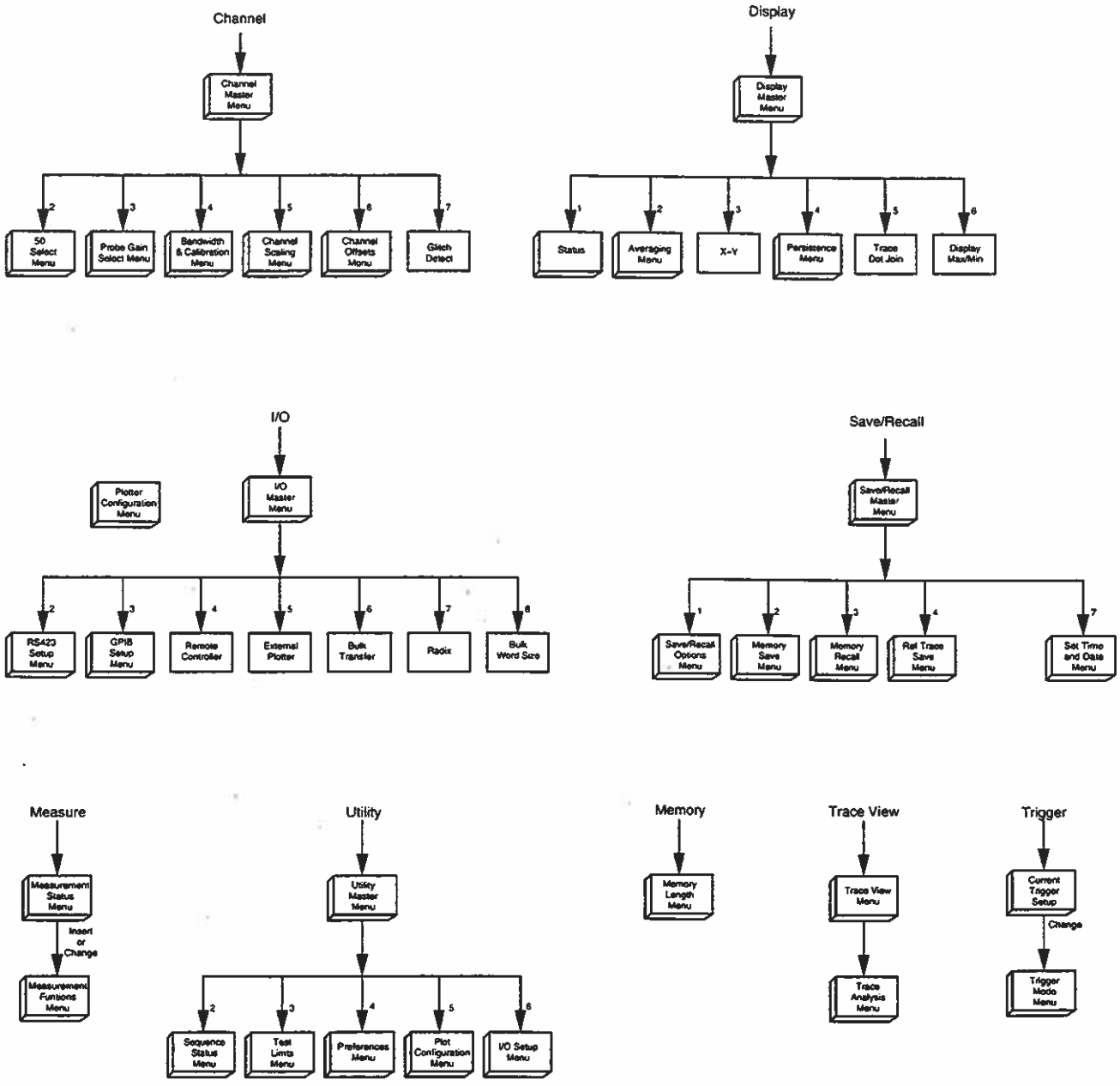


Figure 3.0 The Menu Structure

3.2 Channel Menu

The Channel menu contains a mixture of sub–menus and control selections. The text is aligned with the numeric buttons 2 to 8 (1) alongside the display. To obtain the sub–menu or control selection, press the relevant button.

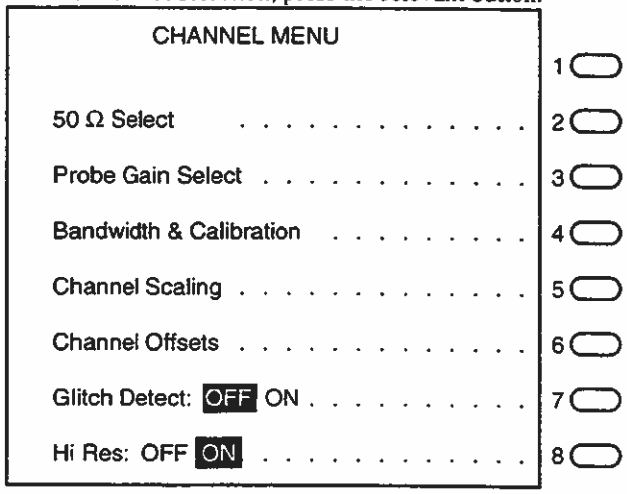


Figure 3.2 The Channel Menu

50 Ω Select Menu. See section 3.3.
Probe Gain Select Menu See section 3.4
Bandwidth & Calibration Menu See section 3.5
Channel Scaling Menu See section 3.6
Channel Offsets Menu See section 3.7

3.2.1 Glitch Detect

This entry does not select a further menu, it directly controls the glitch detect or Max/Min function. Each press of button 7 alternately turns Glitch Detect on and off.

Glitches are detected by a Glitch Detect capture system which is designed to detect narrow glitches that may occur between timebase sample points. It operates on the signal as it is captured and can detect narrow pulses down to 10 ns wide. Any glitches detected will at least be displayed as a spike. They will be detected whether they are positive (Max) or negative (Min).

Glitch Detect is useful for detecting aliases because if there are many maximum and minimum points in a capture these levels will be stored thus building up an envelope of the true waveform. If the signal peak–to–peak amplitude is constant then the envelope will appear as two horizontal lines of data points with, if dot join is on, the band between these lines filled in.

Each pair of dots on the display will represent the maximum and minimum levels of all the samples during that two dot display period. For example, in 50 k mode there will be 200 samples represented by each pair of display points.

3.2.2 High Resolution (Hi Res) 6100 and 7200 only

This entry does not select a further menu, it directly controls the High Resolution mode. Each press of button 8 alternately turns Hi Res on and off.

High Resolution for the Classic 6100 and DataSYS 7200 switches in a mode that gives 12 bit resolution (1 in 4094) up to 25 MSamples/sec. The improved resolution achieves low noise, improved linearity and accuracy which ensures the high quality data gives meaningful results when analysed and measured. This feature will be of particular interest to users involved in analytical research where the increased dynamic range guarantees the complete signal is acquired, including the fine detail. To preserve data integrity, avoiding aliasing on high frequencies is of paramount importance.

Hi Res automatically applies an anti alias bandwidth limit filter as shown at the top left of the screen which removes high frequency noise beyond the maximum sample rate. Its frequency is related to sample rate and varies with memory length and timebase. To get the best results, use the longest memory possible.

Because the Oscilloscope's display is 240 levels, viewing the lower levels beyond 8 bit is acheived by using vertical zoom which provides voltage ranges down to 62.5µV per division.

To get the most benifit from Hi Res, it is recomended that the signal of interest is as close as possible to full screen height.

All measurements are performed using the full 12 bit data and FFTs are calculated using all the data available.

When Hi Res is turned on, averaging is not available. If averaging is already on when Hi Res is selected, averaging is forced off.

When Hi Res is turned on, glitch detect is not available. If glitch detect is already on when Hi Res is selected, glitch detect is forced off and will be turned back on when Hi Res is turned off.

3.3 50 Ω Select Menu

The input impedance of each of the input channels can be independently set to either 1 MΩ or 50 Ω using this menu.

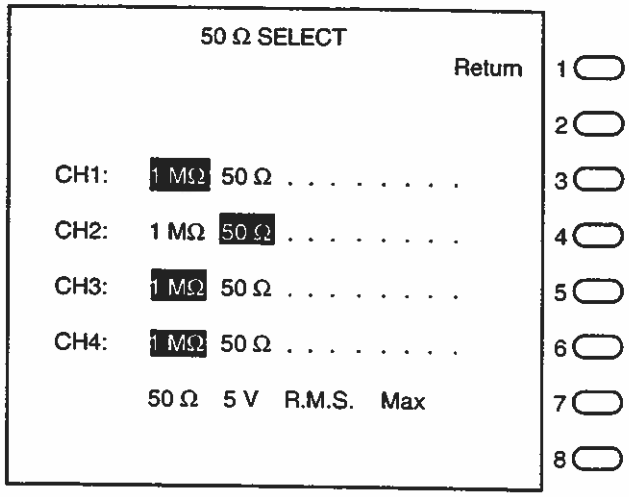


Figure 3.3 The 50 Ω Select Menu

The numeric button alongside the required channel number on the display toggles the impedance between 50 Ω and 1 MΩ. When changing from 1 MΩ to 50 Ω a second press of the button is required to confirm the action.

While a channel's impedance is set to 50 Ω the relevant front panel indicator (43) is illuminated.

CAUTION: The maximum input voltage to the instrument in 50 Ω mode is 5 V RMS. Voltages in excess of this may damage the instrument and make it unsafe.

3.4 Probe Gain Select Menu

This menu is used to set the instrument to suit attenuating probes.

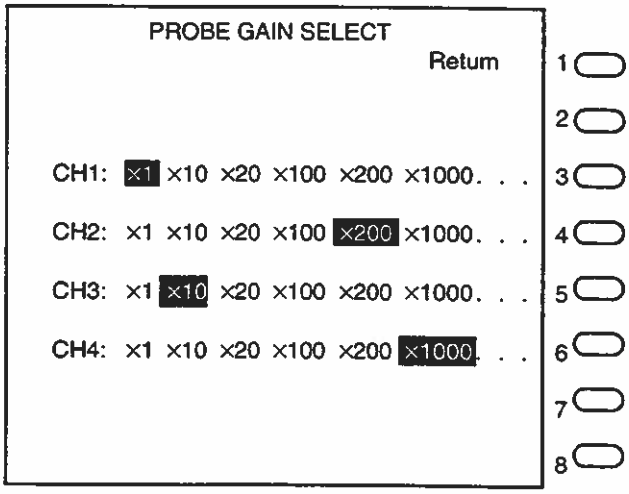


Figure 3.4 The Probe Gain Select Menu

An independent probe attenuation ratio can be set for each of the input channels with successive presses of buttons **3**, **4**, **5** or **6**. The available ratios are ×1, ×10, ×20, ×100, ×200 and ×1000. Once a ratio has been selected, if a probe of the chosen ratio is attached to the appropriate inputs, the new sensitivities at the probe tip will be displayed correctly on the screen.

These numbers merely alter the measurements and the displayed sensitivity for the user's convenience.

An altered sensitivity is shown in inverse video on the trace display.

3.5 Bandwidth & Calibration Menu

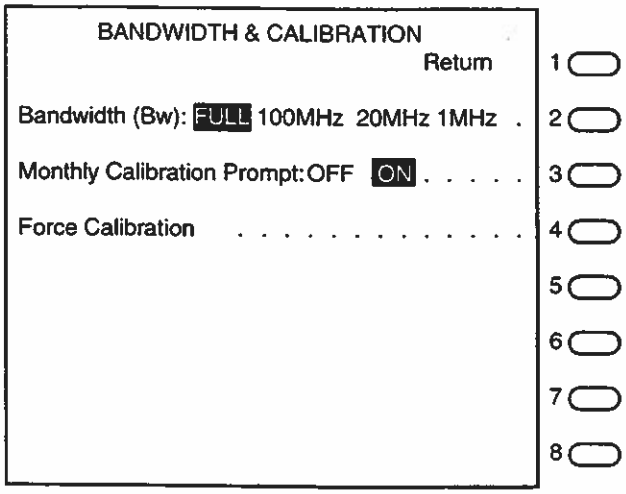


Figure 3.5 The Bandwidth & Calibration Menu

Bandwidth Depending upon the instrument model, the bandwidth of all input channels can be limited to 200 MHz, 100 MHz, 20 MHz or 1 MHz using button 2 as shown in the table below.

	200 MHz	100 MHz	20 MHz	1 MHz
9500	✓		✓	✓
6500			✓	✓
6000		✓	✓	✓

Table showing bandwidth limits available

This can be useful when the signals of interest have high frequency noise superimposed on them. When bandwidth limit has been turned on, the Bw symbol will appear at the upper left hand side of the trace display.

Monthly Calibration Prompt If this option is turned on, once a month a prompt appears on the display to remind users that if they so desire they should force a calibration by pressing button 4 on this menu.

Force Calibration Button 4 causes the instrument to perform a re–calibration of all channels and ranges. To obtain the best results from this function, the instrument should have been operating for at least 15 minutes.

Force re-calibration is always available regardless of the instrument's acquisition status. Forcing a calibration will stop any acquisition that is in progress and will not store any data already acquired.

When a forced calibration is complete, the display will return to the normal trace display.

3.6 Scaling

The scaling menus enable the user to scale cursor measurement results into user defined units.

Scaling is applied to the cursor measurement trace in both horizontal and vertical axes as required to produce scaled volts and scaled time measurements. The measurement on screen can have a 4 digit user defined annotation to indicate scaling units. These units also replace the ordinary V/div readings and carry through all subsequent analysis automatically without the user having to scale and define the units for each analysis.

Scaling factors are only applied to the following measurements.

Volts and time	Volts and 1/time
Top and base	Amplitude (top – base)
Peak to peak	Max and min
Rise and fall time	Pulse width
RMS and ACRMS.	X and Y
t	
Period (from frequency, period and duty cycle)	

Scaled volts measurements consist of a scaling factor to multiply by and an offset. Therefore a scaling factor of 1 with an offset of 0, will in effect mean that no scaling has been applied. The scaling factor and the offset can vary between ±1E±30.

Scaling is calculated in the following way: The offset is subtracted from the original value then the result is multiplied by the scaling factor. The offset is therefore in reality an offset from 0 or ground. Therefore the scaled measurement =

$$(\text{unscaled measurement} - \text{offset}) \times \text{Scalefactor}$$

Scaled time measurements, however, are calculated in one of two ways, Direct or Datum to Cursor.

In Direct mode, the specified scale factor is applied directly to the timebase setting to produce a result.

In Datum to Cursor mode, the positions of the time datum and time cursor are used.

$$\text{Scale Factor} = \frac{\text{number entered}}{\text{Time (in secs) between datum and cursor}}$$

This can be useful if, for instance, a pulse is known to represent a certain amount, this can be entered and then measurements taken from the rest of the trace that relate to the known amount.

Note that scaling affects all subsequent analysis and not just the original cursor measurement.

3.7 Channel Scaling Menu

The measurement traces and their current scalings are displayed. Select the one to be scaled using buttons **2** and **3**. The current scaling type of the selected trace is shown.

The scaling of the highlighted trace or time can be turned on and off using button **1**. To turn off all scaling, press button **8** to change the Measurement Scaling parameter from Enabled to Disabled.

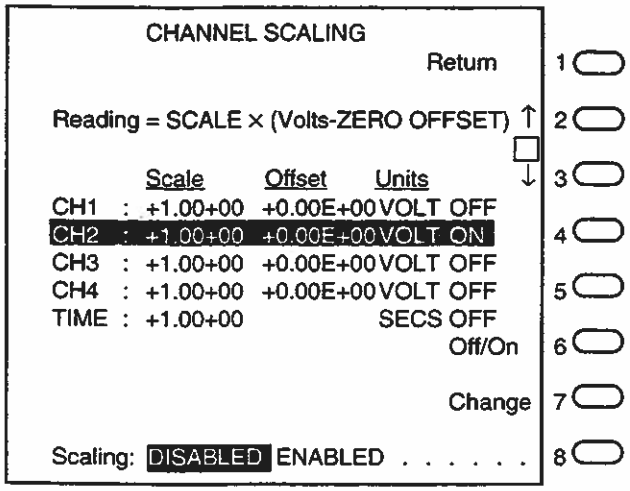


Figure 3.7a Channel Scaling Menu Example

When the required item is highlighted, press button **7** to change the scaling factors.

If one of the traces is selected, the menu will change to the Scaled Volts Measurements menu and if Time is selected the menu will change to the Scaled Time Measurements menu.

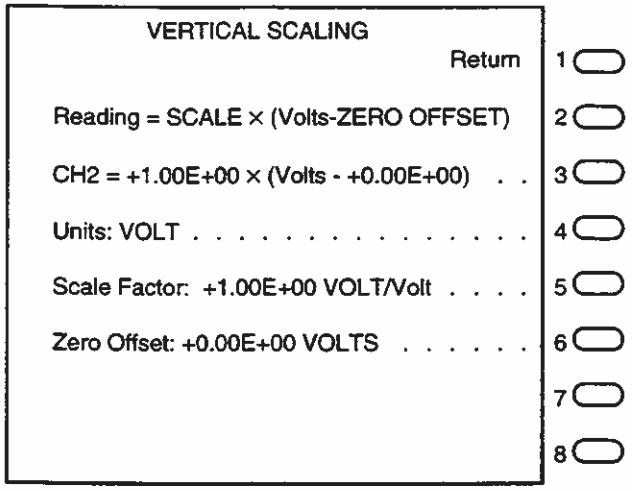


Figure 3.7b A Vertical Scaling Menu Example

From this menu the trace to be scaled, the units, scale factor and zero offset can all be set or changed. To enter data for any of the items, press the appropriate button, **4**, **5** or **6**.

To select a trace, press button **3**. Each press of the button will step to the next trace name or Time and the currently set scale factors will be displayed.

If units is pressed, the display changes to the Scale annotation entry pad from which four characters can be entered.

If either Scale Factor or Zero Offset is pressed, the display changes to a numeric entry pad from which a nine digit number can be entered.

When all the entries are as required, press button **1**, return to go back to the Channel Scaling menu.

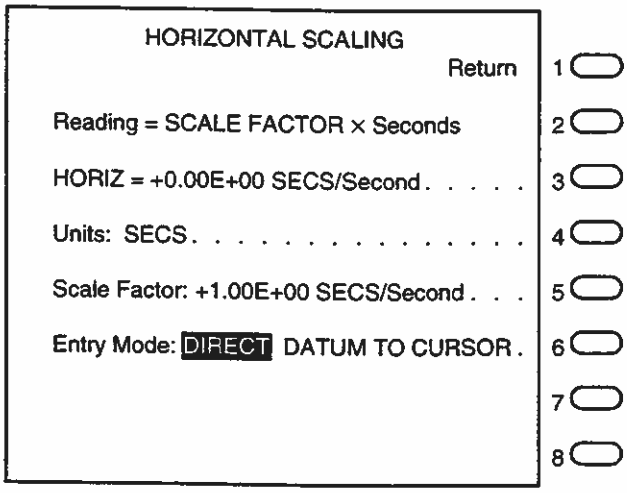


Figure 3.7c Horizontal Scaling Menu Example

The Horizontal Scaling menu has two forms depending upon the entry mode selected in line 6. If the entry mode is Direct, the menu is as shown in figure 3.7c above, but if the entry mode is Datum to Cursor, then the menu is as shown in figure 3.7d below.

To change from one mode to the other, press button **4**.

From this menu the units and scale factor or datum to cursor time can be set or changed. To enter data for any of the items, press the appropriate button, **5** or **6**.

To select a trace instead of Time, press button **3**. Each press of the button will step to the next trace name from CH1 through CH4 and back to Time and the currently set scale factors will be displayed.

If units is pressed, the display changes to the Scale annotation entry pad from which four digits can be entered.

If either Scale Factor or Datum to Cursor is pressed, the display changes to a numeric entry pad from which a nine digit number can be entered.

When all the entries are as required, press button 1, return to go back to the Channel Scaling menu.

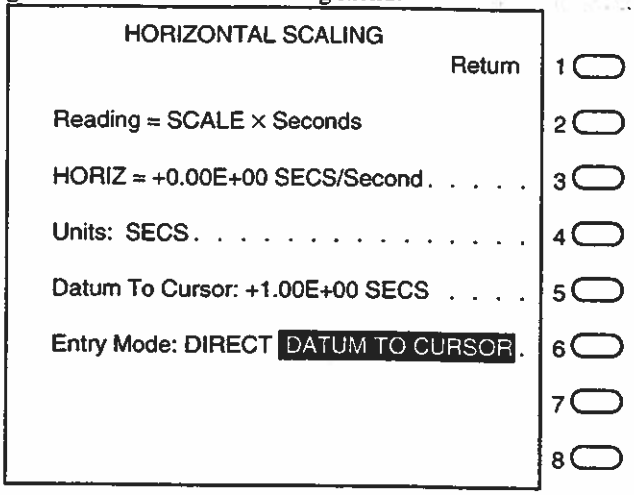


Figure 3.7d Horizontal Scaling Menu Example

If an attempt is made to set the horizontal scaling in Datum to Cursor mode when the cursor and the vertical datum are at the same position on the screen, the message CURSOR AND DATUM SAME will be displayed and the scaling will not be set. Similarly, if the cursor is off the message CURSORS OFF will be displayed and again the scaling will not be set.

When the instrument is in XY mode the horizontal scaling cannot be set. An attempt to do so will result in the message CANNOT SET SCALING IN XY being displayed.

3.8 Channel Offsets Menu

The offset facility enables a DC pedestal on a signal to be cancelled out so that a more sensitive V/DIV range can be used to examine the actual signal in greater detail.

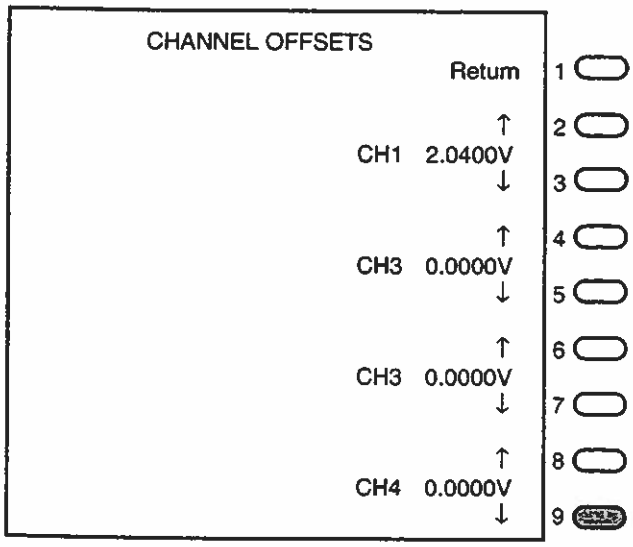


Figure 3.8. Offset Menu

The effect of the offset voltage is to add a clibrated shift to the actual signal so that for example for a signal which has a +20 V DC component, applying a +20 V offset will cause the +20 V signal level to be displayed where 0 V was originally displayed.

The relevant ↓ and ↑ keys increase and decrease the applied channel offset voltages. Note that the traces move relative to the screen in the opposite direction to the arrows. The rate of change of the offset voltage increases if the button is held down for longer than 1 second and there is a short pause in the change as the voltage passes through zero.

The offset voltage range varies with the vertical V/div setting as shown in the table below:

V/Div	**Maximum Offset**
2 mV – 50 mV	±500 mV
100 mV – 500 mV	±5 V
1 V – 5 V	±50V

The offset voltage step size also varies with the V/Div setting.

If the V/DIV sensitivity is changed so that the offset voltage set is larger than permitted, the offset voltage will be set to the maximum allowed for the V/DIV setting and its value shown in reverse video.

When a probe other than a ×1 is selected in the Probe Gain Select Menu, the displayed V/DIV and offset voltage will be scaled accordingly.

The offset facility is available only when the channel coupling is set to DC.

Offset is temporarily cancelled if the input coupling is switched AC and the message No Offset with AC coupling briefly appears at the bottom of the screen. The instrument saves the offset value and when the channel coupling is returned to DC or ground the offset voltage is once again applied.

Applying an offset may cause the oscilloscope to lose trigger because it applies an offset to the signal and not to the trigger level.

If a large offset is applied, the trace may be off the screen and if the offset is sufficiently large, the vertical position control may not have enough range to bring the trace back into view.

3.9 Display Menu

This menu controls many of the parameters of the instrument's display.

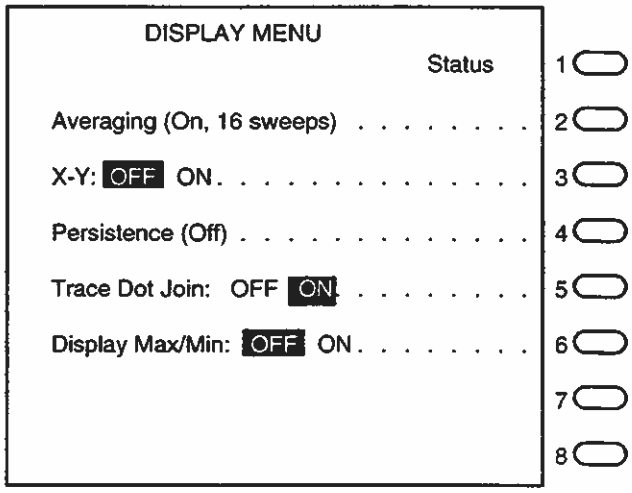


Figure 3.9 Display Menu

Status Pressing button 1 selects the Status page. See section 3.10.

Averaging Menu This button selects the Averaging menu which is used to average repetitive signals on the display. See section 3.11.

Persistence Menu Selects the Persistence menu which is used to adjust the persistence parameters. See section 3.12.

3.9.1 X-Y

This button turns X-Y display mode on and off. In X-Y mode, the CH1 input signal controls the X (horizontal) component of the trace and the other channel inputs control the Y (vertical) component of the trace. See section 2.2.3.

3.9.2 Trace Dot Join

The individual dots making up a displayed trace can be joined together using this function. If trace dot join is Off, gaps can be seen between the sample points on some traces, depending on the signal content. Selecting On, causes the dots to be automatically joined by straight vertical lines.

3.9.3 Display Max/Min

Because the instrument's display displays 500 points across the screen, when the sample length is set to 5000 or 50000 samples every 10th or every 100th sample is displayed. When Display Max/Min is turned on, there are 500 pairs of samples displayed. For each pair of display samples the maximum and minimum acquisition samples will be displayed in the order in which they occurred rather than the actual 10th or 100th sample. This ensures that glitches that have been acquired will be seen. Display max min operates after signals have been acquired whereas glitch detect acts on signals being acquired. If an alias is being displayed (see section 1.6.2) it will probably be displayed as a wave envelope formed from the maximum and minimum samples.

3.10 Current Status Menu

The Current Status menu allows the various horizontal, vertical and trigger settings of the instrument to be viewed. A typical display is shown in figure 3.10.

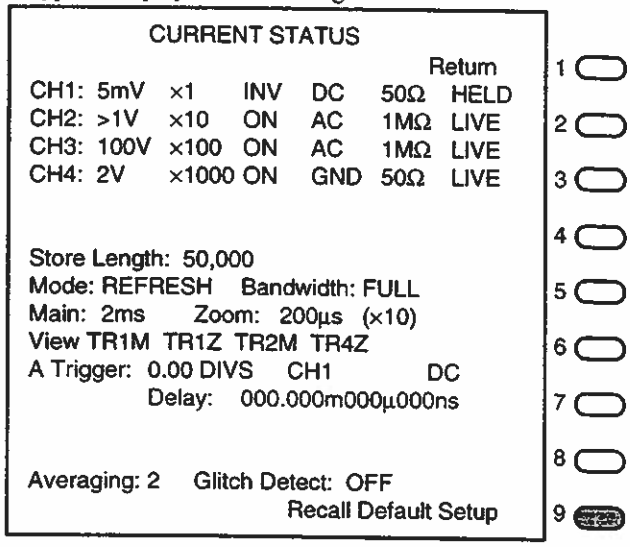


Figure 3.10 A Typical Status Display

Return Pressing button **1** returns the display to the previous menu, either the Display Master menu or the Instrument Setups menu.

CH1 to 4: Following the channel number, the channel input sensitivity is shown in volts/div. The range is 2 mV to 5 V per division. If Add mode is selected, a + sign is shown in front of the second channel of the channel pair.

If a channel is un–calibrated, a > sign is shown in front of the sensitivity.

After the sensitivities the probe gain settings are shown as ×1, ×10, ×100, or ×1000. These may be set using the Probe Gain Select menu. See section 3.4.

Next the channel status is shown. This will be either ON, OFF or INV. Next on these lines, the input coupling is shown. This can be AC, DC or GND.

The next item on the channel line is 50 Ω impedance, 50 Ω shows if the channel is set to 50 Ω otherwise 1 MΩ is shown. The final item is channel hold or Hold All. If an individual channel is held, HELD shows alongside it but, if Hold All has been pressed, the words ALL HELD appear on every channel line. Channels which are not held are live.

Store Length: There are five possible store lengths 500, 5000, 10000, 50000 and 200,000. They are described in section 3.33.

Mode: There are five possible display modes: Refresh, Roll, Persistence XY and TruTrace. XY can be applied to any of these except XY. They are all described in section 2.3.

Main: The sweep rate of the timebase is shown in s, ms, µs or ns per division.

Zoom: The status of any zoom factor can be either ×1, ×2, ×5, ×10, ×20, ×50, ×100 ×200, ×500 or ×1000. See section 1.6.4.

View: The displayed traces are shown. See sections 1.6 and 3.34.

A Trig and B Trig: The selected trigger options are shown in this part of the display. See sections 1.8, 3.13 and 3.14.

Averaging: If averaging is on, the averaging factor is shown as 2, 4, 8, 16, 32, 64, 128, 256, 512 or 1024.

Glitch Detect: The status of the Glitch Detect system is shown, either Off or On.

Recall Default Setup This line only appears on a 6500 or 9500 instrument and is used to return the instrument to its original default setup. On other instruments use button 9 on the Save/Recall File options Menu (section 3.31).

3.11 Averaging Menu

It is possible to improve the signal to noise ratio of repetitive input signals by averaging them. Averaging is switched On or Off by pressing button 2.

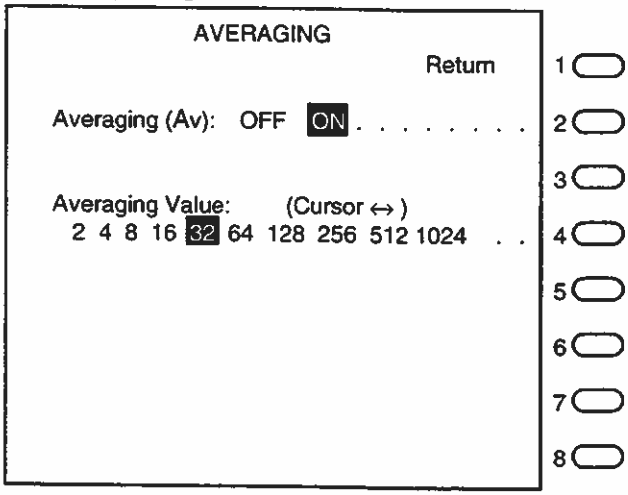


Figure 3.11 Averaging Menu

When averaging is turned on, the Av symbol will appear at the upper right hand side of the trace display.

Averaging works on input signals in two different ways depending upon whether the instrument is in continuous or single–shot mode.

If the instrument is in continuous mode, this function converts the display into a weighted average of previous acquisitions. Button 4 selects the averaging factor used in the algorithm:–

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

Where: n = The data point (1 to 50000)
A_n = New value at n
a_n = Old value at n
f = Averaging factor (2 to 1024)
d_n = Latest value at n

In continuous mode, if 8 acquisitions are selected, the instrument adds 1/8 of each new acquisition to 7/8 of the existing trace. This means that any single acquisition that deviates from an otherwise consistent level, contributes 1/8 of its deviation to the display.

Averaging over 512 or 1024 acquisitions is not available with a memory length of 10 k or over. When the instrument is in any of these modes (10 k, 50 k or 200 k), the selections are removed.

If the instrument is in S/Shot mode, only the number of acquisitions selected by button **4** contribute to the resultant, unweighted, held display, i.e. true averaging where each display point is the average level of that point for the specified number of acquisitions.

3.12 Persistence Menu

This menu is used for setting the persistence mode parameters. To turn persistence mode on or off use the Refr/Roll button (18) see section 2.3.4.

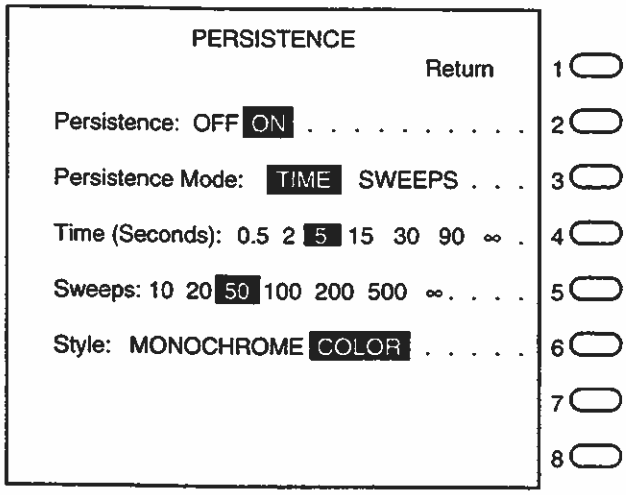


Figure 3.12 Persistence Menu

Persistence: Either the number of acquisitions accumulated before the display is cleared or the absolute time between display clearances can be set from this menu.

The choice of Persistence for time or number of acquisitions is made using button **3** with the actual time or number of sweeps set by button **4** or **5** as appropriate.

Persistence Time: Button **4** sets the time in seconds between screen clears when persistence mode is turned on. When this selection is set to ∞, the screen is never automatically cleared, (although the user may always press Run (17) or single shot (15), which will force a display clear), so the resulting display will be a composite picture of all the acquisitions performed from the point at which persistence mode was selected.

Persistence Sweeps: Button **5** sets the number of acquisitions between screen clears when persistence mode is selected. When this selection is set to ∞, the screen is never automatically cleared, (although the user may always press Run (17) or single shot (15), which will force a display clear), so the resulting display will be a composite picture of all the acquisitions performed from the point at which persistence mode was selected.

Persistence Style: The style of the persistence display can be either Monochrome or Color, the selection is made using button **6**. When set to Monochrome, all traces are persisted in the same color as set in the Display color menu. The most recent acquisition is still displayed in the trace's own color.

When set to Color, each trace is persisted in its own color.

3.13 Trigger

When the Trigger menu button (2) is pressed, the display changes to show the current trigger setup. To change the setup press button 1 which is labeled Change. This will then show the trigger mode menu from which a different trigger mode can be selected using buttons 2 and 3.

Numerical Entry: Certain functions on the trigger menus require numbers to be entered. This can be done in two ways: The appropriate front panel controls e.g. the delay paddle (22) and the Pre Post button (27) can be used or the numeric buttons can be used to type in the required numbers.

To use the numeric keys, select the field to be changed by pressing the appropriate numeric key (e.g. 8 in figure 3.8a) then:

1 The digits are entered one at a time, starting with the most significant digit –the left hand one– using the numeric keys.
2 The digit currently being entered is shown in inverse video.
3. After a digit has been entered, the next one to the right is highlighted.
4. After all the digits have been entered the numeric buttons return to their normal menu functions.
5. If it is required to skip a digit or go back to a previous digit, the cursor paddle (6) can be used to move the entry point along the number and to leave the field to complete the entry.

To terminate numeric entry and de–select the feature at any time during input, press ABORT. The previous value is retained.

Paddle Entry: To use the Position paddle (22) to provide a pre trigger percentage or a delay time, press the Pre/Post button (27) so that either pre or post is selected as appropriate and then use the Position paddle to set the required time or percentage.

When using the Position paddle to enter a delay, the resolution of the delay steps is dependent on the timebase selected. Faster timebases have smaller delay steps. The steps are 2% of the timebase range or 2 ns whichever is greater i.e. at 250 ns/div the delay steps are 2 ns while at 1 s/div the delay steps are 20 ms.

Trigger indication: On the Trigger menus there are "soft LEDs" which provide an indication of the trigger states for various sources. These become increasing more useful as the trigger setups become more complex, particularly when using trigger tools. When a trigger signal is present they are shown as solid circles otherwise they are shown as hollow circles.

Slope: To change the slope or edge to which the trigger systems will respond, press the +/– button 28. This will also change the diagrammatic representation on the trigger menus so that the trigger setup can be readily seen.

Source: To change the trigger source the front panel source button (24) is always available and on some trigger menus it can be selected using the numeric buttons. The trigger menu in use will change to reflect the change of source.

A/B Trigger: To change the trigger setup from the A to the B trigger (or B to A) the A/B button (14) is always available. The trigger menu in use will change to reflect the different state of the two systems.

Pre Trigger View/ Post Trigger Delay : The menu shows, for either the A or B trigger, either the amount of post trigger delay time set for the sweep or the pre trigger percentage.

To change from pre trigger percentage to post trigger delay press the apropriate numeric button or the front panel Pre/ Post button (27).

Post trigger delay is shown in 2.5 ns increments as a combination number with '.', 'm', 'µ' and 'ns' as the separators. A number such as 012.452m372µ747n5s means 12.4523727475 seconds or 12 seconds, 452 ms, 372 µs and 747.5 ns.

Pre–trigger percentage can be set from 0.0% to 100.0% in 0.2% steps.

3.13.1 TV Trigger

The TV Trigger menu is used to set the parameters of the TV triggering facilities. A typical display is shown in figure 3.13.1a below.

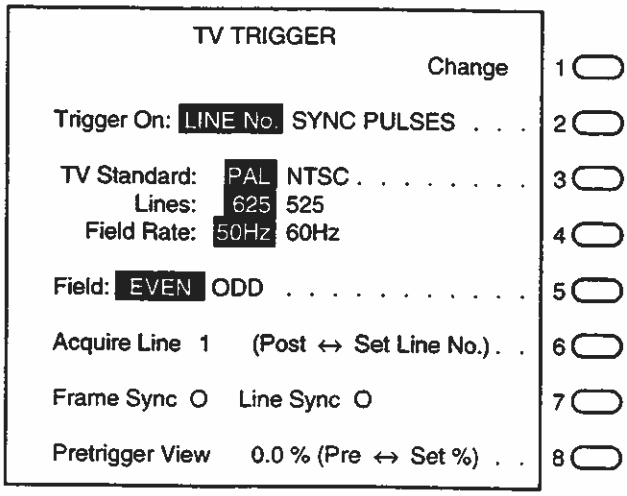


Figure 3.13.1a A TV Trigger Menu

When TV trigger is in use, the characters Tv will appear on the second line at the left–hand side of the trace display. TV trigger can only be used CH1 as the trigger source.

The TV trigger system will reliably trigger with as little as one division of either 525 or 625 line composite video (0.3 div sync) of either polarity.

Trigger On: Button **2** is used to set the trigger system to trigger on either a specific TV line number or on sync pulses. If Sync pulses are selected the menu will change as shown in figure 3.13.1b. If trigger tools is turned off in the options configuration menu, then this line simply shows:

Trigger on sync pulses.

and Trigger on line number is not available.

To trigger on a particular line without trigger tools, use the Frame Gates Line feature and set the delay to the required multiple of the line time.

TV Standard: Button **3** is used to set the trigger system to respond to either PAL or NTSC TV signals .

Field: Button **5** is used to select either the ODD or EVEN field for the line number trigger system. When using PAL system, the line number in line 6 will change to the opposite field counterpart as ODD and EVEN is toggled, i.e. line 1 to 313 etc.

Acquire Line: To select the required line number, use the Post trigger paddle to increase or decrease the displayed line number. Alternatively, numeric entry can be used by pressing button **6** and entering the required number with the numeric buttons.

As the line number scrolls to Even or Odd field line numbers, the highlight in line 5 also changes field as appropriate.

Pre Trigger View: Pre trigger can be applied to the TV trigger system by adjusting the pre trigger percentage using the pre trigger paddle or by pressing button **8** and using numeric entry .

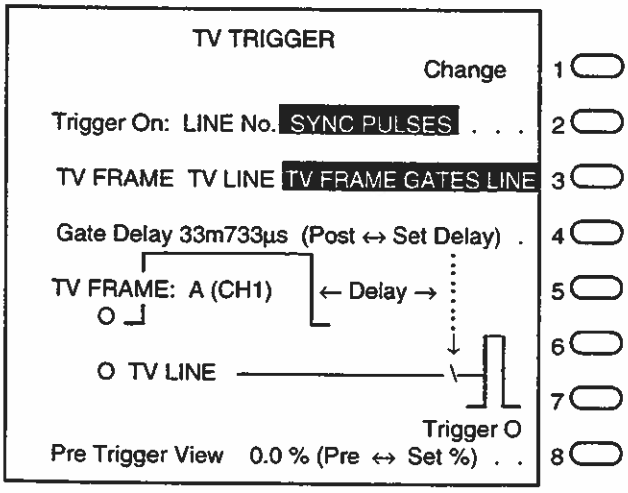


Figure 3.13.1b A TV Trigger Menu

Sync Pulses: If sync pulses are selected by button **2** (or if line 2 shows simply trigger on sync pulses), button **3** can be used to select either frame or line sync pulses or a combination of both pulses where the Frame pulse is used to gate the line pulses. If required, a delay time can be included after the frame pulse.

The maximum delay time that can be used with TV trigger is 39.999 ms.

The delay time is set using the Post trigger paddle, or by numeric entry after pressing button **4**.

Pre trigger view can also be used by using the pre trigger paddle to set the pre trigger percentage or by numeric entry after pressing button **8**.

3.14 Trigger Types

The Trigger Tools system is an optional feature (not available on 6500 & 9500) and is activated by turning on Trigger Tools in the options configuration menu.

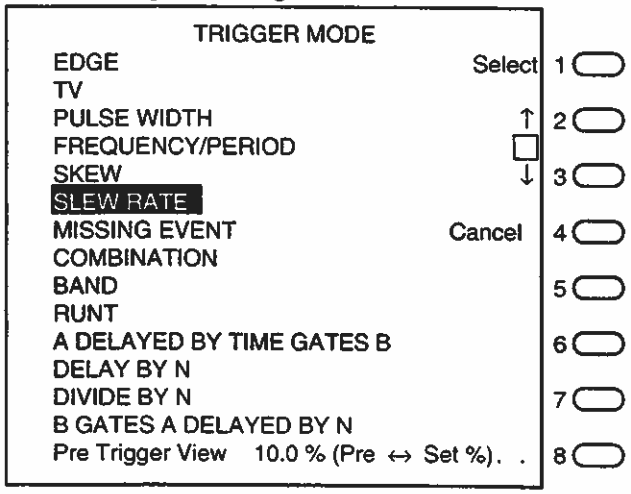


Figure 3.14 Trigger Tools Menu

When Trigger tools is selected by pressing the Trigger menu button (3), the current trigger tools configuration menu is displayed, an example of which is shown in figure 3.14.1.

When Trigger Tools is in use a 'TTs' icon is displayed at the top left of the display.

To change the trigger type, press button **1** and the display will change to the trigger tools menu as shown in figure 3.14.

If Trigger tools have not been enabled in the Options Configuration Menu, then only Edge and TV trigger types will be in the list.

To select the required trigger, use buttons **2** and **3** to scroll the highlight up and down the displayed list. When the required type is highlighted, press button **1**, Select.

For a description of how many of the trigger menu–features work, see section 3.13.

3.14.1 Edge Trigger

Edge trigger can be used to trigger on an edge, either positive or negative, with pre or post trigger if required. The menu picture changes to show the selection.

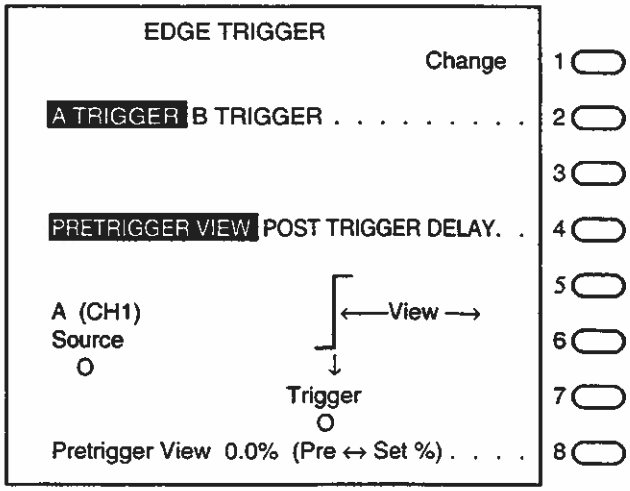


Figure 3.14.1 Edge Trigger Menu

To set a pre or post trigger time, use the Position paddle (22) or press button **8** and use the numeric buttons.

To select whether the time is Pre or Post trigger use button **4** or the Pre/Post button (27).

The trigger point can be on the rising or falling edge by changing the setting of the polarity button (28).

3.14.2 Pulse Width Trigger

Pulse width trigger can be used to trigger when the width of a pulse is either narrower or wider than a pre-defined time. The menu picture changes to show the selection.

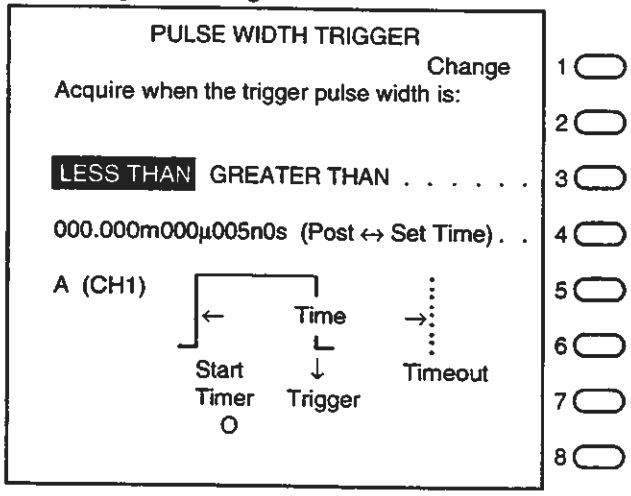


Figure 3.14.2 Pulse Width Trigger Menu

To set the time, use the Post trigger paddle (22) or press button 4 and use the numeric buttons.

The trigger point is always on the back edge of the pulse regardless of the pulse polarity or whether pulse width trigger is set to greater than or less than. To produce a trigger after a particular time has elapsed, use Missing Event Trigger. See section 3.14.6.

The slope button (28) should be used to change the polarity of the pulse to which the system will respond.

Less Than / Greater Than: To change from triggering when the pulse width is less than the preset time to triggering when the pulse width is greater than the preset time, press button 3 until Greater Than is highlighted.

3.14.3 Frequency/Period Trigger

A trigger can be produced by a frequency or a period being less than or greater than a pre-defined value. The frequency is specified in Hz and the period in seconds.

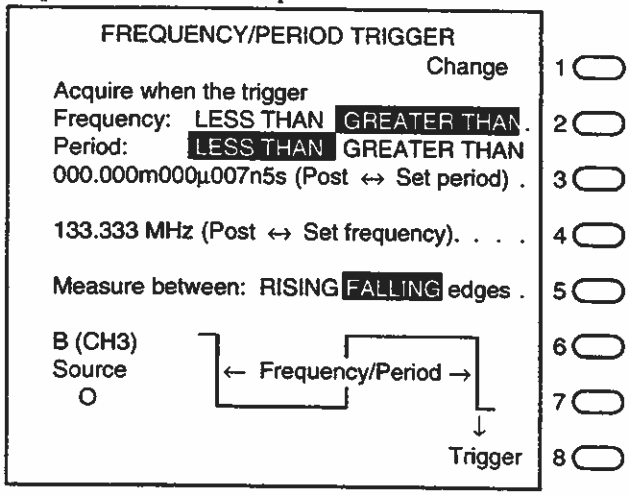


Figure 3.14.3 Frequency/Period Trigger Menu

Less Than Greater Than: To change from triggering when the frequency or period is less than the specified number to triggering when the frequency or period is greater than the specified number, press button 2.

To set the frequency or period, use the Post trigger paddle (22) or press button 3 or 4 and use the numeric buttons.

Measure Between: The edges which the trigger system will use can be either the rising or falling edges of the waveform as set using button 4 or the slope button (28).

3.14.4 Skew Trigger

Skew trigger responds to the difference in time between two trigger events. The two events, the A and B, can be on the same or different input signals.

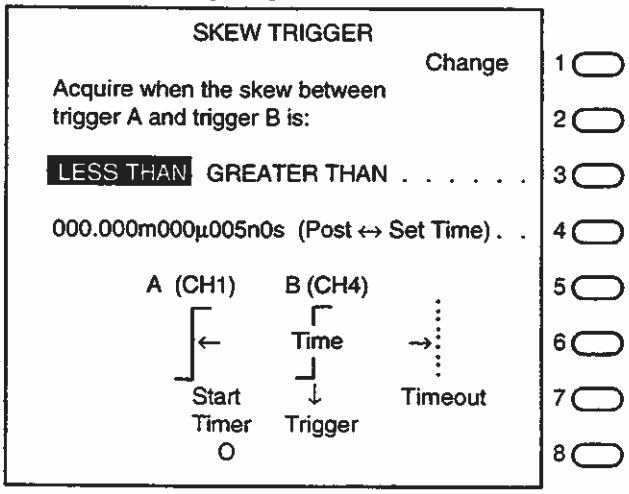


Figure 3.14.4 Skew Trigger Menu

Less Than Greater Than: To change from triggering when the time difference is less than the specified time to triggering when the time difference is greater than the specified time, press button 3.

To set the time difference, use the Post trigger paddle (22) or press button 4 and use the numeric buttons .

To set the A and B Sources, slopes and levels, select either A or B as appropriate using the AB button (14) and use the source or slopebutton (24) or (28) or the level paddle (12).

3.14.5 Slew Rate Trigger

Slew rate trigger responds to the time for a signal to cross two preset trigger levels. The system can look for a transition time that is less than or greater than a specified time interval.

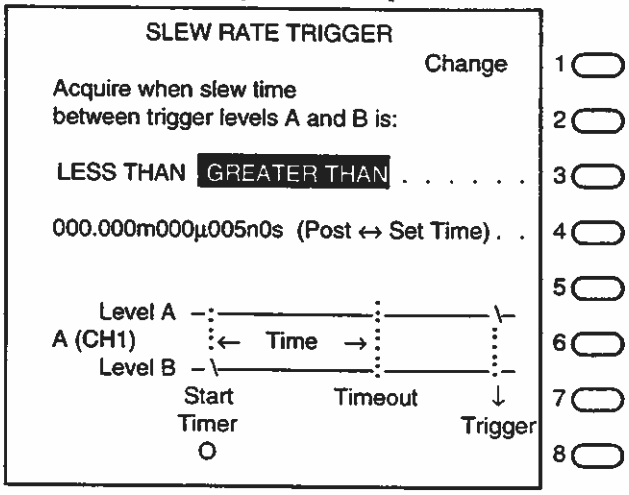


Figure 3.14.5 Slew Rate Trigger Menu

Slew rate trigger can only be used with CH1 as the trigger source.

Less Than Greater Than: To change from triggering when the slew rate is less than the specified time to triggering when the slew rate is greater than the specified time, press button 3.

To set the time difference, use the Post trigger paddle (22) or press button 4 and use the numeric buttons .

To set the two trigger levels select the appropriate one using the AB button (14) and adjust using the level paddle (12).

To set the trigger source and slope, use the source and slope buttons (24) and (28). These will change the settings regardless of the state of the AB button (14).

3.14.6 Missing Event Trigger

Missing event trigger looks for two events occurring within a preset time. If the second event does not occur, a trigger is generated.

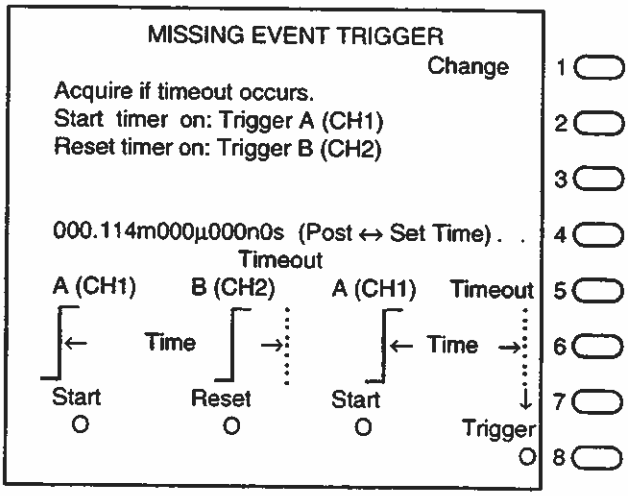


Figure 3.14.6 Missing Event Trigger Menu

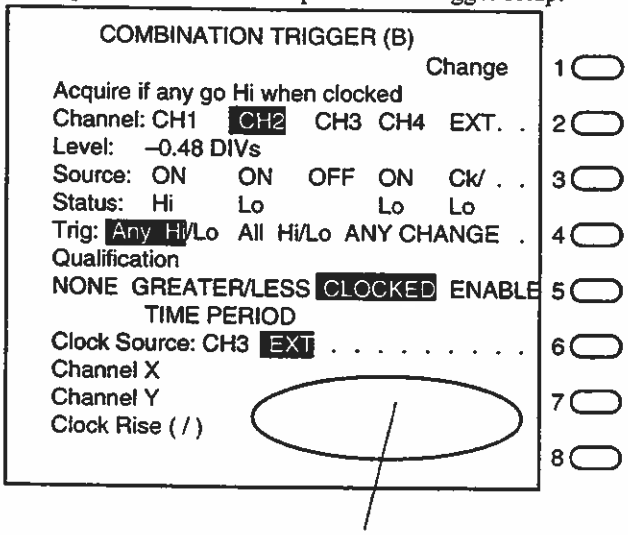
The two events, A and B, can be on the same or different input signals.

To set the time difference, use the Post trigger paddle (22) or press button **4** and use the numeric buttons .

To set the sources and the slopes for the A and B triggers, use the AB button (14) to select the appropriate system and the source button (24) and the Slope button (28).

3.14.7 Combination Trigger

Combination trigger is used to produce a trigger when a particular combination of events occur. The top line of this menu provides a brief description of the trigger setup.



N.B. This part of the display shows a representation of waveforms and trigger conditions, and changes as the combination parameters are changed.

Figure 3.14.7 Combination Trigger Menu

The selected occurrence can be enabled or clocked by one of the trigger sources or qualified by a time period.

Channel: To select a particular input signal, press button **2** until the required input is highlighted and toggle it on and off using button **3**.

Level: This line shows the trigger level that has been set for the input signal highlighted in line 2. Use the level paddle (12) to change this setting.

Source: This line shows which of the input signals are to be used to provide the combination of signals. To stop using a signal, use button **3** to toggle the selected channel on and off. For a channel that is selected as the clock or enable signal, button **3** changes the slope. The menu representation of the slope also changes.

Status: This line shows the current status of the signals for the input channels in use. The status is shown as Hi, Lo or as a double pulse symbol, this indicates the state of the signal relative to the trigger level for that particular signal. The double pulse symbol shows that the signal is continuously crossing and recrossing the trigger level.

Trig: The state which will cause a trigger is set using button 4. There are five possible selections; Any Hi, Any Lo, All Hi, All Lo and Any Change.

Any Hi will produce a trigger each time any one of the active signals goes above its trigger level. If a signal goes above its level when one of the other active signals is already above its own level then a trigger will not occur.

Any Lo will produce a trigger each time any one of the active signals goes below its trigger level. If a signal goes below its level when one of the other active signals is already below its own level then a trigger will not occur.

All Hi will produce a trigger each time all of the active signals end up above their own trigger levels.

All Lo will produce a trigger each time all of the active signals end up below their own trigger levels.

Any Change will produce a trigger each time any of the active signals crosses its own trigger level. A trigger will be produced regardless of the direction of crossing and regardless of the state of the other active signals.

Qualification: The above 5 trigger conditions can all be qualified by a further condition so that a trigger will only occur if the trigger conditions and the qualification are both met.

The qualification is chosen using button 5 to scroll around the displayed list.

The qualifications available are:

Greater than a time period, Less than a time period, Clocked, and Enabled.

Only Enabled is available for the Any Change trigger condition.

Greater To produce a trigger with this qualification, the trigger conditions have to be met and maintained for at least the time set as the time period. At the end of the time period, a trigger will be produced. If the trigger conditions are not maintained for the entire time period, the timer will be reset and a trigger will not be produced. The timer will be restarted the next time the trigger conditions are met.

Less To produce a trigger with this qualification, the trigger conditions have to be met and maintained for less than the time set as the time period. A trigger will be produced when the trigger conditions are no longer true as long as this situation occurs before the end of the time period. e.g. if All Hi is selected a trigger will occur when any one of the signals goes Lo before the time period has expired.

Clocked will produce a trigger in sync with each positive or negative edge of the clock signal (as set by the slope control (28)), if the trigger conditions are met. i.e if All Lo is set and all the signals are Lo on the positive edge of the clock signal then a trigger will occur. If the signals are still all Lo on the next clock edge, then another trigger will not occur. In order for another trigger to occur, the original triggering condition must first go away for at least one clock edge.

Enabled will produce a trigger each time the trigger conditions are met during enable period. If the enable signal is not valid when the trigger conditions are met then a trigger will not occur, similarly if the enable signal becomes valid while the trigger conditions have already been met a trigger will not occur.

To change the polarity of the enable signal, select the enable signal with button 2 and either press the slope button (28) or button 3.

Clock/Enable Source: When using a clocked or enabled qualification, the source of the clock or enable signal can be set to any of the input channels which are not already On and in use in line 3. To change from one source to the other, press button 6.

Qualification Time: When using a time period qualification, the time period is set by pressing button 6 and then using the numeric buttons or the Post trigger paddle (22).

3.14.8 Band Trigger

Band trigger produces a trigger when the selected input signal either enters or leaves a band which is defined by the two trigger levels.

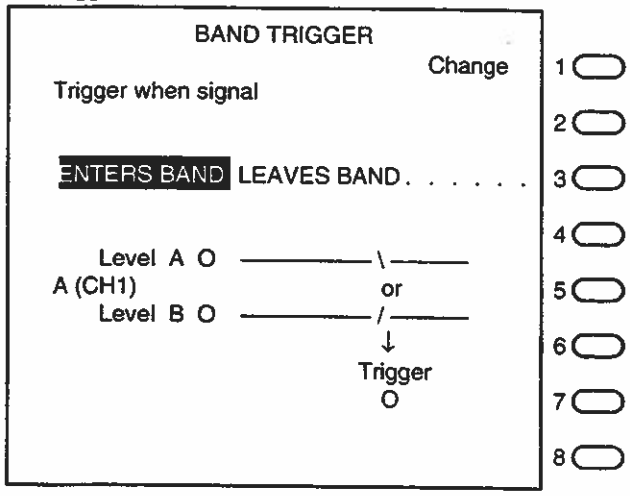


Figure 3.14.8 Band Trigger Menu

Band trigger can only be used with CH1 as the trigger source.

To set the A and B trigger levels, select the appropriate one using the AB button (14) and adjust using the level paddle (12).

Enters Band Leaves Band: To change from triggering when the signal enters the band to when the signal leaves the band, press button 3 or the slope control (28).

Level To set the A and B levels, select A and B as appropriate using the AB button (14) and the level paddle (12).

The A level will always be above the B level. If the A level is reduced too far it will also force the B level down. Similarly if the B level is increased too far it wil force the A level up. The minimum separation is approximately 0.5 div.

3.14.9 Runt Trigger

Runt trigger produces a trigger when a pulse only crosses one of the two trigger levels, for example when one pulse has a lower amplitude than other pulses.

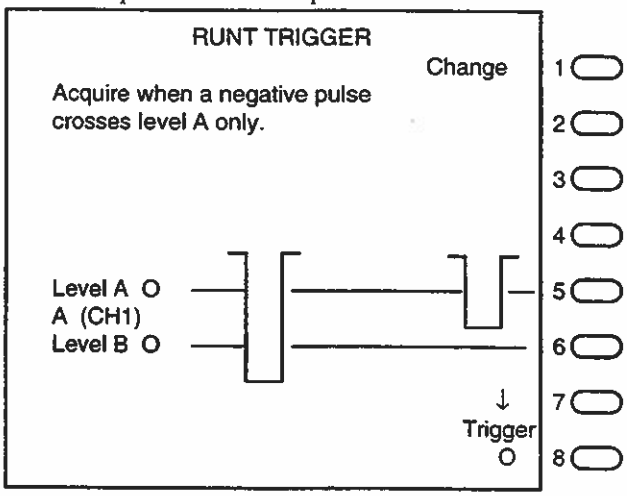


Figure 3.14.9 Runt Trigger Menu

Runt trigger can only be used with CH1 as the trigger source.

The trigger point occurs when the pulse crosses the first level a second time without crossing the second level.

To set the A and B trigger levels, select the appropriate one using the AB button (14) and adjust using the level paddle (12).

To change the polarity of the pulses being detected, press the polarity button (28).

3.14.10 A Delayed by Time Gates B Trigger

A delayed by Time gates B trigger produces a trigger on the first B trigger that occurs after a preset time following an initial A trigger.

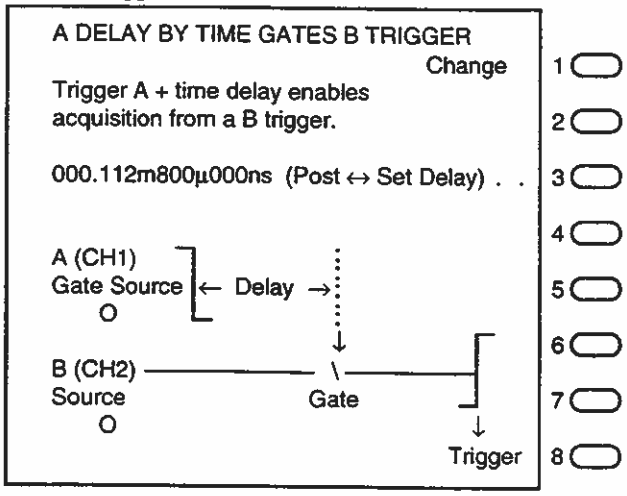


Figure 3.14.10 A Delay by Time Gates B Trigger Menu

To set the time delay after the A trigger, use the Post trigger paddle (22) or press button 4 and use the numeric buttons.

To set the trigger sources and slopes for the A and B triggers, select A or B using the AB button (14) and set the source using the source button (24) and the slope using button (28).

3.14.11 Delay by N Trigger

Delay by N trigger produces a trigger on the Nth A or B trigger event.

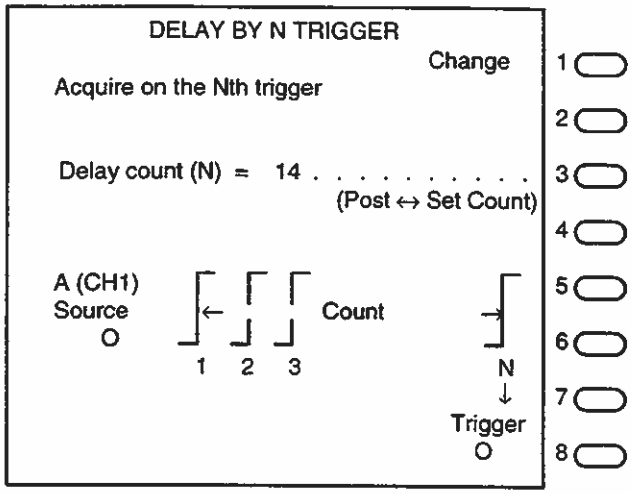


Figure 3.14.11 Delay by N Trigger Menu

To set the number for N, use the Post trigger paddle (22) or press button 3 and use the numeric buttons.

The number of events can be set to a maximum of 9999.

To start the count, press single shot and the trigger events will be counted from then. In run mode the count starts immediately following the end of the previous acquisition.

3.14.12 Divide by N Trigger

Divide by N trigger produces a trigger every N events. The actual trigger point can be phase slipped so that the trigger occurs earlier or later in the signal cycle.

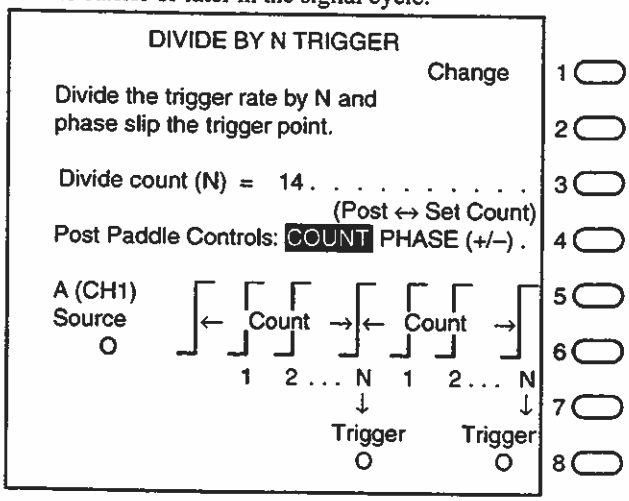


Figure 3.14.12a Divide by N Trigger Menu

To set the number for N, ensure that COUNT is selected on line 4 and use the Post trigger paddle (22) or press button 3 and use the numeric buttons.

To change the phase of the trigger point, press button 4 so that PHASE (+/–) is highlighted and then use the Post trigger paddle (22).

This trigger mode is useful when the input signal has a repeating pattern of triggers, for example a waveform consisting of repeating groups of three pulses as shown in figure 3.14.12b.

If N is set to 3 (or an interger multiple of 3) then the resulting stable display will be a random choice of one of the three pictures shown in figure 3.14.12c. To select the required picture use the Phase +/– facility to step the trigger point through the waveform.

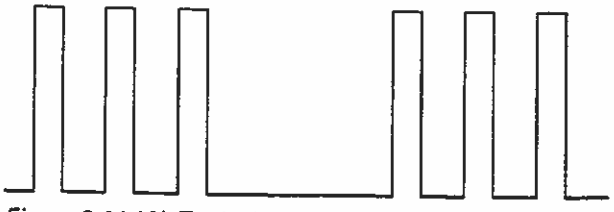


Figure 3.14.12b Typical waveform for Divide by N trigger

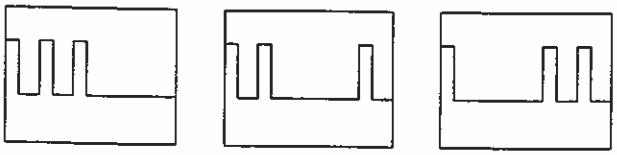


Figure 3.14.12c Possible displays from figure 3.14.11.b

3.14.13 B Gates A Delayed by N Trigger

B Gates A delayed by N functions as follows: A B trigger gates the A trigger which then produces a trigger on the Nth A event after the B trigger has occurred.

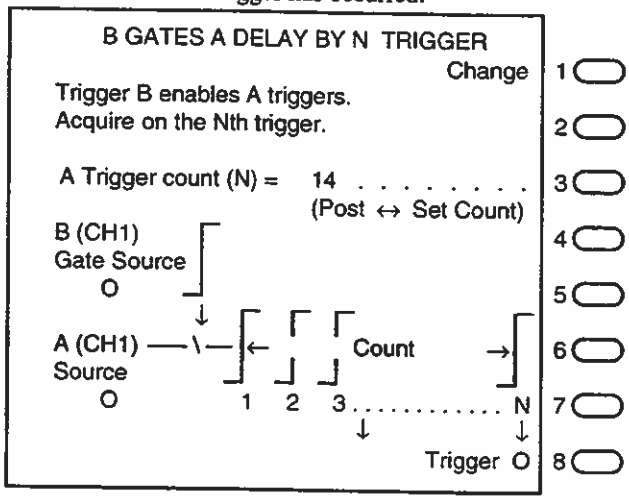


Figure 3.14.13 B Gates A Delayed by N Trigger Menu

To change number of A triggers required after the gate is opened, press button 3 and use the numeric buttons or use the Post trigger paddle (22).

The gate action is latched and is reset at the end of the acquisition

This trigger selection is useful in cyclic systems in which the start of a cyclic count is the B trigger and then N Counts (A triggers) are received to produce a trigger at a particular angular position.

3.14.14 A Delayed by N Gates B Trigger

A delayed by N Gates B functions as follows: The B trigger path is gated by the A trigger. The gate is opened on the Nth A trigger after which the first B trigger is the trigger point.

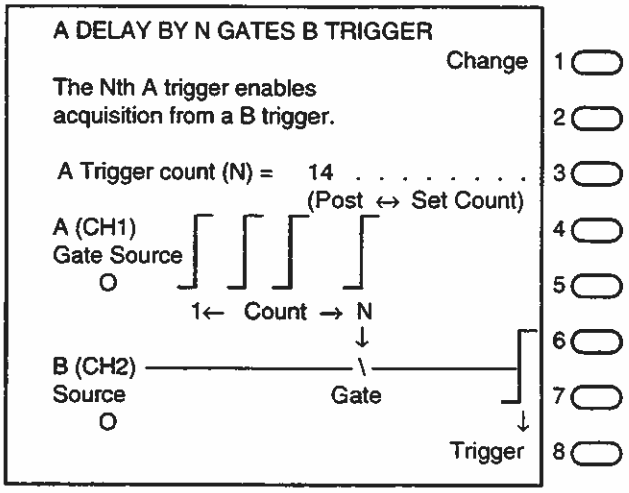


Figure 3.14.14 A Delayed by N Gates B Trigger Menu

To change number of A triggers before the gate is opened, press button 3 and use the numeric buttons or use the Post trigger paddle (22).

3.15 YT Measurements.

Custom YT Measurements allows some very powerful custom measurements to be defined. Measurements can be assigned to various waveform points (for example the max of a waveform); these individual results can be further combined by using simple arithmetic operators in several stages to provide results to complex calculations.

Waveform points are definable on different channels so that measurements can be made on more than one channel at once.

The top and base levels, for use in such measurements as risetime, amplitude and overshoot, can be automatically calculated as defined by IEEE standard 181–1977 or can be defined by the datum and cursor positions.

For pulse transitions, a particular transition number can be selected.

Customised measurement results based on arithmetic combinations of previous results such as difference in time or voltage, or ratio of voltage/time or time/voltage can be created.

Custom measurements can also have a scaling factor and an offset applied and each measurement can have its units specified and be given a unique name.

3.15.1 Measurement Parameters

Each measurement has a specific set of parameters some of which are unique to that particular measurement and some of which are drawn from a standard set of parameters. The standard parameters are described here and the unique parameters are described under the appropriate measurement heading.

3.15.2 Standard Parameters

Trace

The Trace (TRC1 to TRC8 or whichever trace the cursor is sitting on) on which the measurement is to be performed.

Bounds

The horizontal extent over which a trace is measured; can be either between cursors (the time datum and the cursor) or the full trace or between the two previous crossing type measurements. These can be Max/min, Trigger, Rising/Falling Crossing or Knee.

Top/base

The method of determining the top and base levels of a trace; can be either the IEEE standard statistical method (IEEE std 181-1977) or simply the values of the trace where the horizontal positions of the time datum and the cursor.

The basic principle of the statistical method of analysis achieved as described in IEEE 181–1977, the IEEE Standard on Pulse Measurement and Analysis by Objective Techniques is also described here:

Assume a pulse waveform such as that shown below in figure 3.15.2a has a grid superimposed on it where the dimensions Δt and Δm are equivalent to the sample times and the instrument's ADC levels. An occurrence histogram (figure 3.15.2b) is then produced for each ADC level (Δm) through which the waveform passes.

From this histogram the two peaks corresponding with the top and the base of the waveform P_T and P_B can be identified.

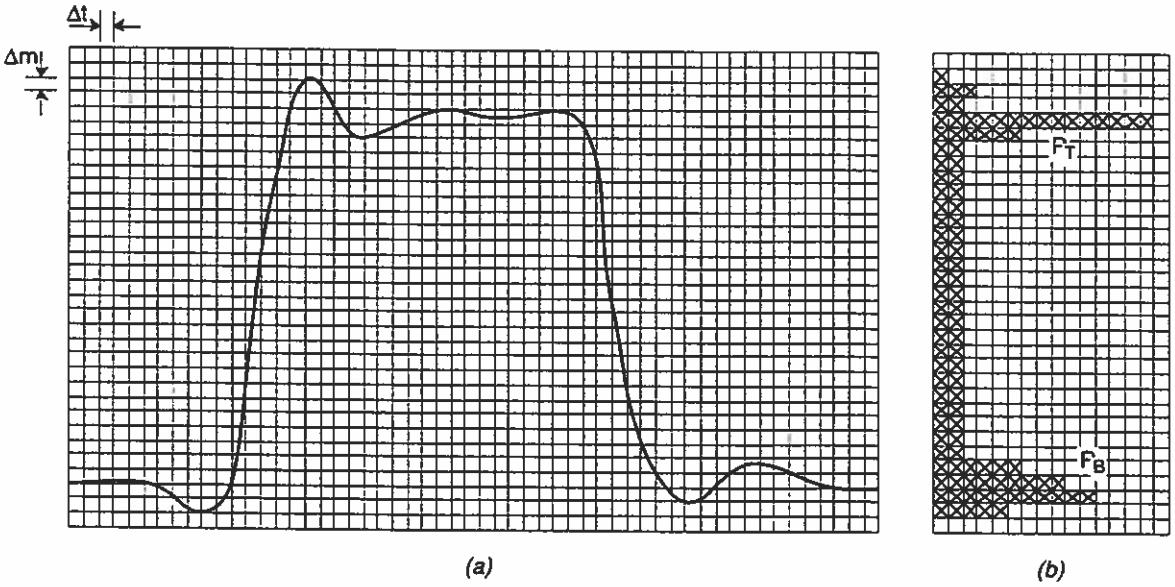


Figure 3.15.2 Top/Base Statistical Analysis

The means of the P_T and P_B are calculated and taken to be the Top and Base levels respectively.

This analysis is best suited to pulse waveforms with bases and tops of significant relative duration.

Some waveforms such as a triangular wave do not produce a suitable histogram with two peaks so the maximum and minimum of the waveform are used. The user can choose to define the levels using the cursor and datum lines.

Crossing
Defines the method of specifying crossing level for a trace; this can be either where the trace intersects the voltage datum, where it intersects the ground level, or where it intersects a certain percentage of the top and base. Depending upon the crossing level selected, the voltage will be either an absolute or a delta value. Crossing can also be a measurement. When using ground or % of top and base an Absolute value is obtained and when using the voltage datum, a delta value is obtained.

Crossing Level
If the crossing is set to be a percentage of top and base, then this defines the percentage value of that crossing.

Transition No.
This defines the transition number to be measured. The transition level is set by either Left/right transition or Low/high transition.

Left/right Transition
For pulse width measurements, this specifies the left and right transition level in terms of a percentage of the top and base levels.

Low/high Transition
For risetime measurements, this specifies the low and high transition levels in terms of a percentage of the top and base levels.

Scaling off/on
For measurement operators, a scaling factor, offset and annotation may be applied to the result. This parameter is used to turn the scaling factor off and on.

Scaling
For measurement operators, a floating point scaling factor may be applied to the result. This parameter is used to specify the scaling factor.

Offset
For measurement operators, a floating point offset may be applied to the result. The offset is applied before any scaling so that the offset is in the same units as the measurement. This parameter is used to specify the offset level.

Scaling Annotation
For measurement operators, a scaling annotation may be applied, to represent user defined units, to the result. The annotation is specified with this parameter.

Name
This is used to specify the name associated with a particular measurement.

Markers
Allows a measurement to have a set of markers (a pair of dotted horizontal "datum lines") to be associated with a particular measurement. They can be used to indicate the top & base, max, min, crossing etc. Only one set of markers are available and are "owned" by a particular measurement.

Reference
Specifies if voltages are displayed referenced to the channel ground or to the time (horizontal) datum line. See section 3.15.3. Reference can also be used as a measurement result.

Datum Locked to Trace
In XY measurements, this allows the horizontal and vertical datum lines to be locked to a trace.

Display Area Fill
This selects whether the area measured in the XY area measurement is displayed on the screen as a filled area.

Reset
In the Average measurement allows the accumulating value to be reset to the current measurement value.

3.15.3 Measurement Modes
These are set individually for each measurement and are selected by changing the "REFERENCE" parameter to either "GROUND" or "DATUM".

The exception to this is the "CROSSING" measurement which uses the "CROSSING" parameter to set this. "GROUND" or "% OF TOP-BASE" gives an absolute measurement while "DATUM" gives a delta measurement.

Ground
Voltage measurements are made with respect to the ground for a channel, i.e. an absolute value.

Datum
Voltage measurements are made with respect to the voltage datum line, i.e. a delta value.

In either case time measurements are made with respect to the time datum.

XY CURSOR MODES

Ground mode with datum locked to trace
The horizontal and vertical datum lines are fixed to the trigger point; voltage and time measurements are made with respect to this. If the trigger point is off screen, for example if trigger delay is on, the voltage measurement will use the value on the left hand edge of the screen.

Datum mode with datum locked to trace
The voltage datum line is fixed to where the time datum line crosses the trace; measurements are made with respect to this point.

3.15.4 Measurements Display
The screen generally shows one measurement per line and will display only those which are selected ON. Where a single measurement returns two results (vertical and horizontal, for example MAX), these will be displayed on consecutive lines. There are no restrictions on how many measurements can be displayed; if there are too many to fit on the screen, the list will scroll up the screen.

```
MAX    :TRC1 100.0 mV
              10.23 S
CURRENT :    +1.123E-03 AMPS
```

The measurements display list does not overwrite the top two lines of the screen: these are reserved for channel status, timebase, zoom factor etc. Note, however, that messages, such as pretrigger percent, or remote message will overwrite the measurements. The limits test message is considered as a measurement display line and will therefore scroll up the screen, at the top of the list.

3.15.5 Measurement Resolution.
Resolution, the number of digits displayed for measurement results is as follows:

Time Results	
Memory Length	**Digits Displayed**
500	3
5000	4
10000	5
50000	5
200000	6
1000000	6

Voltage Results	
8 bits	3
12 bits	5

3.15.6 Measurement Units

When measurements are performed on traces that have been acquired using an external timebase, the horizontal results will be in Samples and not a specific time. Measurements on analysis traces such as differentiated or integrated will be presented in suitable units.

3.15.7 Using Measurements

To use custom measurements, a sequence of the required measurements and calculations is set using the Measurement Functions Menu. A measurement is inserted into the sequence and then the parameters for that measurement are set. Measurements can be added to the end of the sequence, inserted between existing measurements or deleted from the sequence.

When a measurement is inserted, it is placed after the selected position.

Custom measurements provides an extended readout of cursor position for trace types such as histograms and FFT traces.

The measurements can be turned off individually or as a whole.

To insert a measurement, first select the YT or the XY Measurement Status Menu by pressing the Measure Menu button (2).

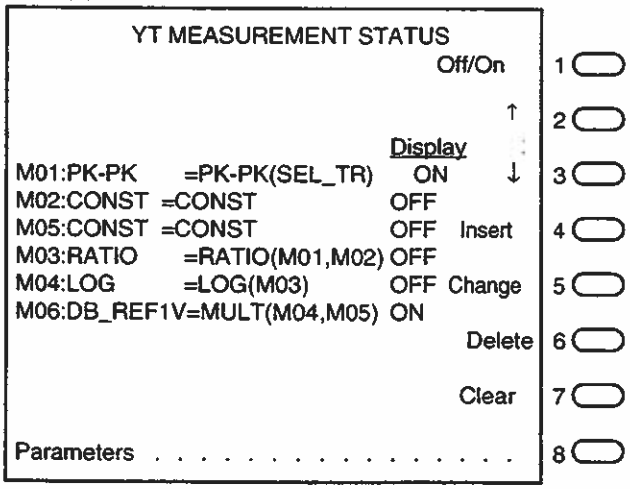


Figure 3.15.7a Measurement Status Menu

From this Menu press button 4, insert, and the display will change to the Measurement Functions Menu which is simply a list of all the possible measurements. Figure 3.15.7b shows part of the complete list of measurements

Highlight the required measurement by using buttons 2 and 3 to scroll up and down this list. When the required measurement is highlighted, press button **1**, Select, to add the measurement to the sequence. The display now shows a list of traces (or a list of existing measurements) from which the required source or sources for the new measurement can be chosen by using buttons **2** and **3** to scroll to the required item. Having selected the source the display will change back to the measurement status menu.

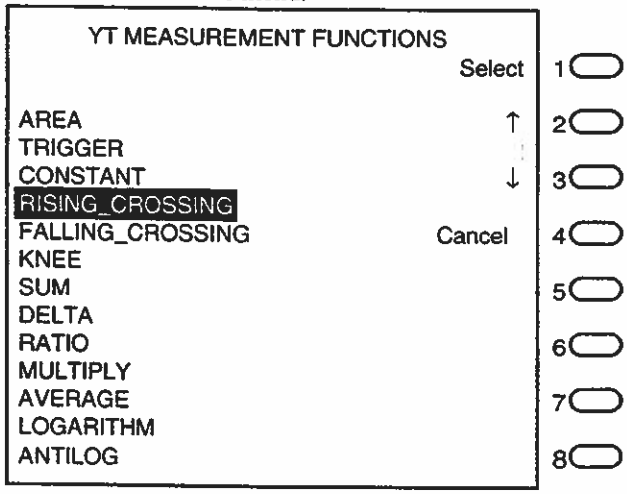


Figure 3.15.7b Measurement Functions Menu

The parameters for the measurement that has just been inserted can now be set. Press button 8, Parameters, and the display will change to the Parameters menu. This menu is similar for each measurement. The parameters for the selected measurement can all be set from this menu. The parameters and what they mean are described for each individual measurement in sections 3.16 and 3.17.
To set or change the parameters for any other measurement, simply scroll through the sequence using buttons 2 and 3 until the required measurement is highlighted and press button 8 parameters.

3.15.8 Plotting Measurements

Measurements can be plotted on the internal thermal printer, or on an external plotter via the GPIB, RS423 or Parallel port (see section 3.26). On the internal thermal plotter up to seventeen lines of measurement results can be printed to the right of the trace area as shown in figure 3.15.8.

On an external plotter, the plotted results are limited to 2 columns of 5 lines plotted underneath the traces.

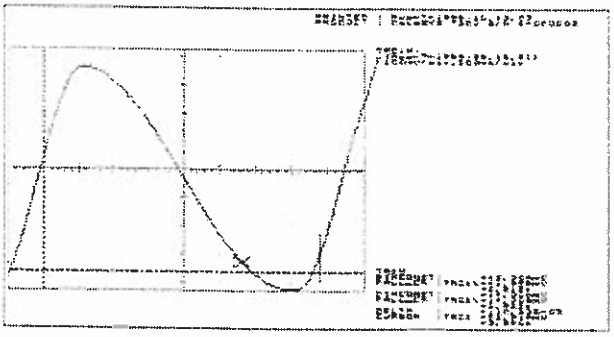


Figure 3.15.8 A Typical Measurement Plot

3.16 YT Measurements & Operators

Of the YT Measurements available, some are standard on every instrument and some are only accessible if the Optional Custom Measurement software has been purchased.

Standard Measurements:

Cursor Position (see section 3.16.1)
Top/ Base (see section 3.16.2)
Amplitude (see section 3.16.3)
Peak–to–Peak (see section 3.16.4)
Max/Min (see section 3.16.5)
Risetime/Falltime/Pulse width (see section 3.16.6)
Overshoot/Preshoot (see section 3.16.7)
Frequency/Period/Duty Cycle (see section 3.16.8)
RMS/AC RMS (see section 3.16.9)
Area (see section 3.16.10)
Squarewave Amplitude **Not 6500/9500** (section 3.16.11)

Custom Measurements:

Trigger (see section 3.16.12)
Constant (see section 3.16.13)
Rising/Falling Crossing (see section 3.16.14)
Knee (see section 3.16.15)
Sum/Delta (see section 3.16.16)
Ratio (see section 3.16.17)
Multiply (see section 3.16.18)
Average (see section 3.16.19)
Logarithm/Antilog (see section 3.16.20)
Cosine (see section 3.16.21)
Mean (see section 3.16.22)
Count (see section 3.16.23)
FFT Harmonic (see section 3.16.24)
Datum (see section 3.16.25)
Dimensioned Constant (see section 3.16.26)

3.16.1 Cursor Position

Applies to: YT traces, FFT, graphs, histograms

Meaning:

YT traces: This returns the cursor x,y position (referenced to ground or the datum lines) in default units (generally volts, time) or if user scaling/units are on then these will be used.

Graphs: This returns the value at the position of the cursor on the graph (in whatever units the measurement was made). The horizontal reading will reflect how the graph was generated (either in time units or in number of acquisitions). User scaling/units do not apply to this readout.

Histograms: This returns the bin start and end values (in whatever units the source measurements were made) and the number of readings in the bin. The total number of readings may be available from the "area" measurement. The percentage of readings in a bin may be calculated by dividing the number of readings in a bin by the total number of readings obtained from the "area" measurement.

FFT traces: This returns the voltage (in volts or dBV for a log scale) and frequency of the cursor position, and the ratio of the cursor position to the reference (harmonic). For a logarithmic vertical scale, the top of graticule offset in dB is also given. Absolute and relative mode are available.

Parameters: reference, name

Result: vertical, horizontal

3.16.2 Top/Base

Applies to: YT traces, graph

Meaning:

Statistical: When this is selected the top and base values used will be those calculated as defined in IEEE standard 181-1977.

Cursors: When this is selected, the top base values are taken to be the trace values at the positions of the vertical datum line and the cursor.

Parameters: bounds, top/base, reference, name, marker - top/base

Result: vertical

3.16.3 Amplitude

Applies to: YT traces, graph

Meaning: This returns the amplitude of the trace between the bounds and is top - base in default units/scaling or using any trace scaling/units if available. Ground/Datum modes are not relevant.

Parameters: bounds, top/base, name, marker - top/base

Result: vertical

3.16.4 Peak-to-Peak

Applies to: YT traces, graph

Meaning: This returns the peak to peak value of the trace between the measurement bounds and is maximum value minus the minimum value in default units/scaling or using any trace scaling/units if available. Ground/Datum modes are not relevant.

Parameters:bounds, name, marker - max/min

Result: vertical

3.16.5 Max/Min

Applies to: YT traces, graph

Meaning: This returns the maximum or minimum of a trace (either absolute or delta mode) in default units (generally volts, time) or if user scaling/units are on then these will be used. Ground mode takes the ground as the vertical reference. The time reading is always in datum mode.

Parameters: bounds, reference, name, marker - max/min

Result: vertical, horizontal

3.16.6 Risetime/Falltime/Pulse width

Applies to: YT traces, graph

Meaning: These measurements are defined as the time between where the trace crosses two defined levels (two percentages of top and base). Default units/scaling are used or any trace scaling/units if available. Ground/Datum modes are not relevant. These measurements use the first transition found within the measurement bounds.

Parameters: bounds, top/base, low/left transition, high/right transition, name, marker - top/base

Result: horizontal

3.16.7 Overshoot/Preshoot

Applies to: YT traces, graph

Meaning: This is used to provide the overshoot and preshoot of a pulse. The values are calculated on the first transition using the following formulas:

$$\text{Overshoot} = \frac{\text{max - top}}{\text{top - base}} \times 100$$

$$\text{Preshoot} = \frac{\text{base - min}}{\text{top - base}} \times 100$$

and their results are in percent.

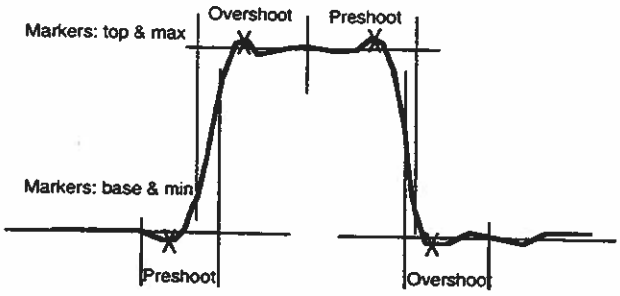


Figure 3.16.7 Overshoot and Preshoot Measurement

Parameters: bounds, reference, name, marker - top/max or base/min - see diagram

Result: vertical

3.16.8 Frequency/Period/Duty Cycle

Applies to: YT traces, graph

Meaning: The period is calculated as the mean of the time between at least three crossing points as defined by the crossing parameters. Default units/scaling are used or any trace scaling/units if available. Ground/Datum modes are not relevant.

The frequency is the reciprocal of period and duty cycle is the ratio of mean time spent above the crossing level to the period of the waveform. The word AUTO is displayed if the trace does not cross the specified crossing level, indicating that the 50% of the max/min range will be used instead.

Parameters: bounds, top/base, crossing, crossing level, name, marker - top/base

Result: horizontal

3.16.9 RMS/AC RMS

Applies to: YT traces

Meaning: RMS returns the rms value of a trace (either absolute or delta mode) in default units (generally volts) or if user scaling/units are on then these will be used. Ground mode uses the trace ground as the vertical reference; datum mode take the voltage datum as the reference. AC RMS is used to calculate the AC component by taking the mean of the trace as a reference.

Parameters: bounds, reference - DC only, name

Result: vertical

3.16.10 Area

Applies to: YT traces, graphs, histograms

Meaning: **YT traces & graphs:** This returns the area, between the bounds specified, of a trace (either absolute or delta mode) in default units (generally volts-time) or if user scaling/units are on then these will be used. Ground mode takes the ground as the vertical reference; and in datum mode the voltage datum will be used.

Histograms: This returns the total number of samples in the histogram.

Parameters: bounds, reference, name

Result: vertical

3.16.11 Squarewave Amplitude (6000/6100/7100/7200 only)

Applies to: YT Traces

Meaning: Measures the amplitude of a square wave between 30 % after the rise and 90 after the rise (10 % before the end of the pulse) thus only measuring the 'flat' part of the wave ignoring any overshoot ringing at each end. See Figure 3.16.26.

Parameters: value, units, name

Result: vertical or horizontal

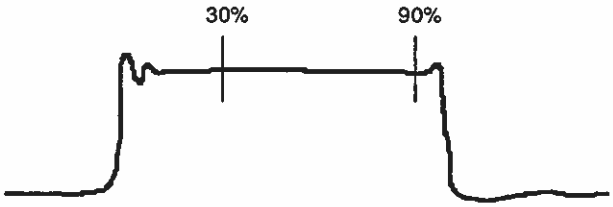


Fig 3.16.11 Squarewave Amplitude Measurement

3.16.12 Trigger

Applies to: YT traces

Meaning: This gives the voltage and time at the trigger position in default units, or user scaling/units where they exist. The results are always relative to the vertical datum. Another measurement may be made to read in absolute time by subtracting the trigger time.

Parameters: name, reference

Result: vertical, horizontal

3.16.13 Constant

Applies to: not applicable

Meaning: This is used to provide a fixed numeric value which can then be used to provide for instance a multiplication factor or an offset for a measurement by using the multiply or add measurements.

Parameters: value, name

Result: dimensionless

3.16.14 Rising/Falling Crossing

Applies to: YT traces

Meaning: These measurements return the voltage and time of a particular transition of a waveform: this is specified as the "nth" time a trace crosses a particular level in the rising or falling direction. Units are either default or user specified. Ground and datum modes are defined by the Crossing parameter of this measurement.

This measurement displays the word AUTO if the trace does not cross the specified level, indicating that the 50% of max/min level has been used instead.

Parameters: bounds, top/base, crossing, crossing level, transition no, name, marker - crossing voltage

Result: vertical, horizontal

3.16 15 Knee

Applies to: YT traces

Meaning: This returns the voltage and time of the 'knee' of a waveform. The units are either default or user specified. Ground and datum modes are available. To find the knee positions, this measurement uses 30% and 70% crossings and extrapolates to the top or base as show below.

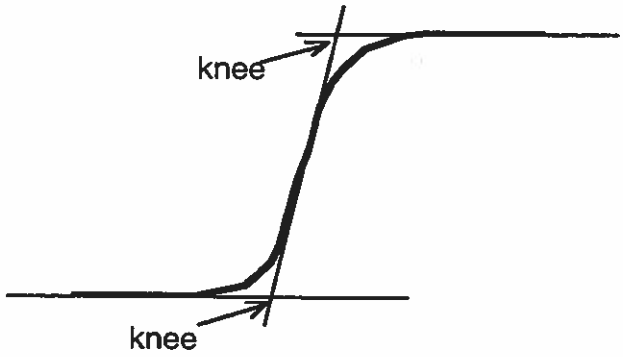


Figure 3.16.15 Knee Measurement

Parameters: bounds, top/base, reference, transition number, top/bottom, name, marker - base/top

Result: vertical, horizontal

3.16.16 Sum/Delta

Applies to: measurement result

Meaning: This operator calculates the difference between, or the sum of, two previous measurement results. Where measurement results contain more than one value (e.g. cursor), the user can specify which values to subtract.

This operation has no regard to units. The user is also able to select a user scaling and units for the result of this calculation if desired.

Parameters: operands, scaling on/off, scaling, offset, annotation, name

Result: vertical or horizontal

3.16.17 Ratio

Applies to: measurement result

Meaning: This operator calculates the ratio of two previous measurement results. Where measurement results contain more than one value (e.g.cursor), the user can specify which values to divide. The operation will proceed with no regard to units: by default, the result will be unitless. The user is also able to select a user scaling and units for the result of this calculation if desired.

Parameters: operands, scaling on/off, scaling, offset, annotation, name

Result: vertical or horizontal

3.16.18 Multiply

Applies to: measurement result

Meaning: This is used to produce the product of two previous measurement results. Where measurement results contain more than one value (e.g. cursor), the user can specify which values to multiply. This operation has no regard to units and by default, the result will be unitless. A user scaling and units for the result of this calculation can be specified if desired.

Parameters: operands, scaling on/off, scaling, offset, annotation, name

Result: vertical or horizontal

3.16.19 Average

Applies to: measurement result

Meaning: This measurement calculates the weighted average of a measurement result. Where a measurement result contains more than one value (e.g. cursor), the user can specify which values to average. The result of this calculation is in the units of the measurement result to being averaged.

Parameters: operand, weighting factor, reset, annotation, name

Result: vertical or horizontal

3.16.20 Logarithm/Antilog

Applies to: measurement result

Meaning: This is used to calculate the Log to base 10 of a measurement or 10 to the power of a measurment.

Parameters: operand, annotation, name

Result: vertical or horizontal

3.16.21 Cosine

Applies to: measurement result

Meaning: This is used to calculate the Cosine of a measurement and accepts measurements scaled in degrees.

Sine measurements can be obtained by simply adding 90° first.

Parameters: operand, annotation, name

Result: vertical or horizontal

3.16.22 Mean

Applies to: YT traces

Meaning: This returns the mean value of the trace in volts.

Parameters: bounds, reference, name

Result: vertical

3.16.23 Count

Applies to: YT traces

Meaning: This returns the number of occurences of the trace passing through a level.

Parameters: bounds, top/base, crossing, crossing level, transition, name

Result: horizontal

3.16.24 FFT Harmonic

Applies to: FFT Traces

Meaning: This returns the frequency and amplitude of a harmonic. The harmonic number is specified by a parameter in the FFT Harmonic Parameters menu.

Parameters: fundamental, harmonic number, datum noise floor, name

Result: vertical, horizontal

3.16.25 Datum

Applies to: not applicable

Meaning: This returns the position of the voltage or time datum line or the trace value where the trace crosses the time datum.

Parameters: time/voltage, time–at–datum, reference, name

Result: vertical or horizontal

3.16.25 Dimensioned Constant

Applies to: not applicable

Meaning: This is a fixed numeric value for vertical or horizontal readings. The default value is 1.

Parameters: value, units, name

Result: vertical or horizontal

3.17 XY Measurements

XY measurements are performed on the cursor trace only. Locking the datum to the trace affects all XY measurements.

3.17.1 Cursor X, Y

Applies to: XY trace

Meaning: This returns the X,Y value of the cursor with respect to the datum or ground expressed in volts, or other units if set, for the channel(s) concerned.

Parameters: name, reference, datum locked to trace

Result: vertical, vertical

3.17.2 Cursor t

Applies to: XY trace

Meaning: This returns the time value of the cursor with respect to the datum or trigger expressed in seconds, or other units if set, for the channel(s) concerned. If the datum is not locked to trace the measurement is with respect to trigger.

Parameters: name, reference, datum locked to trace

Result: horizontal

3.17.3 Radius

Applies to: XY trace

Meaning: This returns the distance from the cursor to the datum (Ground/datum and lock/unlocked to trace) expressed in volts, or other units if set, for the channel(s) concerned.

Parameters: name, datum locked to trace

Result: vertical

3.17.4 Angle

Applies to: XY trace

Meaning: This returns the angle between the line joining the cursor to the datum (Ground/datum and lock/unlocked to trace) and the vertical datum, expressed in degrees as viewed on the screen, and does not take into account any different trace scalings.

Parameters: name, datum locked to trace

Result: vertical

3.17.5 Area

Applies to: XY trace

Meaning: This returns the value of the area bounded by the trace and the intersection of the vertical and horizontal datums and is expressed in volts^2, or other units if set, for the channel(s) concerned. This measurment is only available if the trace is stored or held.

Parameters: name, datum locked to trace, area fill

Result: vertical

3.17.6 Integration with respect to x

Applies to: XY trace

Meaning: This returns the integral of the area bounded by the vertical datum, the horizontal datum, the X position of the cursor and the cursor trace expressed in volts^2, or other units if set, for the channel(s) concerned. This measurment is only available if the trace is stored or held.

Parameters: name, datum locked to trace, area fill

Result: vertical

3.17.7 Constant

Applies to: not applicable

Meaning: This is used to provide a fixed numeric value which can then be used to provide for instance a multiplication factor or an offset for a measurement by using the multiply or add measurements.

Parameters: value, name

Result: vertical or horizontal

3.17.8 Operators

The operators for YT trace (DELTA, SUM, RATIO, MLT, AVERAGE, LOG, ANTILOG, COS) are also able to operate on the results of XY measurements.

3.18 Utility Menu

The Utility menu is selected by pressing the Utility button (50) on the instrument's front panel and is used to select various Utility function menus.

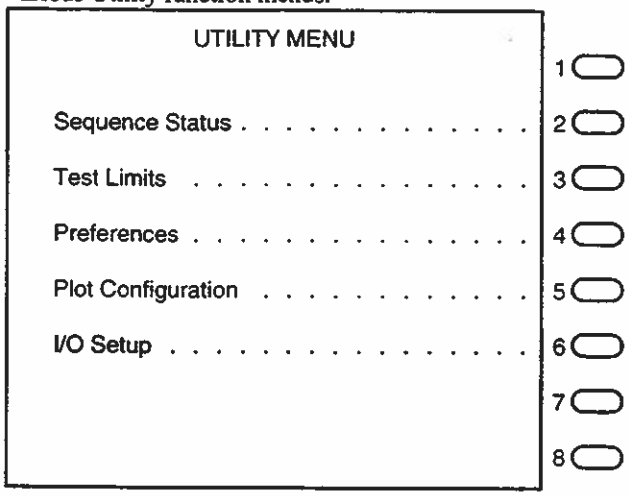


Figure 3.18 Utility Menu

Sequence Status Menu: The Sequence Status menu provides access to the sequence functions. See section 3.19.

Test Limits Menu: The Test Limits menu provides access to the limits testing functions. See section 3.20.

Preferences Menu: The Preferences menu provides access to the instrument's basic or preference settings. See section 3.21.

Plot Configuration Menu: The Plot Configuration menu provides access to the instrument's plotting settings. See section 3.26.

I/O Setup Menu: The I/O Setup menu provides access to the instrument's Input/Output settings. See section 3.27.

3.19 Sequences Status Menu

Sequences of events can be programmed and replayed in the instrument using the Sequences Status menu. Using this feature repetitive complex series of operations can easily be automated.

Up to eight sequences can be programmed, from up to a total of 240 steps in any combination.

This menu is reached by selecting button **2** from the Special Master menu.

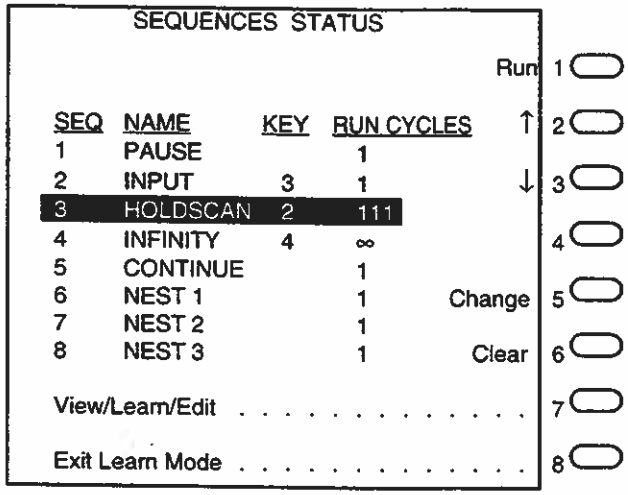


Figure 3.19 Sequences Status Menu

This menu shows the current status of the 8 sequences. It shows their name the soft key allocated to them and the number of times a particular sequence will run when the Run button is pressed.

Run To run a sequence press button **1**. The sequence will either run the number of times shown against its entry and specified on line 3 of the Sequence menu.

When a sequence has finished running, the message SEQUENCE RUN COMPLETE appears on the display.

To stop a sequence running, press the Abort button (53). The sequence is stopped and the message SEQUENCE RUN ABORTED is displayed.

Each sequence step will take on average 150 ms to complete.

Change (Options on 6500/9500) To modify a sequence, select it using buttons **2** and **3** and then press button **5**. The Sequence menu is then displayed from which the sequence attributes and the sequence itself can be changed.

Clear To clear an existing sequence, press button **6**. This deletes every entry in the sequence, removes it from the list and resets the name to SEQ1 to 8 as appropriate. Because a deleted sequence cannot be recovered, the user is asked to confirm this action with a second press of button **6** before the deletion occurs.

View/Learn/Edit Pressing button 7 selects the sequence entry mode which allows items to be entered into the selected sequence.

Exit Learn Mode This line appears only if this menu is entered whilst learning a sequence in which case the menu title is "Learning Sequence". Pressing it exits the learn mode.

3.19.1 Sequence Setup

Pressing button 5 in the Sequences Status menu causes the Sequence menu to be displayed.

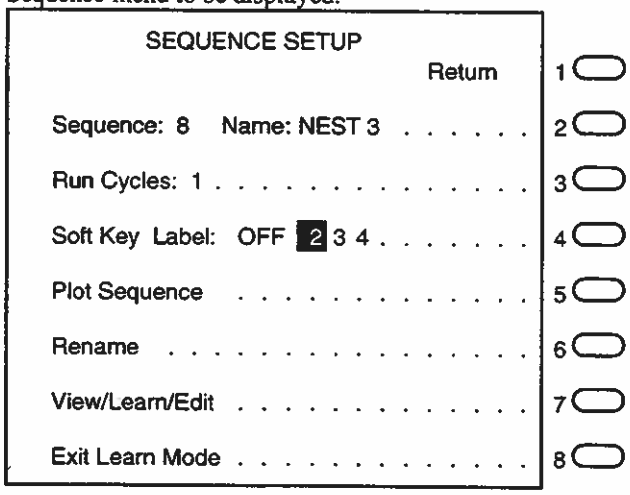


Figure 3.19.1 The Sequence Setup Menu

From this menu, the attributes of the selected sequence can be set or changed.

When this menu is entered, the selected sequence will be the one highlighted in the Sequence Status menu. To select another sequence press button 2 until the required sequence is shown in line 2.

Run Cycles A sequence can be set to run from 0 to 999 cycles or infinity. Press button 3 to change the display to the Run Cycles entry pad from which the required number can be entered.

Soft Key Label Sequences can be assigned to either "Soft Key" 2, 3 or 4 so that they may be run from the trace display. To assign a label to the sequence, press button 4 until the required key number is highlighted.

Plot Sequence To plot the sequence, pressing button 5. The sequence will be plotted as a list of events and the instrument will remain in the sequence menu.

Rename To name or rename the sequence, press button 6 and the display will change to the Sequence Name entry pad from which an eight character name can be entered.

View/Learn/Edit Pressing button 7 selects the sequence entry mode which allows items to be entered into the selected sequence.

Exit Learn Mode This line appears only if this menu is entered whilst learning a sequence in which case the menu title is "Learning Sequence". Pressing it exits the learn mode.

3.19.2 Editing or Learning a Sequence

When View/Learn/Edit is pressed in either the Sequence Status or Sequence Menus, the display changes to the Sequence Learn page. This page will list the sequence steps for the selected sequence.

There are three standard sequences available specifically designed for operating the oscilloscope in a "babysitting" mode. There are: Autoplot, Autosave and Plot and Save.

Autoplot causes a single shot acquitition to be performed which is them plotted. The plot will use the parameters set in the plot configuration menu.

Autosave causes a single shot acquitition to be performed which is them saved. The save oprtation will use the parameters set in the save menu, and will be a trace, sequence or setup.

Plot and save When this step is reached, the current display is printed and a save operation is performed, using the parameters set in the Plot Configuration and Save menus.

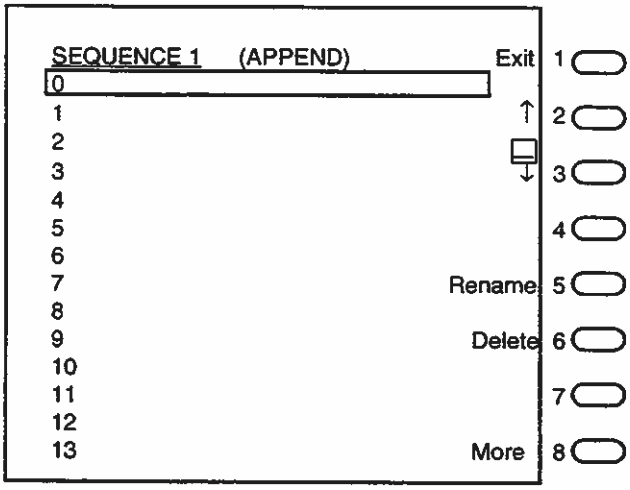


Figure 3.19.2a The Learn/Edit Sequence Menu

The cursor position is indicated by the inverse video characters on the appropriate line. Buttons 2 & 3 move the cursor forwards and backwards through the sequence (up and down on the display).

A sequence is automatically generated by operating the instrument's controls. An entry is retained when the next

control selection is made. e.g. Volts/div can be changed from 2 mV to 1 V through the intermediate steps and only result in one sequence step. When another control is operated CH1 V/DIV will be entered into the sequence. The only mass storage functions that can be used in a sequence are the save and recall items from the save and recall menus. Selecting any other mass storage function will result in the error message ENTRY NOT ALLOWED IN SEQUENCE While learning a sequence, pressing either save or recall does not result in a save or recall being performed.

Rename To rename a sequence, press button 5 to get the Sequence name pad from which an eight character name may be entered.

Delete To delete an item form the sequence, press button 6 and the highlighted item will be deleted. All subsequent steps will move up one place.

More While editing or learning a sequence, some extra functions are available by pressing button 8 to obtain the list of "More" functions.

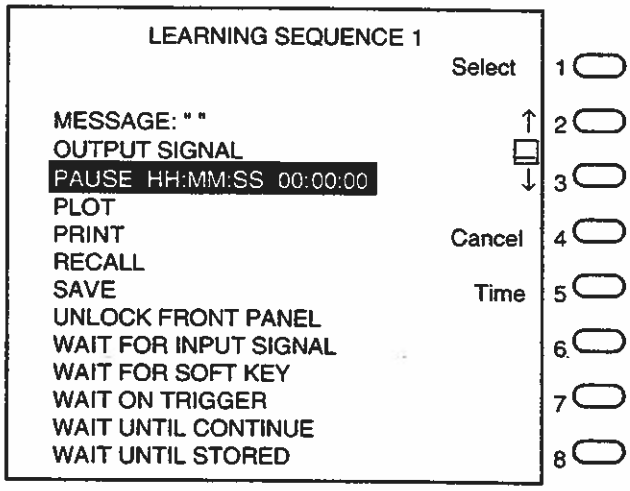


Figure 3.19.2b Learning Sequence Menu

BEEP Selecting BEEP will add a short beep into the sequence so that for instance a user's attention can be attracted immediatly prior to a "wait for soft key" command.

CALL SEQ1 ...8 Another sequence can be called from any other sequence so that if desired, a longer sequence can be created or a particular routine run at several points during a sequence without having to re-create it each time it is required.

COMMENT A message may inserted into a sequence for documentation purposes, so that when a sequence list is plotted, the sequence is commented. The text for the comment, which can be up to 18 characters long, is entered using the Comment Entry pad obtained by pressing button 5.

GOTO This causes the sequence to jump to a specified sequence step. This can be used to set up a continuous sequence that returns to the start from the end.

IF ... GOTO A conditional jump can be added to a sequence. If the parameters specified are true, the sequence will continue from the specified step number otherwise it will continue with the next sequential step. The parameters refer to previous measurements and are >, <, <=, >=, and <>.

INSERT AUTOPLOT When this step is reached while running a sequence a single shot acquisition will be performed which will then be plotted. The plot will use the parameters set in the plot configuration menu. Selecting this command actually puts 4 steps into the sequence; "Start Autoplot", SINGLE SHOT, PLOT, and "End Autoplot".

INSERT AUTOSAVE When this step is reached while running a sequence, a single shot acquisition will be performed which will then be saved. The save operation will use the parameters set in the save menu, and will be a trace, sequence or setup. Selecting this command actually puts 4 steps into the sequence; "Start Autosave", SINGLE SHOT, SAVE TRACES, and "End Autosave".

INSERT PLOT & SAVE This command enters the following steps into a sequence. "Start plot & save", HOLD ALL ON, PLOT, SAVE TRACES, HOLD ALL OFF and "End plot and save".

When these steps are reached, the current display is printed and a save operation is performed, using the parameters set in the Plot Configuration and Save menus.

MESSAGE A message may inserted into a sequence so that when the step is reached, the message will be displayed on the screen. The text for the message, which can be up to 18 characters long, is entered using the Message Entry pad obtained by pressing button 5.

LOCK FRONT PANEL All controls with the exception of the Cancel button can be made inactive by locking the front panel.

OUTPUT SIGNAL While a sequence is running, a TTL level signal can be generated by the instrument at a particular point in the sequence. This signal appears on pin 4 of the miscellaneous I/O connector on the rear panel and is a positive going pulse between 10 ms and 50 ms long. See Appendix 5.

PAUSE HH:MM:SS If it is required to introduce a pause into a sequence, choose this function. A pause time can then be entered using the time entry pad obtained by pressing button 5. The time can be from 1 second to 99 hours 59 minutes and 59 seconds. When the sequence is run and this step reached, the instrument will pause for the specified time.

PLOT Selecting Plot will add a plot command into the sequence without actually causing a plot to happen thus saving paper. The front panel Plot/Save button is disabled during learn or edit, and a plot command is NOT added to the sequence if it is pressed. When this command is reached during a sequence, a plot of the current display occurs using the plot parameters from the Plot Configuration menu.

PRINT This will add a step into the sequence which will cause a one line measurement result to be printed on the plotter.

RECALL This will add a step into the sequence which will cause a recall operation to be performed using the current recall setup set in the save/recall menu.

SAVE This will add a step into the sequence which will cause a save operation to be performed using the current save setup set in the save/recall menu. This has the same effect as pressing the front panel save button

UNLOCK FRONT PANEL Normally, the front panel is locked while running a sequence. It can be unlocked with this function.

WAIT FOR INPUT SIGNAL A sequence can be paused to await an external TTL signal. The signal should be connected to pin 3 of the miscellaneous I/O connector on the rear panel. This signal may typically come from a foot switch and requires a high to a low transition to occur. The input must remain low for at least 100 ms for an input to be registered. See Appendix 5.

WAIT ON SOFT KEY A sequence can be paused to await a press of any one of the numeric buttons. This can be used in conjunction with the Message and Beep commands to prompt the user to complete an action.

WAIT ON TRIGGER A sequence can be paused to await the next valid trigger.

WAIT UNTIL CONTINUE When a sequence is run and reaches this command, the sequence will stop and display on the screen, CONTINUE alongside button 3. When button 3 is then pressed by the user, the sequence will continue. A possible use for this feature may be to stop a sequence to allow probes to be changed or repositioned.

WAIT UNTIL STORED When a sequence is run and reaches this command, the sequence will stop and wiat until the current acquisition is complete and stored before the sequence will continue.

3.20 Test Limits Menu

This menu is always transparent and is used to set and control all aspects of limits testing

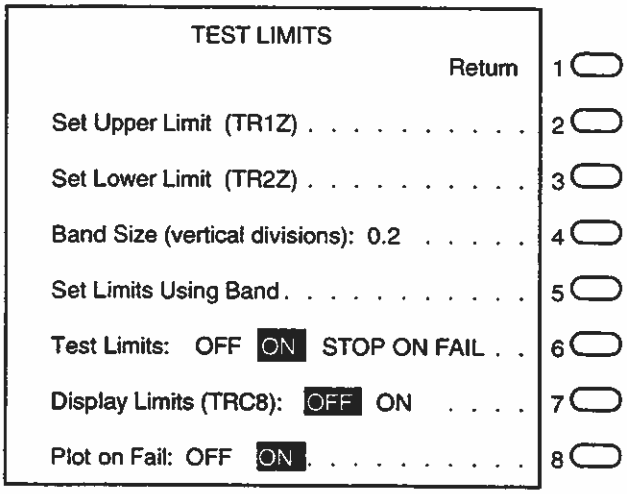


Figure 3.20 Test Limits Menu

To select which display trace is to be used as either the upper or lower limit, position the cursor on it using the Select trace button (5). The trace names in both lines 3 and 4 show the current cursor trace.

Set Upper and Lower Limits: The upper and lower limits to be tested against are set by selecting the desired trace with the cursor and then pressing either button **3** or **4** as required. When a limit has been set, the message UPPER LIMIT SET or LOWER LIMIT SET as appropriate is briefly displayed at the bottom of the screen.

Set Limits Using Band: A limit that consists of a band above and below a trace can be set by pressing button 5. The width of the band is set by pressing button 4 and entering the required band size which can be from 0.2 to 1 division.

If Display Limits is turned On using button **6**, the limit traces will be displayed as trace 8 and the band between the upper and lower limits will be shaded.

Limit traces will only be plotted if display limits is turned on in line 6. See section 3.26.

Limits testing will be performed on all the memory of both the upper and lower limit traces within the area bounded by the cursor and time datum lines.

Limit testing may be turned On or Off or set to Stop–on–Fail by pressing button **5**. When turned On, each successive acquisition is tested and a warning message displayed when a trace is outside the limits. This warning and trace will be overwritten by the next acquisition.

If the limits mode is set to Stop–on–Fail, acquisitions are halted when a trace that is outside the limits is captured, allowing it to be examined. This screen picture can be plotted and the area between the upper and lower limits can be shown filled with vertical lines.

Test Limits only operates when the DSO is in Refresh mode in either YT or XY modes. Limits test is not available in roll mode. If an attempt to select Limits testing is made when the instrument is not in refresh mode, an error message will be displayed.

Display Limits will not displayed in any mode other than YT refresh.

3.21 Preferences Menu

The Preferences menu is selected by selecting Preferences from the Utility Menu and is used to set various basic instrument settings. It differs depending upon the instrument type.

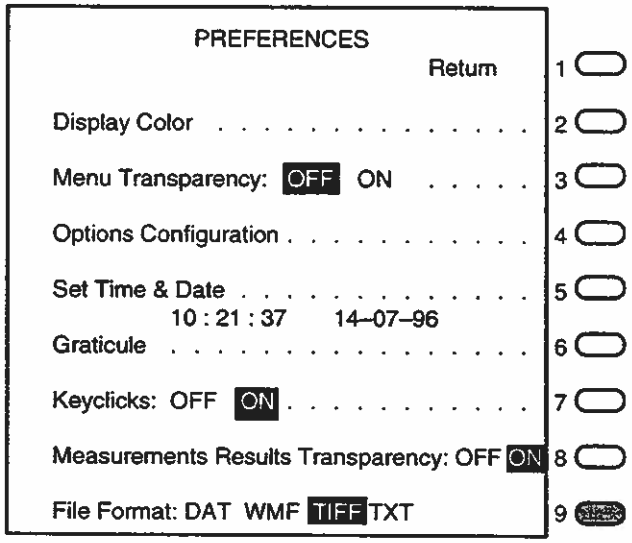


Figure 3.21a The Preferences Menu (6000/6100/7100)

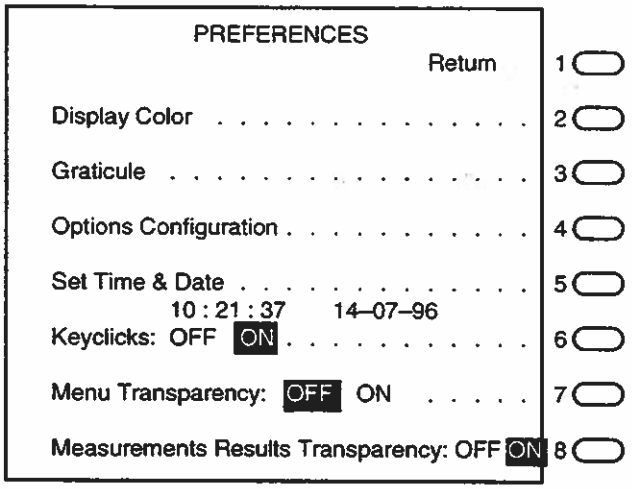


Figure 3.21b The Preferences Menu (6500/9500)

Display Color Menu: The Display Color menu provides the user with a means of setting the colors of various display items. See section 3.22.

Option Configuration Menu: The Option Configuration menu is used to turn options on and off and to install new options. See section 3.23.

Set Time & Date Menu: The current time and date held by the instrument is displayed below this line. If required, these settings can be changed by selecting the Set Time and Date menu by pressing button 5. See section 3.24.

Graticule Menu: The Graticule menu is used todefine the way in which the graticule is displayed on the instrument's screen. See section 3.25.

3.21.1 Menu Transparency

The Menus can be set so that they are either "see–through" (transparent) or solid. When they are transparent, the trace display and the menus are on the screen at the same time allowing the effects of menu items to be seen as they are changed.

When transparency is Off, selecting a menu replaces the trace display with the menu display.

Menu Transparency works with all menus except the Display Color menu, the Test Limits menu and the Channel Offsets menu which are always transparent.

3.21.2 Keyclicks

This line turns the keyclick feature on and off. If keyclicks are turned on then each time a front panel control is pressed a keyclick will sound giving a positive indication that the action was recognized.

3.21.3 Measurements Results Transparency

This line makes the background of the measurements results box transparent or solid.

3.21.4 File Format (6000/6100/7100)

This button is used to select the file format for saving screen pictures. The options are DAT which produces a standard classic data file suitable for recalling at a later date, WMF – Windows Meta File, TIFF – Tagged Image File Format and TXT which produces an ASCII text file suitable for use on a computer in spreadsheets or other data manipulation programmes.

For further details of the .DAT format see the Gould Transition2 Operator Manual.

On 6500 and 9500 instruments, this feature is available on the Save/Recall File Options Menu.

3.22 Display Color Menu

This menu is used to change the color of any of the items contributing to the overall display. This menu is always overlaid on the trace display so that the colors of the display items can be viewed as they are changed.

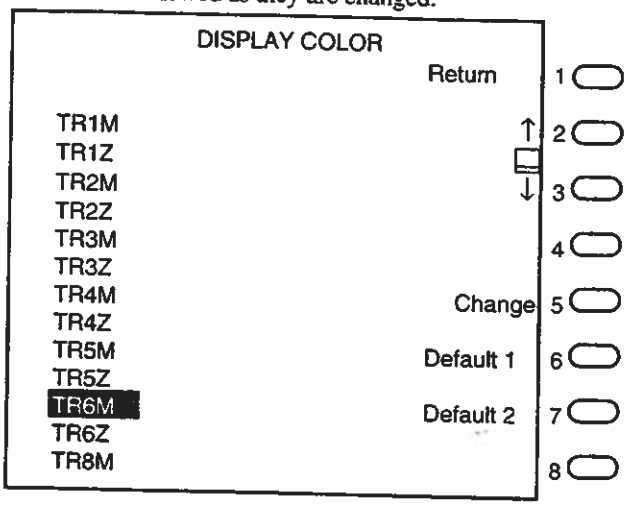


Figure 3.22a Display Color Menu

An item is selected by using buttons **2** and **3** to scroll through the list of items. The color of the highlighted item can be changed by selecting Change with button **5**. This causes the Customize Color menu to be displayed.

The colors can also be remotely set and modified using either the RS423 or IEEE 488 interfaces.

The complete list of items that can be individually colored is:

Defaults
The instrument is pre–set with two sets of defaults for the colors of the display items. These color sets can be reverted to at any time.

Default 1: To set all display items back to their default 1 colors press button **6**. This set of colors has a black background with all items set to a usable selection. The zoom trace colors are similar to their respective main traces.

Default 2: To set all display items back to their default 2 colors press button **7**. This set of colors has a white background with all items set to a usable selection. The zoom trace colors are similar to their respective main traces.

This setting is useful for saving TIFFs and WMFs for printing on white paper.

Customize Color Menu The item selected is shown under the menu title. The levels of the three colors which contribute to the actual color of the selected item can be increased or decreased using buttons **2** to **7** respectively.

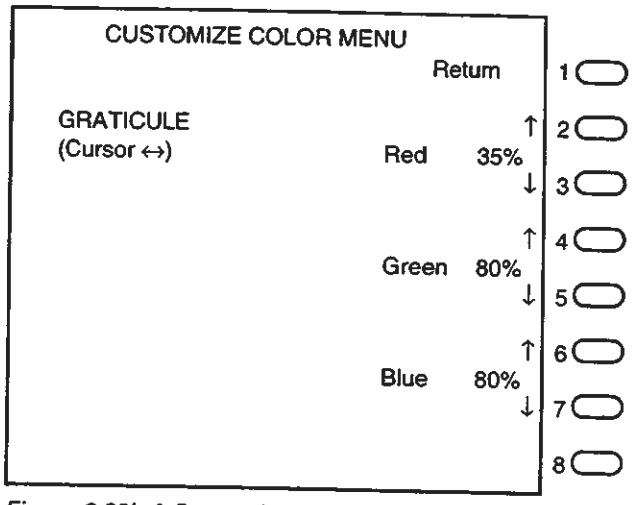


Figure 3.22b A Customize Color Menu

Each press of a button changes the level by 5%, holding a button down causes the level to step through the levels until either 100% or 0% is reached.

To select, for instance, primary red, set Red to 100% and both Green and Blue to 0%. For magenta set Red and Blue to 100% and Green to 0%, and for white set all three colors to 100%.

A good orange can be created by setting Red to 100%, Green to 50% and Blue to 0%.

CAUTION: If the color of the alphanumerics is set to the same as the background, no menus or text will be visible.

If this situation occurs, press the Display Menu button (3) and then button **2**. Next press button **6** twice to restore the colors to default selection 1.

3.23 Options Configuration Menu

The option configuration menu is used to turn on and off instrument options and to install new options.

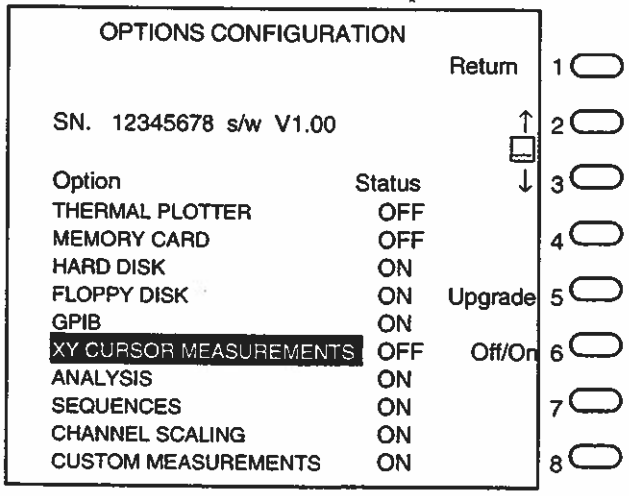


Figure 3.23 Options Configuration Menu

To add a new option to an instrument:

1) If it is a hardware option, first physically install it into the instrument following the instructions supplied with the hardware.

2) Select the new option from the list using buttons **2** and **3**. When the option is highlighted, press the Upgrade button **5** and the display will change to the Authorisation Code entry pad. Note that the Memory Card is not an option for Classic.

If the new option is a hardware device, enter the 3 digit number supplied with your order.

If the new option is a software facility, enter the 8 digit code number supplied with your order.

Once an option has been added and authorized, it can be activated or disabled as required using button **6**. The user may want to turn off some features to simplify some of the menus and thus the instrument operation. For instance if the only memory device required for a particular job is the floppy disk, the other devices can be turned off so that they do not appear in the Save and Recall Menus.

3.24 Set Time and Date Menu:

The DSO is fitted with a real time clock which is set from this menu. The clock is kept running even with the power disconnected for at least a month by its own internal battery back–up.

The current date and time together with the date and time of acquisition will appear on any screen plot.

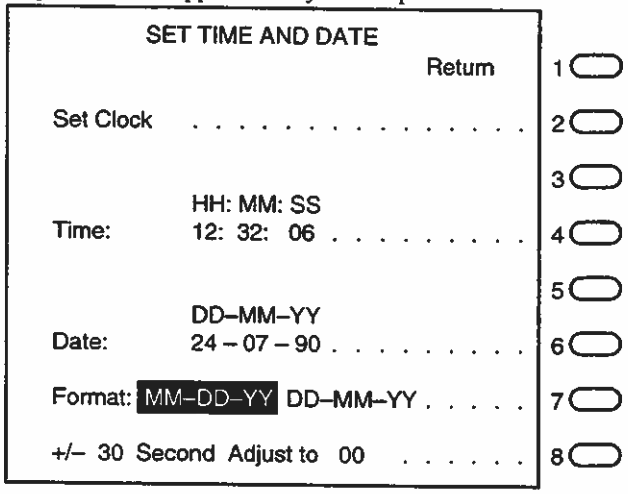


Figure 3.24 A Date and Time Menu

Set Clock: Once the correct date and time has been set, line 2 appears and then, pressing button **2** enters the data. This makes it easy to set a time that is a few seconds in advance of the real time and then press button **2** at a time signal. If the menu is exited without pressing button **2**, then the date and time will remain unchanged.

Time: The current time shown on this line can be changed by pressing button **4.** Once button 4 has been pressed the first digit of the time will be shown in inverse video. To change this number press the required numeric key, the highlight will then move to the next digit. Repeat this until all digits have been entered. To skip a number or return to a previous digit the cursor paddle can be used to move the highlight along this line.

Date: The current time shown on this line can be changed by pressing button **6.** Once button 6 has been pressed the first digit of the date will be shown in inverse video. To change this number press the required numeric key, the highlight will then move to the next digit. Repeat this until all digits have been entered. To skip a number or return to a previous digit the cursor paddle can be used to move the highlight along this line.

Format: The date format can be switched between European or American formats using button **7.** Once a format has been selected, all places where dates are used, such as plots and GPIB/RS423 commands, will use and plot in that format.

+/– 30 Second Adjust to 00: Pressing button **8** forces the current time to jump to the nearest whole minute and zero seconds, i.e. forward or backwards a maximum of 30 seconds. If the time is from 1 to 29 seconds the time will jump back and if it is from 30 to 59 seconds the time will jump on to the next minute.

3.25 Graticule Menu

This menu is used to change the settings of the graticule on the display.

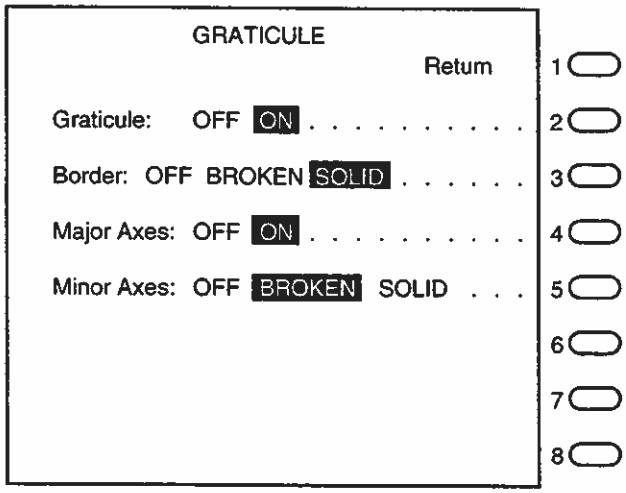


Figure 3.25 Graticule Menu

Various parts of the display graticule can be controlled individually with the current settings shown in inverse video

Graticule: All the graticlue lines (Border, Major Axes and Minor Axes) can be turned on ond off using button 2. The normal setting is on.

Border: Outside the graticule there is a border which can be set to be a solid line a broken line or it can be turned off. The normal setting is Solid.

Major Axes: The major axes are the center two lines of the graticule which form a cross in the center of the display. They contain the 0.2 division markers. The normal setting is on.

Minor Axes: The minor axes are the division markers on the display there are 8 vertical divisions and 10 horizontal divisions. These axes can be set to be off solid lines or broken lines. The normal setting is broken.

3.26 Plot Configuration Menu

This menu allows various plot parameters to be set.

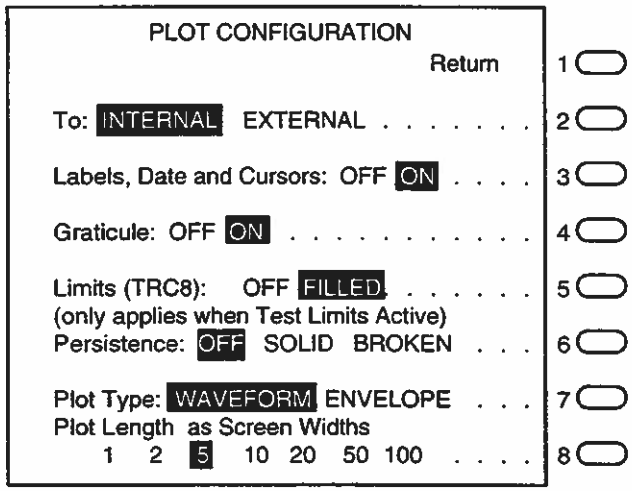


Figure 3.26a A Plotter Configuration Menu

There are 3 possible plot types set from this menu. They are plots to an internal thermal plotter (if fitted) and plots to an external plotter via either the Parallel, RS423 or GPIB interface.

Many of the features set on this menu are common to each of the plotter types and they are discussed below. Features unique to individual plotter types are described under the appropriate headings.

Trace plots will contain a complete copy of the instrument's display including the datum lines and measurement cursor if they are turned on. Menu plots will simply be a copy of the screen display. Transparent menu plots will be a complete copy of the display including both trace and menu data.

To: Selection 2 allows the required plot destination to be selected. When only one destination is available, i.e. when either an internal plotter is not fitted, this line simply displays EXTERNAL and does not allow any selection.

Internal: Choose this option if an internal thermal plotter is fitted and is required to be the plot destination.

External: This item should be selected if the required plot destination is an external plotter connected via either the Parallel, GPIB or RS423 ports.

The DSO communicates with an external plotter on the GPIB and RS423 ports using HPGL.

For GPIB plots, the plotter must be in listen only mode.

Note that in order for GPIB plots to function correctly all the address switches on an HP7475 plotter must be switched to 1.

To output to the parallel port and select the external plot type, ensure that External is selected as the destination on line 2 of the Plot Configuration Menu and that Parallel is selected on line 5 of the I/O menu. Line 7 and 8 of the Plot configuration Menu will then show the current selection for example:

Plotter Type: HPGL 7

External Plotter: RS423 GPIB PARALLEL . 8

To change the plotter type press button 7 and select the required printer or plotter form the list shown in the Plot/ Driver Menu.

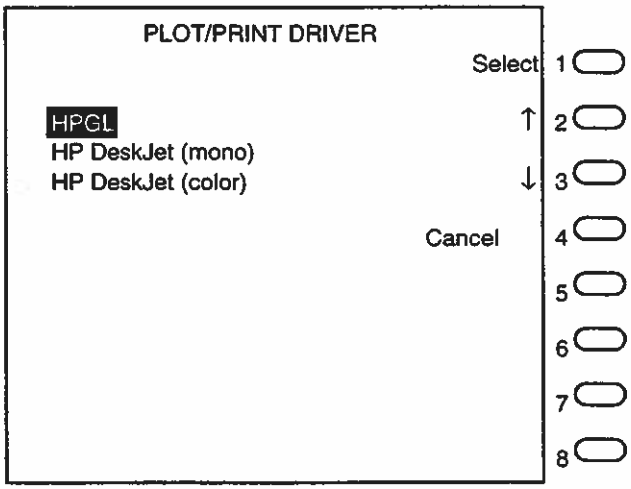


Figure 3.26b A Typical Plot/Print driver Menu

It is recommended that when using an external pen plotter the pen colors are set as shown in the table below so that the colors on the plotted picture will be as good a match as possible to the colors on the display.

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

The pin connections for the RS423 interface are listed below in table 3.26 and typical connection diagrams for RS423 interfacing cables are shown below in figure 3.26c.

RS423 Port

Pin	Function
2	TXD (out)
3	RXD (in)
5	Ground
7	CTS (in)
8	RTS (out)

Table 3.26 RS423 Port

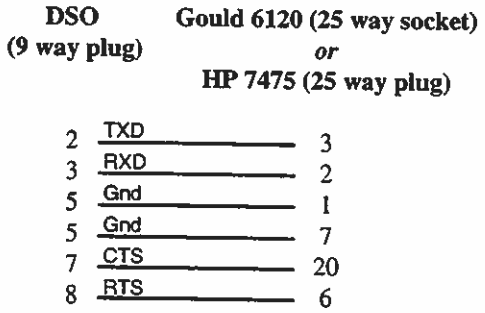


Figure 3.26c RS423 Interface cables

Note: *When using an HP 7475 the handshake should be set to CTS/RTS in the RS423 menu as described in section 3.16.*

Labels, Dates and Cursors: All the alphanumerics that can appear on the plots can be included or omitted depending on the highlighted option selected with button **3.**

If the alphanumerics are turned on, all the on screen labelling including GPIB entries, cursors and waveform processing measurements are reproduced on the plots.

This selection does not affect menu plotting which will always appear if a menu is displayed.

Graticule: On any external plotter, the graticule can be plotted as solid or broken lines or omitted from the plots by selecting the required option using button **4.** If an internal thermal plotter is fitted the graticule, if selected, is always broken lines.

Limits: When the Limits display feature (see section 3.28) is turned on, and the internal plotter is selected, line 5 appears. This is used to determine how the limits traces are plotted. This item is only available when the plot length is set to a screen width of 1.

They can be omitted (OFF), shown as ordinary trace LINES or the area between them can be FILLED with vertical lines. The choice is made using button **5.**

3.26.1 Thermal Plotter

Lines 6, 7 and 8 as shown in figure 3.26 above only appear if an internal thermal plotter is fitted to the instrument.

Print Density: The plotter produces plots in two ways; Grey and Black mode. The mode is selected with button **6.**

When plotting a signal which changes rapidly compared to the selected timebase, and only the envelope is of interest, Black mode should be selected.

This ensures a crisp solid black plot free from the white streaks which can result from the normal max–min operation.

When traces are overlaid, grey mode permits both traces to be printed rather than one be overwtirren and blacked out by another.

Persistence: Persistence plots can only be plotted with a screen width of one and will be as displayed on the instrument's screen.

Plot Length as Screen Widths: The trace display is expanded to produce a plot that is the number of screen widths selected. This is useful because each screen width consists of 500 display points so that, for instance, with a 50 k trace and 100 screen widths every acquired data point is plotted.

Selecting a 100 screen plot with a 500 point store is likely to produce a strange looking plot as there will only be one true data point for every two of the 1000 plotted divisions (100 screens × 10 divisions). If the trace is also zoomed, there will be even fewer data points per plotted division.

If 1 screen width is selected, the displayed data is directly transferred to the plotter so envelope plotting mode is not available.

3.27 I/O Setup Menu

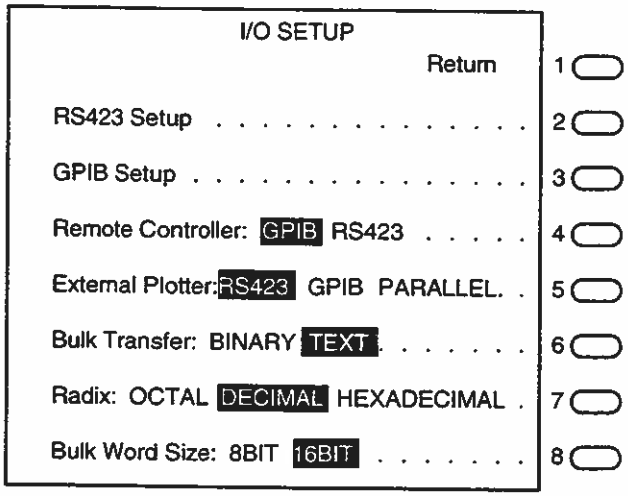


Figure 3.27 The I/O Setup Menu

RS423 Menu This button selects the RS423 menu which is used to define the RS423 port characteristics. See section 3.15.

GPIB Menu This line only appears if the Remote Controller is selected to be GPIB. See section 3.14 for the GPIB menu.

3.27.1 Remote Controller

This option is used to select the function of the GPIB and RS423 ports. Pressing button 4 toggles the function of the two ports. One port is for a plotter and one for remote control. When the GPIB port is set to be the plot output, the message Plotter Listen Only appears under line 5 and the GPIB menu is not selectable.

3.27.2 External Plotter

This option is used to select the function of the GPIB and RS423 ports. Pressing button 5 toggles the function of the two ports. One port is for a plotter and one for remote control. When the GPIB port is set to be the plot output, the message Plotter Listen Only appears between lines 5 and 6.

In addition to the standard HPGL plotter output, the Classic series of instruments support HP DeskJet printers via the rear panel parallel port.

3.27.3 Bulk Transfer

This option is used to select the data format for bulk transfers. The format can be either BINARY, or TEXT. Binary mode is not compatible with RS423 communications using XON/XOFF handshaking because of the special handshaking characters which could also appear as data characters. In binary mode the data is transmitted as 'Definite Arbitrary Block Response Data'† and is in the form #NLDDD...DD.

Where:

N is a single digit and is the length of the length data. It will be either 1, 2 or 3

L is the length of the data transmission in bytes. This could be one two or three digits long.

DDD...DD is typically 502, 5020, 10040, 50200, 100400, or 200800 bytes of binary trace data as used by the scope. Segmented stores have the same number of bytes as non segemented stores.

In TEXT mode each item of trace data is converted to ASCII data before transmission as 'Numeric Response Data'† in the number base defined by the Radix entry.

3.27.4 Radix

This line only appears if the data format for bulk transfers is set to text. The numeric base for the data can be selected to be OCTAL, DECIMAL or HEXADECIMAL.

When set to OCTAL, each data byte is preceded by #Q and the data is 'Octal Numeric Response Data'†.

When set to DECIMAL, the data is 'NR1 Numeric Response Data'†.

When set to HEXADECIMAL, each data byte is preceded by #H and the data is 'Hexadecimal Numeric Response Data'†.

† Definite Arbitrary Block Response Data, NR1 Numeric Response Data, Octal Numeric Response Data, and Hexadecimal Numeric Response Data are all defined in the IEEE–488.2 specification and their use in the DSO conforms to that standard.

3.27.5 Bulk Word Size

When performing bulk transfers, the word size can be set to be either 8 bits or 16 bits by pressing button 8.

When transferring 16 bit data in Binary mode, the high and low bytes are sent alternately, high byte first.

When transferring 16 bit data in Text mode complete 16 bit words are sent.

3.28 RS423 Setup Menu

This menu allows the RS423 communication parameters to be set.

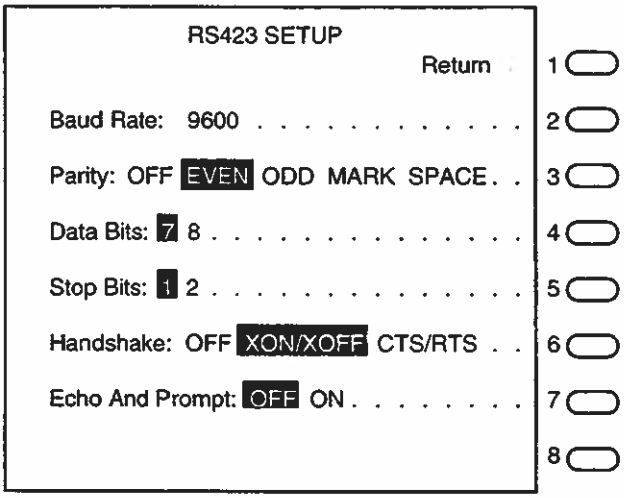


Figure 3.28 RS423 Port Menu

Data communication is always with one start bit. Other data parameters can be set using buttons 2 to 7.

Baud Rate: Pressing button 2 steps around the possible baud rates which are 110, 300, 600, 1200, 2400, 4800, 9600 and 38400 baud.

Parity: The parity can be set to NONE (Off), EVEN, ODD, MARK or SPACE by successive presses of button 3. When the parity is set to Mark, the parity bit is always sent and it is always set to a logic 1. When the parity is set to Space, the parity bit is always sent and it is always set to a logic 0.

Data Bits: Each byte of data can be sent as either 7 or 8 bits as shown by the highlighted option selected with button 4.

Stop Bits: Either one or two stop bits can be sent as selected by button 5.

Handshake: Communication handshaking can be set using button 6. Handshaking can be turned off or set to XON/XOFF (software) or CTS/RTS (hardware) handshaking.

Echo & Prompt: This line only appears when the RS423 port is set to remote. All characters sent to the DSO will be echoed back to the transmitting device and a prompt sent to the user if this option is set to On using button 7.

3.29 GPIB Menu

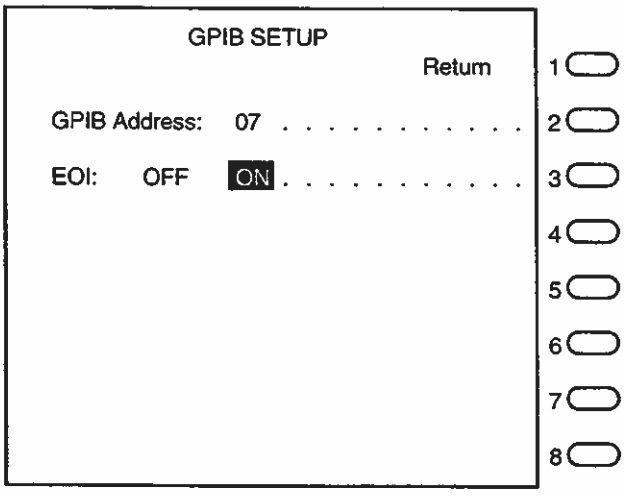


Figure 3.29 GPIB Menu

GPIB Address: The GPIB address can be set to any number from 1 to 31 by pressing button 2. The DSO is then in numeric entry mode and the required address number is entered by pressing the appropriate numeric buttons.

EOI: EOI (End or Identify) can automatically be inserted at the end of each transmission if ON is selected with button 3. The EOI is a dedicated bus line which can be used in addition to carriage return and line feed to denote the end of a transmission and/or the end of a block.

If the GPIB port is selected as the plotter port then this menu is not available.

3.30 Storage Devices

The instrument is fitted with an internal RAM disk as standard and can optionally have up to three other factory fitted storage devices, an internal 1 Mbyte RAM disk, a floppy disk drive and a 500 Mbyte hard disk drive.

The standard internal RAM disk is a 45 kByte battery backed memory.

CAUTION: The battery for the RAM disk is guaranteed to maintain the memory for one month, without power connected to the instrument, assuming that the battery was initially fully charged. Beyond this period, data may be lost if the battery power becomes too low. If the battery power does fall too low, RAM–corruption will occur and when the instrument is next switched on, the instrument will perform a System Reset and reformat the RAM disk.

To avoid loss of data, it is therefore recommended that either valuable data is stored on floppy disk or that the instrument is periodically switched on for at least 2 hours to ensure that the battery is regularly recharged.

The floppy disk drive is a 3.5" high density, 1.44 MByte industry standard MSDOS format drive, enabling data to be transferred to a PC for further processing or storage.

All storage devices are used in the same way and have the same memory and file structure as shown in figure 3.18.

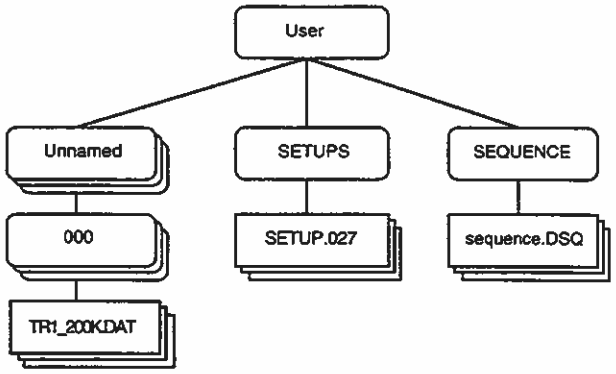


Figure 3.30 Memory File Structure

The boxes with round corners represent storage areas (folders) for each kind of data file and the square cornered boxes represent the actual data files.

The Save/Recall menus are used to save and recall traces or setups from or to the instrument. To copy previously saved information between storage devices, the Copy command is used. The Copy command is selected from the Save/recall options menu.

Up to 100 users can be created and named on each storage device so that individuals can save and recall their own information in their own area.

Any combination of traces, sequences and setups can be saved on any storage device so long as there is space available.

Traces, sequences and Setups can only be saved in their own folders.

The names shown are the default names provided by the instrument. The items shown in upper case are fixed and cannot be changed but all other items can be named or re–named by the user.

The first time a device is used, most users will want to specify the names to be used for the storage areas but thereafter it is simply necessary to press the Save button to save the selected items in the required storage areas.

3.30.1 File names

Trace files are saved in the Unnamed area with the extension (the three characters after the period '.') .DAT so that the trace data can be recognised by ProView, a PC program from Gould for the fast analysis and monitoring of signals or by Transition, a PC program from Gould for the transfer and acquisition of trace data.

The first eight characters of the trace file name describe the trace name and the data length, e.g. TR3_50K.DAT would be the name for a trace file of a 50 K trace from trace 3. The 50K part will change to 200k for a 200,000 point trace, 10K for a 10,000 point trace, 5K0 for a 5,000 point trace and 500 for a 500 point trace.

If the user does not specify a run name, the storage area will be called UNNAMED

Setup files are saved with a user specified name of a maximum of eight characters and a numerical extension 027. If a name is not specified, the Setup will be saved as UNNAMED.027.

Graph, Histogram and FFT files are each saved in their own format in the form ANA_TR1.XXX.

ANA shows that the trace is an ANAlysis trace and TR1 is the trace name from which the trace originates. This can be from TR1 to TR8.

Graphs are saved with the extension .GRH
Histograms are saved with the extension .HST and
FFTs are saved with the extension .FFT.

3.31 Save/Recall Menu

Traces, sequences and instrument setups can be saved and recalled to any of the installed storage media using the save/recall menus.

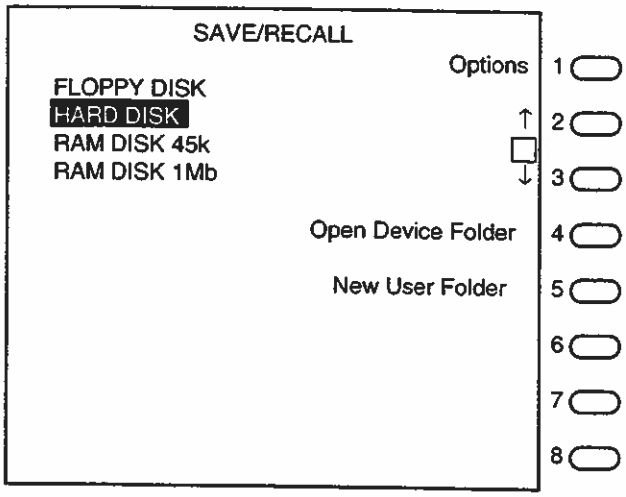


Figure 3.31.1 Basic Save/Recall Menu

The folder (or directory) structure of the storage devices is shown diagramatically on the left–hand side of the Save/ Recall Menus. This structure can be expanded and contracted as desired so that the particular storage area is clearly shown, together with the contents of that area.

To expand a folder, move the highlight using buttons **2** and **3** and press button **4** which is labeled Open Folder.

To contract a folder move the highlight onto an opened folder and press button **4** which will now be labeled Close Folder.

To create a new user, press button **5** and insert the new name from the displayed entry pad. When the name is correct, press button **1**, Done, and a new user folder will be created together with three sub folders called Sequence, Setups and Unnamed.

To save a trace, sequence or setup, the required storage device must be expanded until an appropriate folder for the item in question is highlighted. When a legal location is highlighted, button **4** will be labelled save and it, or the save button (20), can be pressed to save the item.

The save button (20) can be used at any time to save using the location previously set in the Save/Recall menu. If an appropriate area is not selected, pressing the save button (20) will cause the Save/Recall menu to be displayed prompting the user to select the correct folder.

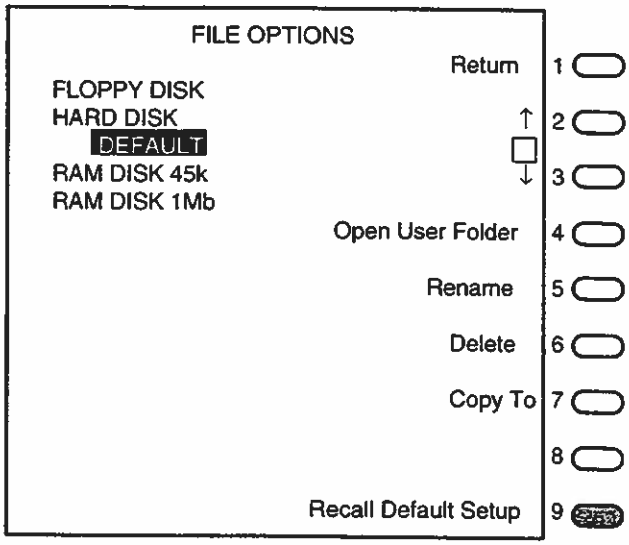


Figure 3.31.2 A Typical File Options Menu

Various utilities are available by pressing the button **1**, Options. The menu will change as shown in the typical example in figure 3.31.2 above.

To rename the selected item, press button **5** and enter the new name on the entry pad that is displayed. This is useful to rename the trace folder, which is initially called Unnamed, so that a number of different trace folders can be created each storing traces from for example different tests.

To delete the selected item simply press button **6**. A second press is then required to confirm that the selected item is to be deleted.

To copy the selected item, press button **7** and then select the destination device using buttons **2** and **3**. The title of the menu changes to show that a copy operation is in progress and the source is shown at the top of the menu. The destination can be the same or a different device. Once the required destination has been selected, press button **1** which is labeled Copy.

If required, the copy can be saved with a different name by pressing button **7** from the Copy menu which is labeled Copy As. The new name is entered using an alphanumeric entry pad. When the required name has been inserted, press button **1** (Done) to start the copy process.

When copying, remember that trace files can only be saved in run folders, sequences in sequence folders and setups in setup folders. If an illegal destination is selected, button **1** will not be labeled copy.

If a file is selected in the option menu, button 8 becomes the File Details option. Pressing this button changes the display to show information about the selected file and about the device it is saved in. This can be used to see how much free space there is on the device.

Button 9 (6000/6100/7200)

Recall Default Setup

Pressing this button will return the instrument to its original default setup. To set the file formats use button on the menu

Button 9 (6500/9500)

FILE FORMAT: DAT WMF TIFF TXT

This button is used to select the file format for saving screen pictures. The options are DAT which produces a standard classic data file suitable for recalling at a later date, WMF – Windows Meta File, TIFF – Tagged Image File Format and TXT which produces an ASCII text file suitable for use on a computer in spreadsheets or other data manipulation programmes. To recall the default setup use button 9 on the Status Menu.

Buttons 5 & 6 If a device is selected in the options menu, button 5 becomes Format and button 6 becomes Optimise.

Before devices can be used by the instrument to store data, they need to formatted using the format device operation. The format operation not only formats the device but also creates the default storage areas as shown in figure 3.30. Unless the default areas are present, the instrument will be unable to complete save, recall or copy operations.

To format a device, select the required device from the displayed list using buttons 2 & 3.

When the device to be formatted is highlighted, press button 1. A message asking for confirmation that the device is to be formatted will appear. Press button 1 again to confirm the action or press any other key to avoid formatting the selected device.

WARNING Once a device has been formatted, any information that was previously stored on it will be lost forever.

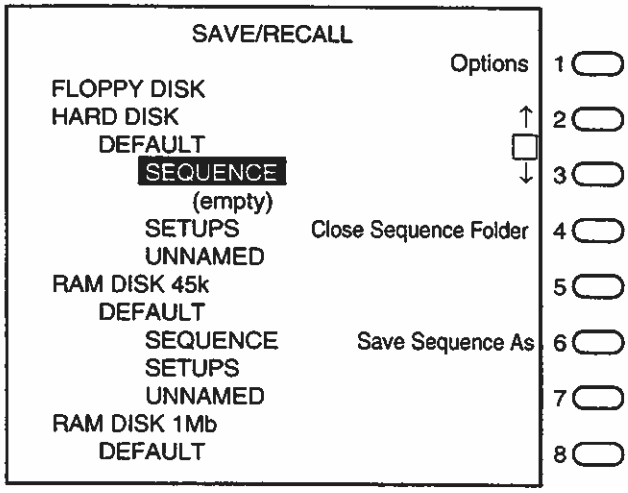


Figure 3.31.3 A Typical expanded Save/Recall Menu

The menu shown above has had several folders opened and it can be seen that there are no sequences stored in the default user's sequence directory.

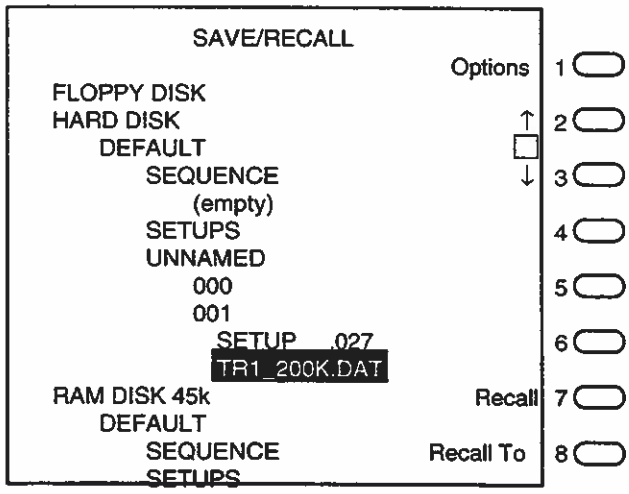


Figure 3.31.4 A Typical Save/Recall Menu –Recall Trace

In the menu shown above (figure 3.31.4) it can be seen that Trace 1 has been selected from run number 001 and if button 7 is pressed it will be recalled as trace 1. To recall it to a different trace press button 8 and select the destination trace from the displayed list. Finally, to actually recall the trace, press button 1.

To recall just a trace or a setup, select the item as described above.

To recall all traces and the setup at the same time, select the folder in which the required files are save and press button 6 which is labeled Recall Traces and Setup.

3.32 Memory Menu

The selection of the memory length for trace acquisitions is controlled by the Memory menu. This menu is obtained by pressing the Memory button (3).

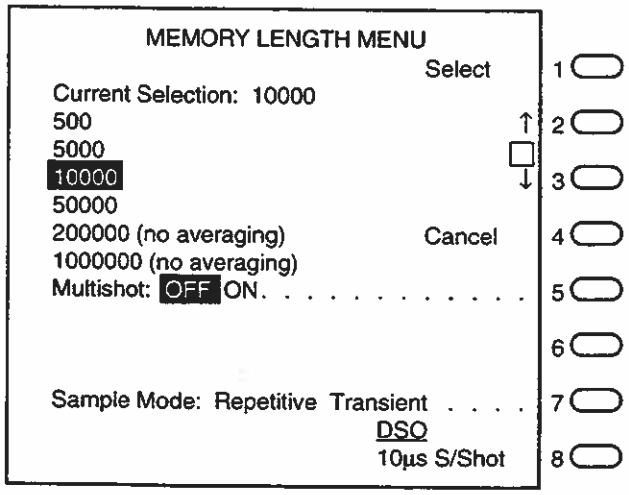


Figure 3.32.1 Memory Length Menu

Memory Length To change the memory length to be used for acquisitions and traces, press either button 2, 5 or 7. To activate the change, a second press of the button is required and is prompted for by the message PRESS AGAIN TO CONFIRM.

WARNING: Changing the memory length impacts on several areas of the instrument's operation. This feature should be used with care.

The maximum timebase, the number of memories and the maximum zoom factor all vary depending on the memory length selected as shown in the menu.

When the memory length is changed, the instrument will attempt to keep the same timebase and zoom parameters if they are permissible for the chosen new memory length. If a particular zoom factor or timebase is not possible, the nearest allowable value will be set.

e.g. If the instrument is set to a zoom factor of ×200 with a memory length of 10 k, changing memory length to 0.5 k will result in the zoom factor being set to ×10.

When changing from a longer memory to a shorter memory the timebase will not change, but changing from a shorter memory to a longer memory may result in the timebase being changed.

Averaging is not available with memory lengths of 200000 or greater.

MultiShot When multishot is turned on, the display is split into a series of separate acquisitions or segments which are displayed as continuous traces.

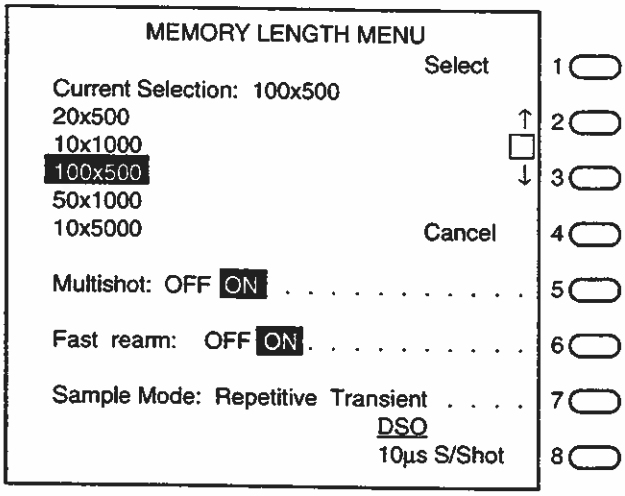


Figure 3.32.2 Memory Length Menu – Multishot

The length and number of segments that the display can be split into vary according to the memory available as shown below:

Segments	10 k	50 k	200 k	1 M
20 × 500	✓	✓	✓	✓
10 × 1000	✓	✓	✓	✓
2 × 5000	✓	✓	✓	✓
100 × 500		✓	✓	✓
50 × 1000		✓	✓	✓
10 × 5000		✓	✓	✓
5 × 10000		✓	✓	✓
2 × 25000		✓	✓	✓
400 × 500			✓	✓
200 × 1000			✓	✓
40 × 5000			✓	✓
20 × 10000			✓	✓
10 × 20000			✓	✓
8 × 25000			✓	✓
4 × 50000			✓	✓
2 × 100000			✓	✓
2000 × 500				✓
1000 × 1000				✓
200 × 5000				✓
100 × 10000				✓
50 × 20000				✓
40 × 25000				✓
20 × 50000				✓
10 × 100000				✓
5 × 200000				✓
2 × 250000				✓

Each segment of the display becomes a separate acquisition which is started by a trigger in the normal way.

Multishot becomes useful if there are a number of events that need to be captured with an appreciable time between events. Instead of setting the instrument to a very slow timebase, the timebase can be kept fast so that the horizontal resolution can be maintained. Each time a trigger is received, the next segment will be acquired.

Cursor measurements made across segments will show the actual time between events and not the apparent time according to the number of screen divisions between events.

Fast rearm When fast rearm is on, the instrument rearms ready for the next acquisition as fast as it can and the display is not updated until all the segments have been acquired. The rearm time is approximately 100 µs. Obviously if there are minutes or hours between each trigger, the time between display updates will be very long.

When fast rearm is on, the display will show the message "Waiting for trigger" even though the trigger light is occasionally flashing to indicate triggers. This is because the display is waiting for all the segments to be acquired.

When there is a long time between triggers it may be better to turn off fast rearm so that the display will update each segment as it is acquired.

3.33 Trace View Menu

The selection of which traces are to be displayed when the DSO is in Main, Zoom or Main & Zoom mode is controlled by the Trace View menu.

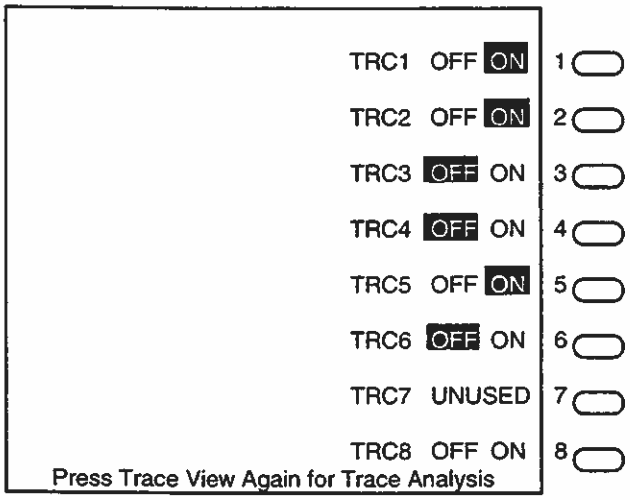


Figure 3.33 Trace View Menu

This menu is obtained by pressing the Trace View button (40) which cycles around the Trace View Menu, the Trace Analysis Menu and the normal trace display. Three versions of this menu exist, one for Main only, one for Zoom only and one for Main & Zoom. The version that is displayed depends on the current display mode as set by the Main/Zoom button (41).

If no signal has been mapped to a particular trace, the annotation alongside the trace button will say Unused.

To map signals to traces, press the Trace View button a second time to get the Trace Analysis Menu.

3.33.1 Main & Zoom mode

To turn traces On and Off while in Main & Zoom mode, the numeric buttons 1 to 8 should be used.

Each button is labeled with its trace number and OFF M Z. M stands for Main and Z stands for Zoom. Each press of the numeric button cyles round the sequence: OFF, M, Z, M & Z and OFF etc.

3.33.1 Main Only and Zoom Only modes

To turn traces On and Off in Main only or Zoom only modes, use the appropriate numeric button which will be labeled with the trace number e.g. button one is labeled TRC1.

3.34 Trace Analysis Menu

To set trace analysis or to display an input channel, the Analysis menu is used. This is obtained by a second press of the Trace view button (40).

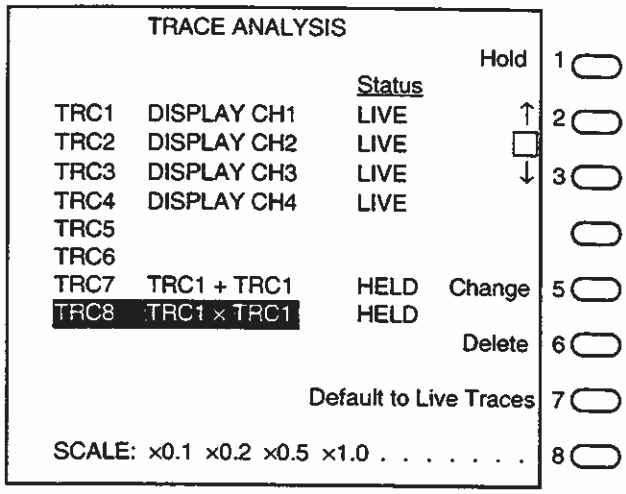


Figure 3.34 A Typical Trace Analysis Menu

When performing any waveform processing that modifies a displayed trace, the new data could be overwritten almost immediately by a fresh acquisition unless the selected trace is held or further acquisitions are prevented e.g. the instrument is in single shot mode and the trace stored. If the instrument is not in this state, the processing will be shown as LIVE.

Trace manipulations are with respect to the voltage datum line.

To stop the highlighted analysis function, press HOLD **1** in this menu.

To change the content of a trace, select it using buttons 2 and 3 and press button 4, change. The Analysis Functions menu is then displayed. Note that traces 1 to 4 only can display their respective input channels. The channel signal can be simply displeyed or it can be filtered, integrated, differentiated or inverted.

Default Pressing button 7 will set the instrument back to displaying Traces 1–4 as live views of channels 1–4.

3.34.1 Analysis Functions Menu

The required analysis is selected from this menu. The traces or channels involved in the analysis are then chosen using the Source Trace menu. The status of all analysis functions are shown on the Trace Analysis Menu.

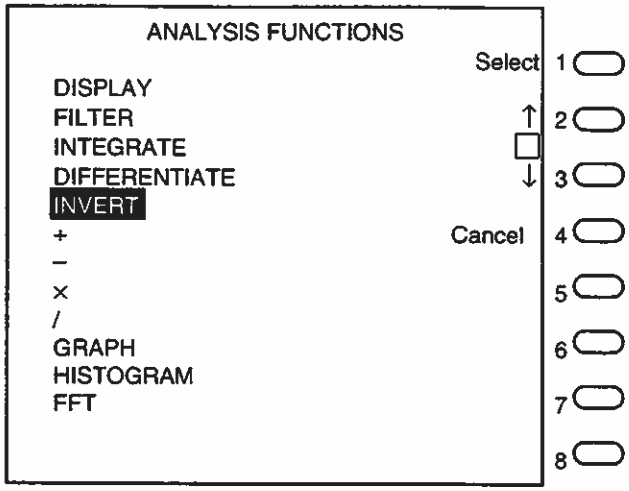


Figure 3.34.1 Analysis Functions Menu

Select To confirm that the analysis selected with buttons **2** and **3** is the required function, press button **1** and the display will change to the Source Trace menu.

Functions

Note: All functions after invert, i.e. +, –, ×, /, graph, histogram and FFT can only be applied to traces 5–8.

Filter The trace or channel can be filtered by a simple low pass filter and the 3 dB point displayed on the trace display.

The frequency of the filter applied to the waveform is selected from the Analysis Status menu after the source trace entry is complete.

Integrate The display will show the integrated waveform of the selected trace or channel. The voltage datum is taken as zero for integration and the cursor reads out the value of the area under the original curve between the time datum and the cursor in Vs – volt–seconds – or similar units.

To allow an integrated waveform to fit on the screen a scaling factor can be applied to the integrate function using button **8** in the Trace Analysis menu.

Differentiate The display will show the differentiated waveform of the selected trace or channel. The voltage datum is taken as zero for differentiation.

To allow a differentiated waveform to fit on the screen a scaling factor can be applied to the differentiate function using button **8** in the Trace Analysis menu.

Invert The selected trace or channel will be inverted about the voltage datum. Any cursor measurements will be made on the inverted waveform.

+ The selected traces will be added together. Each point on the resultant trace will the sum of the voltages from the equivalent points on the two source traces.

– The second trace will be subtracted from the first trace.

× The selected traces will be multiplied. To allow a multiplied waveform to fit on the screen a scaling factor can be applied to the multiply function using button **8** in the Analysis Status menu.

/ The first selected trace will be divided by the second trace.To allow a divided waveform to fit on the screen a scaling factor can be applied to the multiply function using button **8** in the Analysis Status menu.

Graph Graphing will produce a trace of a selected measurement result so it may be seen how a measurement value varies over time. The graph parameters are set using the Graph Parameter menu which is obtained by pressing button **8** from the Analysis Status menu. See section 3.34.4.

Histogram Histograms will show the spread of a measurement result with like values being placed into bins to build up a histogram of the measurement. The histogram parameters are set using the Histogram Parameter menu which is obtained by pressing button **8** from the Analysis Status menu. See section 3.34.5.

FFT An FFT will be performed on the selected trace or channel. Various parameters for the calculation can be set from the FFT parameters menu, see section 3.34.3.

3.34.2 Analysis Source

Once an analysis function has been chosen, the display will change to the Source Trace menu.

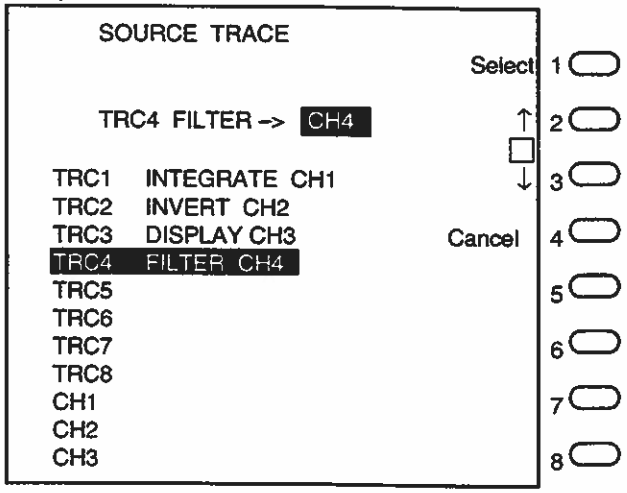


Figure 3.34.2 Analysis Source Menu

Select the required source trace using this menu by highlighting the required trace using buttons **2** and **3**.

Select To confirm that the trace selected with buttons **2** and **3** is the required source trace, press button **1**.

For some analysis functions such as add, a second source trace is required. For these functions the Source Trace menu will remain displayed after the select button has been pressed but the highlight in line 2 will move to the second source trace, allowing the user to select the required second source from the list, again using buttons **2** and **3**.

If a destination trace is also required, the display will change to the Destination Trace menu which is similar to the source trace menu except that the destination trace is to be chosen.

Pressing select from the Destination Trace menu will cause the display to change to the Analysis Status menu.

Scale: When Integrate, Differentiate, Divide or Multiply is selected as the operation, the scale line next to button **8** on the Trace Analysis menu appears so that a scale factor can be applied to the calculation result to allow it to fit on the screen. Pressing button **8** steps around the available factors. For Integrate, Divide and Multiply, the factors are ×0.1, ×0.2, ×0.5 and ×1.0. For Differentiate the factors are ×0.5, ×1.0, ×2.0, ×5.0, ×10, ×20 and ×50.

Filter Frequency: If a filter operation is shown and highlighted, the frequency of the 3 dB point of the simple low pass filter is shown on line 8.

The frequency of the filter applied to the waveform is selected using button **8**.

One of six filter stages can be chosen from the roll–around list. The actual frequencies available depend on the timebase at which the selected trace was acquired and is determined by the following equation:

$$\frac{Ff}{Timebase}\ Hz$$

Where:

Ff is one of 5.44, 2.46, 1.15, 0.547, 0.261, 0.124

Timebase is in seconds per division

Memory Length is in sample points

e.g. for a timebase of 2 ms/div the first filter frequency will be:

$$\frac{5.44}{2e{-}3} = 2.72\ kHz$$

If external timebase is selected, the filter factors on line 8 simply become a number between 1 and 6.

Defaults: Pressing button 7 returns the Trace displays to the instrument's default setting of Traces 1 to 4 displaying Channels 1 to 4 respectively.

3.34.3 FFT Parameters Menu

This menu controls the variable parameters associated with an FFT analysis. A windowing function may be selected, and linear or log scales selected for the horizontal (frequency) and vertical axes.

For more information see the Gould Publication *Exploring the Frequency Domain.*

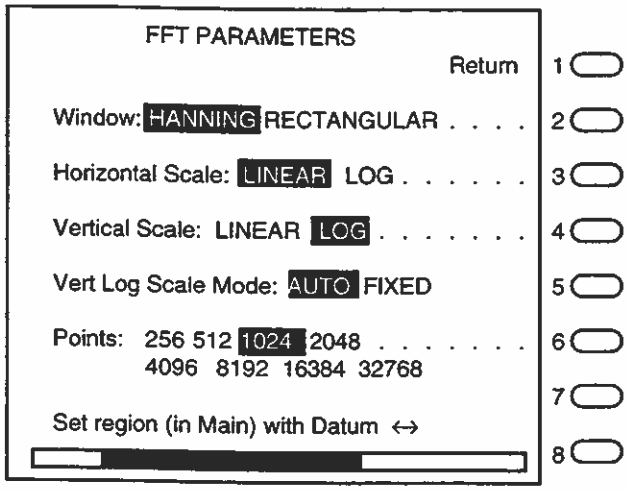


Figure 3.34.3 FFT Parameters Menu

Window: Either a rectangular or Hanning type FFT window can be selected by pressing button 2 to select the required type.

Horizontal Scale: The horizontal scale of the FFT can be set to either Linear or Logarithmic using button 3.

Vertical Scale: The vertical scale of the FFT can be set to either Linear or Logarithmic using button 4.

Points: The number of FFT points can be set using button 6. The portion of the trace to which the points will apply can be set using the datum paddle. The number of point available depends upon the current memory length. On the 6500/9500 instruments, the number of points always defaults to the maximumn available unless over-ridden by the user.

The bar within the box at the bottom of the screen moves to show approximately which part of the trace will be used.

3.34.4 High Resolution FFTs

On instruments fitted with Hi Res (6100 & 7200), FFTs are calculated using all the data available. Figure 3.34.4a shows the FFT of a sinewave that contains some harmonic distortion. The FFT is averaged and shows the noise floor 140 dBV from the top graticule. The harmonics can be clearly seen and a measurement is made with the cursor positioned on the 58th harmonic.

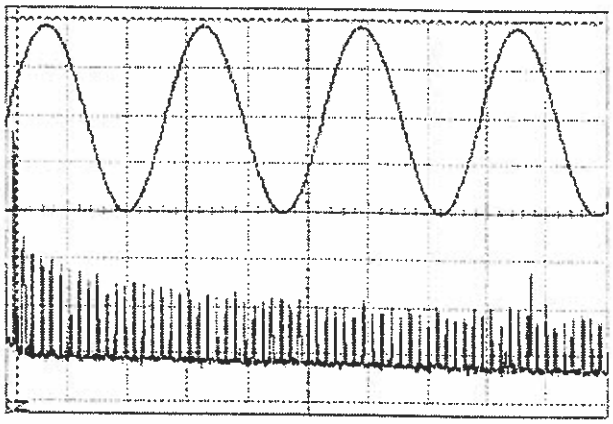


Figure 3.34.4a FFT of a sinewave with harmonic distortion.

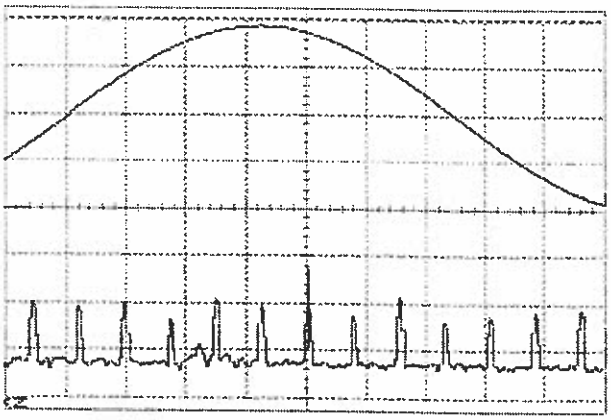


Figure 3.34.4b The FFT from figure 3.34.4a expanded to see individual harmonics.

3.34.5 Graph Parameters Menu

Graphing will produce a trace of a selected measurement result so it may be seen how a measurement value varies over time.

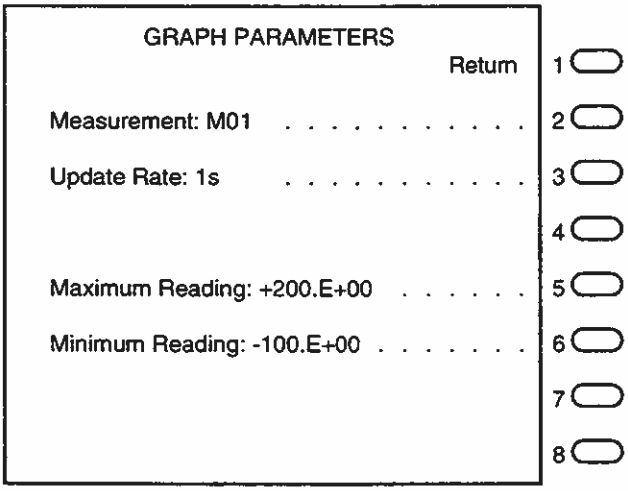


Figure 3.34.5 Graph Parameters Menu

Once graphing is in progress, the cursor and vertical datum lines become locked. It is not possible to move them until the graphing function has been stopped. The function is stopped by means of the Hold button **1** that appears in the Trace Analysis menu when graphing is in progress..

The resultant trace produced by the graphing process cannot be treated as a normal acquisition trace because its horizontal and vertical scalings are different.

Result graphs will only work in refresh mode. If roll mode is selected when a graph is being produced it will stop being updated.

If the volts time measurement is done on a result graph trace, the following results will be produced: In absolute mode the voltage reading will give the value of the selected measurement at that point and the time reading will give the time in seconds of the reading with the start of the graph being taken as zero time. In delta mode the datums are used to define the zero points for the readings.

Any attempt to change any of the following parameters whilst graphing is in progress will result in the message LOCKED WHEN GRAPH RUNNING being displayed. To change a parameter, first stop graphing.

Measurement: This line displays the measurement that will be graphed, taken from the calculations in the Measurement Functions menu.

Update Rate: This line is used to set the update rate for graphing. This is the rate at which measurement values are added to the results graph. This means that the X axis will be time related. The rate can vary from full acquisition rate – ACQ (i.e. one measurement added per acquisition, where results will be duplicated) through to 100 seconds. The full list of possible values is ACQ, 1 s, 2 s, 5 s, 10 s, 20 s, 50 s and 100 s.

This will give an X axis scaling of 500 seconds full scale at 1 second to 50,000 seconds full scale at 100 seconds.

Maximum Reading: Button **5** is used to enter the value of the measurement corresponding to the top of the screen using the Graph Max Reading Entry pad. The maximum allowed value is ±1E±30.

Minimum Reading: Button **6** is used to enter the value of the measurement corresponding to the bottom of the screen. The minimum allowed value is ±1E±30.

3.34.6 Histogram Parameters Menu

Histograms will show the spread of a measurement result with like values being placed into bins to build up a histogram of the measurement.

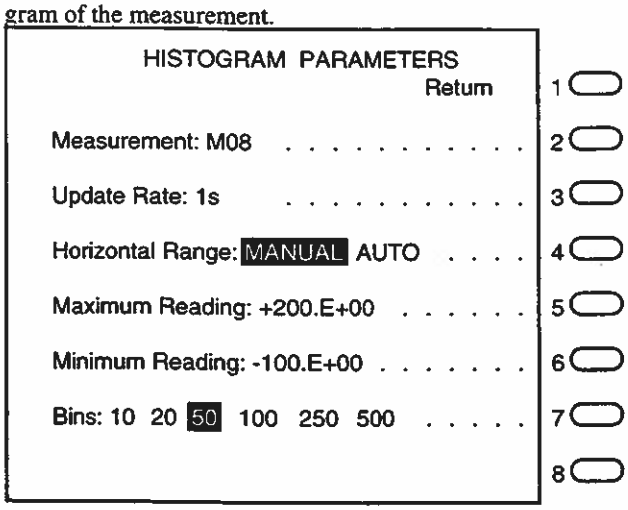


Figure 3.34.6 Histogram Parameters Menu

While the instrument is producing histograms, the cursor and vertical datum lines are locked. It is not possible to move them or change the selected cursor trace until the histogram function has been stopped. The function is stopped by means of the Hold button **1** that appears in the Trace Analysis menu when histograms are in progress.

The resultant trace produced by the histogram function cannot be treated as a normal acquisition trace because its horizontal and vertical scalings are different.

Histograms operate in the same way as Graph results except that the display is accumulated up the screen. This produces a histogram of measurement value along the X axis against number of occurrences on the Y axis.

When a measurement reading is taken it will be placed into the appropriate bin if it lies within the minimum and maximum readings, otherwise it will be discarded. The bin into which it is placed is be calculated from the range (the maximum reading minus the minimum reading) and the number of bins.

If the volts–time measurement is done on a histogram trace, the voltage reading will give the number of occurrences of the selected bin and the time reading will give the measurement range for the selected bin.

Any attempt to change any of the following parameters whilst graphing is in progress will result in the message LOCKED WHEN HISTOGRAM RUNNING being displayed. To change a parameter, first stop histograms.

Measurement This line displays the measurement to produce a histogram, taken from the calculations in the Measurement Functions menu.

Update Rate This item is used to set the update rate for histograms. This is the rate at which measurement values are added to the histogram. The rate can vary from full acquisition rate – ACQ (i.e. one measurement added per acquisition, where results will be duplicated) through to 100 seconds. The full list of possible values is ACQ, 1 s, 2 s, 5 s, 10 s, 20 s, 50 s and 100 s.

Horizontal Range Vertical scaling is automatic and is arranged such that the histogram will always use as much of the height of the display as possible. The horizontal scaling, however, can be set to be either automatic or manual using button 4.

In automatic mode, the number of bins will start at the number set in line 7 but if more are required, the quantity will automatically increase to the next available number up to a maximum of 500.

In manual mode, the number of bins will be as set in line 7 and if more are required an underflow and overflow bin will be created.

Maximum Reading Button 5 is used to enter the value of the measurement corresponding to the right hand side of the screen. The maximum allowed value is ±1E±30.

Minimum Reading Button 6 is used to enter the value of the measurement corresponding to the left hand side of the screen. The minimum allowed value is ±1E±30.

Bins Button 7 is used to set the number of bins into which the measurement results are put. The selection rolls round the following set of values; 10, 20, 50, 100, 250 and 500.

4. PERFORMANCE CHECKING

The aim of this section is to allow the user to verify the major analog performance parameters. Should any of these fail to be within specification, then it is recommended that the instrument be repaired or re-calibrated as necessary. Return the instrument to your local distributor - alternatively, a skilled technician with the aid of the calibration procedure will be able to perform a re-calibration.

4.1 Bandwidth

Equipment Required:

Leveled signal generator: Tektronix SG503 or similar;

50 coaxial cable.

Connect the signal generator to a channel input (set to 50) through the coax cable.

1. Select 10 mV per division on the input channel and set the timebase to 50 s per division.
2. Set the amplitude of the signal generator to give 6 divisions at 50 kHz or similar reference frequency.
3. Increase the frequency of the signal generator until the peak to peak amplitude reduces to 4.2 divisions.

The measured frequency should be greater than 200 MHz (500 MHz for 9500). Repeat for remaining channel inputs.

4.2 Trigger Sensitivity

Equipment Required:

Signal generator: Tektronix SG503 or similar;

50 coaxial cable.

Connect the signal generator to a channel input (set to 50) through the coax cable.

1. Select 10 mV per division on the input channel and set the timebase to 50 s per division.
2. Select **Auto** trigger.
3. Set the signal generator to 50 kHz or similar reference frequency and adjust the amplitude to give 3 divisions peak to peak.
3. Set the input channel to 100 mV per division.
4. Select **AC** coupling and **Norm** on the trigger controls.

Adjust trigger level control to obtain a continuously updating and stable display.

Repeat for remaining channel inputs.

4.3 Trigger Bandwidth

Equipment Required:

Signal generator: Tektronix SG503 or similar;

50 coaxial cable.

Connect the signal generator to a channel input (set to 50) through the coax cable.

1. Select 500 point memory length (Memory menu). Select 100 mV per division on the input channel and set the timebase to 500 ns per division.
2. Select **Auto** trigger. Set the signal generator frequency to 200 MHz (500 MHz? for 9500) and adjust the amplitude to give 1.5 divisions peak to peak.
3. Select **AC** coupling and **Norm** on the trigger controls and set the timebase to 10 ns per division.

Adjust trigger level control to obtain a continuously updating and stable display.

Repeat for remaining channel inputs.

4.4 Timebase Calibration

Equipment Required:

Time calibrator: Bradley (Pulsetek) 192, Tektronix TG501 or similar;

50 coaxial cable.

Connect the signal generator to a channel input (set to 50) through the coax cable.

1. Set the calibrator to produce markers or pulses every 1 ms.
2. Set the timebase to 1 ms per division and set the channel attenuator to give between 2 and 5 vertical divisions of signal.
3. Select **DC** coupling and **Norm** on the trigger controls and adjust the trigger level to give a stable, continuously updating display.
4. Select Period measurement (Measure menu) from the channel in use and ensure parameters (key 8) are set to 'ALL-DATA' (bounds) and '% TOP-BASE' (crossing).

Check for a reading of 1.000 ms to within 0.1% (1 digit).

4.5 System Clock Accuracy

Equipment Required:

Time calibrator: Tektronix TG501 with Option 01 (5 parts in 10^7 accuracy),

digital counter timebase output (5 parts or less in 10^6 accuracy), or similar;

50 coaxial cable.

Connect the signal generator to a channel input (set to 50) through the coax cable.

1. Set the calibrator to produce markers or pulses every 1 ms (1 kHz repetition).
2. Set the timebase to 1 ms per division and set the channel attenuator to give between 2 and 5 vertical divisions of signal.
3. Select **DC** coupling, **+ Slope** and **Norm** on the trigger controls and adjust the trigger level to give a stable, continuously updating display.
4. Set the timebase to 1 s per division.
5. Select Post Trigger Delay (Trigger menu) and then set delay time to 000.009m995000n0s (9.995 ms). Return to trace display (press Menu/Traces).

Check for a **positive** pulse edge, crossing 50% amplitude, within 1 division either side of centre vertical graticule line. This indicates an accuracy of better than 0.01% (1 part in 10^4).

Note: Instruments produced December 1997 onwards should meet an improved specification of 0.0025%, therefore pulse edge as measured above should be within 0.25 division of centre line (0.25 parts in 10^4).

4.6 Vertical Calibration

(i) 6000/6500/9500

Equipment Required:

Oscilloscope voltage calibrator (0.25% or better accuracy): Bradley (Pulsetek) 192 or similar;

Coaxial cable.

Connect the voltage calibration output of the oscilloscope calibrator to a channel input, which must be set to 1M, through the coax cable.

1. Set the timebase to 500 s per division and select 10 mV per division for the input channel, with DC input coupling.
2. Set the calibrator to give 60 mV peak to peak square wave output, i.e. 6 screen divisions.
3. Adjust position controls and trigger level to give a stable, continuously updating display, central within the display area.
4. Select Averaging ON (Display menu) and set Averaging Value to 8.
5. Select Amplitude measurement (Measure menu) from the selected trace (SEL_TR). Ensure parameters (key 8) are set to 'ALL-DATA' (bounds) and 'STATISTICAL' (top/base). Return to trace display (press Menu/Traces). Press Select Trace to show measurements from the channel in use (e.g. 'TRIM' for channel 1).

Allow a few seconds for reading to stabilise and then check for a reading of 60.0 mV to within ± 2% + 0.4% F.S. (58.460 to 61.540 mV).

Note: Full Scale is 8.53 divisions (30 points per division) therefore 0.4% is equivalent to 0.034 divisions.
0.034 x 10 mV = 0.34 mV and 2% of 60mV = 1.2 mV, giving a total allowance of 1.54 mV.

Repeat for remaining channel inputs.

(ii) 6100/7200.

Equipment Required:

DVM voltage calibrator* (0.1% or better accuracy): Fluke 515A, Fluke 343A or similar;

Coaxial cable with 4 mm plug to BNC adapter.

* Alternatively, a stable DC source (e.g. an oscilloscope calibrator) monitored by a digital voltmeter of 0.05% or better accuracy and adjusted by variable control to be within ± 0.1% of nominal at 60 mV DC.

Connect the voltage output of the calibrator to a channel input, which must be set to 1M, through the coax cable and adapter.

1. Select **Hi Res on** (Channel menu). Set the timebase to 5 ms per division and select 10 mV per division for the input channel, with DC input coupling. Select **Auto** trigger.
2. Set the calibrator to give zero DC output and position the channel trace approximately 3 division below the centre horizontal graticule line.
3. Select 'Mean' measurement (Measure menu) from the selected trace (SEL_TR). Ensure parameters are set to 'ALL-DATA' and then return to trace display (press Menu/Traces). Press Select Trace to show measurements from the channel in use (e.g. 'TR1M' for channel 1).
4. Note the reading obtained with zero input. Select 60 mV DC output from the calibrator. Note the reading obtained and calculate the difference between the two readings. These 2 readings should be taken preferably within a few seconds of each other to ensure any effects of long term drift are minimised. If necessary, repeat readings to verify.

   The value obtained above should be 60.0 mV within ± 1% + 0.4% F.S. (59.06 to 60.94 mV).

Note: Full Scale is 8.53 divisions (30 points per division) therefore 0.4% is equivalent to 0.034 divisions.
0.034×10 mV = 0.34 mV and 1% of 60mV = 0.6 mV, giving a total allowance of 0.94 mV.

Repeat for remaining channel inputs.

5 Alphabetical Summary of Controls

A/B Trigger (14) This selects which of the A or B triggers and delays the Level (12) and Delay Paddles (22) control. **A** illuminates when the trigger controls are controlling the A trigger setup and **B** illuminates when the trigger controls are controlling B trigger setup.

AC/Gnd/DC (33) Controls the type of coupling between the instrument and the input signal. **AC** is used to remove DC components from signals above 4 Hz. **Gnd** internally disconnects the inputs from the instrument; a 0 V reference signal is displayed instead. **DC** couples the input signal directly to the instrument, so that all frequency components of the signal will be displayed.

Armed (8) Illuminates after **S/shot** is pressed; it will stay lit until either a valid trigger has been received and a single sweep has been completed or the **Run** or **Auto Setup** button has been pressed.

Auto Setup (45) Will attempt to arrange the instrument so that a stable triggered display of the applied signal is obtained. If the frequency of the input signal is less than 20 Hz, this function may not operate correctly.

Auto/Norm (29) Selects the trigger mode. **Norm** means that valid triggers must be received to initiate captures. **Auto** triggering is the same as **Norm** except that if no valid trigger has been received for 0.04 s, an artificial 'A trigger' will be generated to initiate a capture. This is only true for A triggering. B triggering is always Norm.

Cal Pins (34) A 1 V, ≈1 kHz square wave and a Ground reference are provided on these pins to enable probe compensation adjustments to be made.

Cancel (21) Used to stop a plot, abort a sequence or restore local control from the GPIB bus.

Channel (3) Selects the Channel Master Menu. This menu is used to select and control some features that affect channels. These are the 50 Ω Select, the Probe Gain Select, the Bandwidth/Calibration, the Channel Offset, the Channel Scaling and the Glitch Detect feature.

CH1/CH2/CH3/CH4/Line/Ext (24) Steps through the trigger sources.

CH1(X) (44) One of the four channel input sockets, this one being for the connection of signals up to ± 400 V peak to channel 1. It can also be a trigger source if selected using **CH1/CH2/CH3/ CH4/Line/Ext.**

CH2 (42) One of the four channel input sockets, this one being for the connection of signals up to ± 400 V peak to channel 2. It can also be a trigger source if selected using **CH1/CH2/CH3/ CH4/Line/Ext**

CH3 (38) One of the four channel input sockets, this one being for the connection of signals up to ± 400 V peak to channel 3. It can also be a trigger source if selected using **CH1/CH2/CH3/ CH4/Line/Ext**

CH4 (36) One of the four channel input sockets, this one being for the connection of signals up to ± 400 V peak to channel 4. It can also be a trigger source if selected using **CH1/CH2/CH3/ CH4/Line/Ext.**

CURSOR (6) Controls the left and right movement of the measurement cursor along the trace. This paddle can also used to select options in some menus.

DATUM (4) These two paddles control the movement of the time and voltage datum lines.

Position (22) This control varies the amount of Pre or Post trigger depending on the status of the Pre/Post switch (27).

Display (3) Selects the Display Master Menu. This menu is used to select and control features that affect the instrument's display. These are the Status Page, Averagin menu, X–Y control, Persistence Menu together with Trace Dot Join and Display Max–min controls.

50Ω (35) Illuminates when the relevant channel's input impedance has been set to 50Ω from the menu system.

hf rej/AC/DC (25) selects trigger coupling. The **hf rej** (high frequency reject) option is a 15 kHz low-pass filter. Any coupling may be used with any source except **Line** where the coupling is not selectable.

Hold All (13) instantly freezes the entire display irrespective of the acquisition status. The Hold All light is illuminated when that display is held.

Hold (25) instantly freezes an individual channel's display irrespective of the acquisition status. The Hold On light is illuminated when that channel is held.

Level (12) Adjusts the trigger level, which is indicated by two trigger bars on the display.

MAIN/ZOOM (41) Used to select which picture of the horizontal sweeps will be displayed. This can be either the main trace of a zoomed portion of the trace or both main and zoom. The indicators show the selection.

Measure (3) This button selects the Measure Master Menu. This menu provides access to sub–menus which affect measurement on captured traces.

Memory (3) Used to select the Memory Length menu. This menu allows the selection of 0.5 k, 5 k, 50 k or 200 k acquisitions.

Menu/Traces (2) Swaps the display between the last used menu and the trace display.

Numeric Keys (1) These keys are used in conjunction with the menu system to control the advanced features of the DSO. They are used for menu item selection and numeric entry.

On/Standby (52) Used to toggle the instrument between on and standby mode.

Plot (19) Initiates a plot output. The plot On light is illuminated during the plot sequence. Use the plot configuration menu to define the plot destination.

Position (26) Moves all traces horizontally relative to the graticule.

Position (30) Moves that channel's trace vertically relative to the graticule.

Pre/Post (27) Selects either Post Trigger Delay or Pre Trigger to be varied by the Position paddle (22).

Refresh (15) This is illuminated when the instrument is in refresh mode.

Refresh/Roll (16) This button controls the instrument's data capture and display mode. In **Refresh** the screen is updated from the left. In **Roll** the screen is updated from the right (chart recorder mode).

Roll (17) This is illuminated when the instrument is in roll mode.

Run (11) Puts the instrument in continuous capture mode. The instrument automatically rearms itself after each acquisition and updates the display continuously.

Save (20) Initiates a save operation as specified in the Save/Recall Menu.

S/Shot (9) Arms the instrument for a single-shot triggered acquisition sweep (capture). The **Armed** light (14) will be illuminated to show the status prior to a trigger event.

Save/Recall (3) Selects the Save/Recall Master Menu. This menu is used select the Save and the Recall function It is also used to copy memories and to format storage devices.

Select Trace (5) Places the cursor onto a displayed trace. Each successive press moves the cursor to the next available trace.

Special (2) This button selects the Special Master Menu.

Stored (10) Illuminates on completion of a single-shot acquisition. It will stay lit until the instrument is rearmed or until **Run** is pressed.

TIME/DIV (25) Controls the sweep rate of the Main display. The timebase can be varied from 20 ns/div to 50 s/div.

Trace Control (39) Selects which set of traces, either trace 1 to 4 or trace 5 to 8, will be controlled by the verical controls.

Trace View (40) Selects the trace view menu from which the choice of which Main and or Zoom traces are displayed. A second press of this button displays the Trace Analysis menu from which the instruments analysis functions can be selected.

Trig'd (7) This is illuminated –or flashes– when the relevant trigger system is receiving valid triggers.

Trigger (3) Selects the Trigger menus from which the required trigger can be set. When pressed, this button displays the current trigger setup.

Trig'd (7) This is illuminated –or flashes– when the relevant trigger system is receiving valid triggers.

TruTrace (18) Toggles the instrument between TruTrace display and standard DSO display.

Utility (3) Selects the Utility menu from which the Sequence, Test limits, Plot configuration, I/O setup and Preferences menus are avaliable.

Var (37) This is illuminated when the particular channel is in variable mode to show that the channel's V/DIV paddle will continuously vary the attenuation factor and not step the input sensitivity.

Var (31) Toggles the relevant channel between Variable and normal. When variable is selected, the coarse setting of the vertical attenuator remains unchanged, but a variable attenuation factor is applied to the input signal. The **V/DIV** paddle is used to vary the attenuation factor.

+/– (28) Selects triggering on positive or negative slopes.

Appendix 1: Screen Messages

When something is wrong or not allowed, an error message may be displayed. In some cases, a message appears to confirm that an action is occurring or has occurred. Brief explanation of when these messages occur are given below in alphabetical order:

** AUTO–SETUP **
: While the instrument is performing its Auto Setup routine.

ALL sequence steps in use
: If an attempt is made to use more than 240 steps in total in sequences.

argument expected
: GPIB/RS423 The argument to a command or a query is missing.

argument not known
: GPIB/RS423 does not recognize the argument to a command or query.

A TRIG:NOT IN USE
: If an attempt is made to change any of the A trigger settings when the A trigger is not in use.

A1

AUTHORIZATION CODE INVALID
: The wrong authorization cade was entered while trying to upgrade a software option.

Auto–Setup Cancelled
: If Cancel is pressed while the instrument is performing its Auto Setup routine.

AUTOSETUP ALREADY IN PROGRESS
: If AUTO SETUP is pressed during an autosetup.

AUTO CALIBRATING
: While the instrument is performing its Auto calibration routine.

AVERAGING DISABLED IN ROLL
: If averaging is selected while the instrument is in roll mode.

B TRIG:NOT IN USE
: If an attempt is made to change any of the B trigger settings when the B trigger is not in use.

Calibration Completed
: When an internal calibration is complete.

CANNOT EDIT WHILST RUNNING
: If an attempt is made to edit a sequence while it is running.

CANNOT GRAPH IN XY
: If an attempt is made to use graphing while the instrument is in XY mode.

CANNOT RUN WHILST EDITING
: If an attempt is made to run a sequence while in edit or learn mode.

CANNOT RUN WHILST RUNNING
: If an attempt is made to run a sequence that is already running.

CANNOT SET SCALING IN XY
: If an attempt is made to use measurement scaling while the instrument is in XY mode.

CANNOT TURN OFF TRACE 1 IN XY
: If an attempt is made to set channel 1 to OFF while in XY mode.

CHANNEL HOLD RESTRICTED BY SAMPLE RATE
: (Classic 9500 only) some channels are automatically held when in 1 or 2 GS/s sample rate mode.

command failed
: A GPIB/RS423 command was not correctly actioned.

command not known
: GPIB/RS423, An unknown command was received.

command only
: A query form of an instruction that is only a command was received.

DATA CHECKSUM FAILURE
: Following a data transfer to the DSO if the checksum does not calculate correctly.

data expected
: GPIB/RS423, data was expected in the command but was not received.

data not expected
: GPIB/RS423, data was not expected in the command but was received.

DESTINATION AS CURSOR TRACE
: If an attempt is made to set the destination trace to be the same as the cursor trace for either graphs or histograms.

DELAY TO SWEEP
: While a long trigger delay is in progress a countdown time is displayed.

ENTRY NOT ALLOWED IN SEQUENCE
: If an attempt is made to include one of the disallowed mas storage operations in a sequence.

ERROR: File line
: An internal software problem has occurred. Note the numbers and turn the DSO off and on to reset. Please inform your local service agent of the numbers.

ERROR SEQ. RECURSION NOT ALLOWED
: If an attempt is made while learning or editing a sequence to include a recursive step such as sequence 1 calling sequence 2 which then calls sequence 1.

excessive data
: GPIB/RS423, too much data was received.

GLITCH DETECT NOT AVAILABLE IN ETS
: If an attempt is made to turn on Glitch Detect while an ETS timbase is selected.

GRAPH RUNNING
If an attempt is made to start histograms while graphs are running.

GPIB dcas
When the DSO has received and actioned a IEEE 488.2 Device Clear command.

GPIB deadlock
A GPIB deadlock occurred because the DSO input and output queues were both full.

GPIB ifc
When the DSO has received and actioned an IEEE 488.3 Interface Clear command.

GPIB interrupted
A new program message was received before the entire response message had been read.

GPIB received GET
The GPIB GET (Group Execute Trigger) bus command has been received.

GPIB REMOTE
When the DSO is in GPIB remote mode.

GPIB unterminated
A response message was read before terminating the program message.

GPIB unexpected EOI
EOI was received during a command sequence when a further instruction or parameter was expected.

HISTOGRAM RUNNING
If an attempt is made to start graphs while histograms are running.

illegal data
GPIB/RS423 Data received by the DSO is not allowed. e.g. text where a number is expected.

illegal measurement
If an attempt is made to set graphs or histograms when a measurement that is not allowed is selected.

input too long
GPIB/RS423 The command sequence received by the DSO is too long.

invalid mode
GPIB/RS423 If an attempt to set up an invalid mode is made.

Invalid number entered
If an attempt to enter a number that is outside the permitted range for a particular feature.

invalid selection
GPIB/RS423 If an attempt is made to choose an invalid selection.

Invalid value entered
If an attempt is made to enter invalid data, such as some alpha characters instead of a number.

INVERTING
While a post storage trace inversion is occurring.

L.TEST AVAILABLE IN REFR ONLY
If limits test is selected and the instrument is not in refreshed mode.

LINE TRIG:AC hf–rej ONLY
If an attempt is made to set the coupling to anything other than AC hf–rej when the source is line.

LOCAL LOCKOUT
When the instrument is in local lockout mode.

LOCKED WHEN GRAPH IS RUNNING
If an attempt is made to change any graph parameters when a graph is running.

LOCKED WHEN HISTOGRAM RUNNING
If an attempt is made to change any histogram parameters when a histogram is running.

LOWER LIMIT SET
When a lower limit trace has been successfully set for limits testing.

Measurement: illegal data
When the specified *measurement* cannot be performed. e.g. when the cursor and datum do not enclose a repetitive waveform for a frequency measurement.

MIN IS NOT LESS THAN MAX
If an attempt is made to set the minimum value to more than the maximum value for either graphs or histograms.

NO AVERAGE IN 1M STORE LENGTH
If an attempt is made to select averaging when the instrument has a memory length of 1 M.

NO AVERAGE IN ROLL
If an attempt is made to select averaging when the instrument is in Roll mode.

NO ROLL MODE IN MULTISHOT
If an attempt is made to select Roll when the instrument is in Multishot mode.

No valid input
If autosetup cannot find a suitable input.

NOT COMPATIBLE WITH BINARY MODE
If XON/XOFF handshake is selected when in binary mode.

NOT COMPATIBLE WITH XON/XOFF
If binary mode is selected with XON/XOFF handshake already selected.

No Trigger Found
During Auto setup, a valid signal was recognised but the DSO was unable to trigger from it.

PLOT ABORTED, Flushing Buffer
After a plot has be aborted.

PLOTTER BUSY FOR 10 SECONDS
The DSO tried to communicate with the internal plotter but did not get a response. May be due to a faulty plotter or to the head being lifted during a plot.

PLOTTER FAULT
There is something wrong with the thermal plotter not covered by other messages.

PLOTTER HEAD RAISED
If an attempt is made to plot to the internal thermal plotter while its head is raised.

PLOTTER HOT – ALLOW TO COOL
If the internal thermal plotter gets too hot while it is plotting.

PLOTTER OUT OF PAPER
If an attempt is made to plot to the internal plotter and it runs out of paper.

PRESS AGAIN TO AUTOSETUP
If autosetup is pressed.

PRESS AGAIN TO CONFIRM
If an attempt is made to select 50Ω input termination or to change the Memory Length.

A1

query only
GPIB/RS423 If a command form of an query only instruction is received.

RS423 REMOTE
When the Instrument is in RS423 Remote mode.

SEQUENCE ABORT IN INPUT
If a sequence is stopped while it was at a wait for input step.

SEQUENCE ABORT IN PAUSE
If a sequence is stopped while it was at a pause step.

SEQUENCE ABORT IN WAIT
If a sequence is stopped while it was at a wait step.

SEQUENCE ALREADY RUNNING
If an attempt is made to run a sequence that is already running.

SEQUENCE EMPTY
If an attempt is made to run a sequence that has no steps.

SEQUENCE RUN ABORTED
If a sequence is stopped before it has reached the end and finished running.

SEQUENCE RUN COMPLETE
When a sequence has reached the end and finished running.

SETUP EMPTY
If the selected setup memory has not been used.

SETUP RECALLED
When a setup has been successfully recalled from memory.

SOFT KEY ALREADY ASSIGNED
If an attempt is made to asign a soft key to a sequence and the soft key has already been assigned to another sequence.

string expected
GPIB/RS423 Text enclosed by " " was expected but not received by the DSO.

THE CURSORs ARE OFF
If an attempt is made to set measurement scaling when the dataum and cursors are not on.

THE TIME CURSOR AND DATUM ARE THE SAME
If an attempt is made to use datum to cursor scaling when the dataum and cursor are at the same point.

Time entered Invalid
If an attempt to enter an invalid time is made such as 25:32:93.

TRACE COPIED
When a trace has been successfully copied to a reference trace.

TRACE RECALLED
When a trace has been successfully recalled from memory.

TRACE SAVED
When a trace has been successfully saved to memory.

TRIG:A & TRIG B COMMON SOURCE
If an attempt is made to independently set the two trigger sources while in TV trigger mode.

TRIG:NOT IN USE
If an attempt is made to change any of the A trigger settings when the A trigger is not in use or the B trigger settings when the B trigger is not in use.

TV TRIG:AC COUPLING ONLY
If trigger coupling is set to anything other than AC while TV trigger is selected.

TV TRIG:Changing sync
If an attempt is made to change the trigger slope from the front panel when in TV trigger mode.

TV TRIG:NO AUTO TRIGGER
If Auto trigger is selected when in TV trigger mode

TV TRIG:SLOPE DISABLED
If an attempt is made to change the trigger slope when in TV trigger mode.

TV TRIG: NO LINE TRIG SOURCE
If Line is selected when in TV trigger mode

UPPER LIMIT SET
When a upper limit trace has been successfully set for limits testing.

VALUE OUT OF RANGE
If the number entered is too large or small for the feature in use.

WAITING FOR TRIGGER A THEN B
If S/shot has been selected but no A and or B trigger has been received.

WAITING FOR TRIGGER A
If S/shot has been selected but no A trigger has been received.

WAITING FOR TRIGGER B
If S/shot has been selected but no B trigger has been received.

WARNING:50Ω SELECT CONFIRM
If a setup to be recalled contains 50Ω.

WARNING:CALC ALREADY SELECTED
If the same calculation is selected for more than 1 cursor measurement.

WARNING INFINITE PERSISTENCE
If infinite persistence has been selected and S/Shot is pressed.

WARNING:NO Y TRACE VISIBLE
If XY mode is selected and only CH1 is turned on

WARNING:REFERENCE TRACE OFF
If an attempt is made to select a reference trace to display from the Main and Zoom Trace Display menu before that reference trace has been turned on from the Display Master Menu.

WARNING:TRACES 5 TO 8 SELECTED
Traces 5–8 have been selected

WARNING: TRACE/MEMORY LENGTH MISMATCH
If an attempt is made to select a

WARNING:TRACE NOT VISIBLE
If an attempt is made to select a

WARNING:TRACE UNASSIGNED
If an attempt is made to select a

WARNING:VALUE FORCED INTO RANGE
GPIB/RS423 The argument was not an allowable value and was rounded to the nearest suitable number.

Mass Memory Errors

There are a number of errors associated with memory storage devices. Most of these are self explanatory and generally point to a problem with the selected storage device. The problem may be that the device is write protected or that the device has been misused and may have some data corruption.

These errors are listed below:

COULDN'T CREATE DIRECTORY
COULDN'T CREATE RUN
COULDN'T CREATE RUN NUMBER
COULDN'T CREATE SEQUENCE DIRECTORY
COULDN'T CREATE SETUP DIRECTORY
COULDN'T CREATE USER
COULDN'T DELETE OBJECT
COULDN'T INITIALISE DEVICE
COULDN'T READ DATA FROM DEVICE
COULDN'T RENAME OBJECT
COULDN'T WRITE DATA TO DEVICE
DEVICE FULL
DEVICE IS WRITE PROTECTED
DEVICE NOT AVAILABLE
DEVICE NOT MOUNTED
FILE DOES NOT CONTAIN A VALID SEQUENCE
FILE DOES NOT CONTAIN A VALID SETUP
FILE DOES NOT CONTAIN A VALID TRACE
INVALID NAME
INVALID OPERATION
MEMORY ALLOCATION ERROR, RETRY
NO FILE PRESENT FOR RECALL
NOT A VALID SEQUENCE
NOT A VALID TRACE
OBJECT ALREADY EXISTS
RUN NAME DOES NOT EXIST
RUN NUMBER DOES NOT EXIST
RUN NUMBER IS OUT OF RANGE
SELECTED USER DOES NOT EXIST ON DEVICE
SEQUENCE FILE DOES NOT EXIST
SETUP FILE DOES NOT EXIST
TRACE FILE DOES NOT EXIST

Appendix 2: Specification

VERTICAL	9500	6500	6000/6100/7200	6100/7200 only
Resolution	8 bits	8 bits	8 bits	12 bits
Bandwidth DC	0 – 500 MHz	0 – 100 MHz	0 – 200 MHz	0 – 1 MHz
AC	4 Hz – 500 MHz	4 Hz – 100 MHz	4 Hz – 200 MHz	4 Hz – 1 MHz
Bandwidth Limit (MHz)	1, 20, and 200	1 and 20	1, 20 and 100	Anti alias filter set by timebase
Risetime	0.7 ns	1.75 ns	1.75 ns	350 ns
Vertical Sensitivity	2 mV – 5V	2 mV – 5V	2 mV – 5V	62.5 µV – 5V
Measurement Resolution	0.42 % of FSD	0.42 % of FSD	0.42 % of FSD	0.1 % of FSD
Measurement Accuracy	± 2% rdg. ±0.4% FSD	± 2% rdg. ±0.4% FSD	± 2% rdg. ±0.4% FSD	± 1% rdg. ±0.4% FSD
Effective Bits (1 MS/s Transient)	7.1	7.1	7.5	10.8
HORIZONTAL				
Timebase	1 ns – 200 s	1 ns – 200 s	10 ns – 200 s	2µs – 200 s
Zoom (1, 2, 5) 50 k	× 2 to × 1000	× 2 to × 1000	× 2 to × 1000	× 2 to × 1000
200 k	× 2 to × 4000	× 2 to × 4000	× 2 to × 4000	n/a
1 M				
Maximum transient sample rate	2 GS/s on 1 ch. 1 GS/s on 2 ch. 500 MS/s all ch.	1 GS/s on 2 ch. 500 MS/s all ch.	100 MS/s all ch.	25 MS/s all ch.
Maximum Repetitive Sample Rate	5 GS/s	5 GS/s	5 GS/s	N/A
Glitch Detect	1 ns	2 ns	10 ns	N/A
Waveform Lengths (words/channel)	50 k/200 k/1 M	50 k/200 k/1M	50 k/200 k	50 k
Segmentation (Min. size)	500	500	500	500
TRIGGER				
Sensitivity				
Internal DC Coupled <0.3 div	0 – 20 MHz	0 – 20 MHz	0 – 20 MHz	0 – 20 MHz
<1.5 div	20 MHz – 500 MHz	20 MHz – 200 MHz	20 MHz – 200 MHz	20 MHz – 200 MHz
AC coupled <0.3 div	10 Hz – 20 MHz	10 Hz – 20 MHz	10 Hz – 20 MHz	10 Hz – 20 MHz
<1.5 div	10 Hz – 500 MHz	10 Hz – 200 MHz	10 Hz – 200 MHz	10 Hz – 200 MHz
External DC Coupled <150 mV	0 – 20 MHz	0 – 20 MHz	0 – 20 MHz	0 – 20 MHz
<600 mV	20 MHz – 500 MHz	20 MHz – 200 MHz	20 MHz – 200 MHz	20 MHz – 200 MHz
AC coupled <150 mV	10 Hz – 20 MHz	10 Hz – 20 MHz	10 Hz – 20 MHz	10 Hz – 20 MHz
<600 mV	10 Hz – 500 MHz	10 Hz – 200 MHz	10 Hz – 200 MHz	10 Hz – 200 MHz

DISPLAY, COLOR (option 138)

LCD: 5.6" diagonal liquid crystal screen.

Graticule: Electronically generated 8 × 10 divisions with 5 sub divisions.

Resolution: 501 × 256.

Color: Independent controls for Traces, Alphanumerics and Graticule and of their intersections.

DISPLAY, MONOCHROME (Standard)

As Color except:

Intensity: Independent controls for Traces, Alphanumerics and Graticule.

VERTICAL SYSTEM

Four identical channels, CH1, CH2, CH3 and CH4. Inputs via BNC connectors.

Input impedance: 1 MΩ ± 2%//10 pF or 50 Ω ± 2% VSWR <1.2:1, menu selectable for each channel.

Input Coupling:
1 MΩ: AC–GND–DC.
50 Ω: GND–DC. Also AC but after 50 Ω.

Maximum Input Voltage:

1 MΩ: ±400 V DC or peak AC to 10 kHz or transient.
50 Ω: 5 V RMS <20 V pk.

Vertical Position Range: ± 12 Divisions.

Input Offset Range: 2 mV/div to 50 mV/div: ± 0.5 V
100 mV/div to 0.5 V/div: ± 5 V
1 V/div to 5 V/div: ± 50 V.

Probe Attenuation: Selection of ×1, ×10, ×20, ×100, ×200 and ×1000 for each channel to give measurements at the probe tip..

HORIZONTAL SYSTEM

Timebase Clock Accuracy: ± 0.01%.

Time Resolution: ± 0.01% of full scale (with 10000 word memory).

Glitch Detect: Capture of 10 ns pulse width with 100% probability of capture, timebase ranges > 500 ns/div.

Waveform Record Length: 10 k words per channel, 50 k (option 134), 200 k (option 136), 1 M (option 139-2, 6500 & 9500 only).

Segmentation: in 2, 5, 10 steps to 500 word minimum.

External Clock Input: TTL level on rear panel, maximum frequency 5 MHz.

RECORDER MODE (7200 only)

Record: Direct to hard disk while in roll mode.

Record rate:	**8 bit mode**	**12 bit mode**
1 Channel:	200 kS/s	50 kS/s
2 Channels:	100 kS/s	25 kS/s
4 Channels:	50 kS/s	20 kS/s

Record pre trigger: 60% of display (e.g. 30 k with 50,000 memory)

Record Length: 500 Mwords (8 bit mode).

Replay: Direct from disk with variable speed controls in forward or rewind.

Event Markers: 3 individual event markers with 19 character custom lables. GO TO MARKER search function in replay mode.

Record to Paper: Continuous recording to paper or replay from hard disk with trace annotation, date and time event markers and grids.

Trace Density: Greys for overlapping traces.

Record: Drect to Hard Disk while in roll mode.

TRIGGER SYSTEM
(A and B Triggers)

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

Auto/Normal Mode: In Auto the timebase free runs when insufficient signal (20 Hz to 200 MHz) is present or when the selected level is outside the range of the input signal.

Source: CH1, CH2, CH3, CH4, EXT, Line.

Coupling: AC, DC, ACHFrej, DCHFrej, TV Sync separator for NTSC, PAL and SECAM. (Line number selection with Trigger Tools options 128, 133 only).

Slope: +ve or -ve.

Level Control: On screen indicators, resolution of < 0.1 div.

External Trigger Impedance: 1 MΩ//10 pF, Front panel BNC.

External Input Protection: ±400 V DC or peak AC to 10 kHz or transient.

Trigger Output: TTL level qualified trigger on rear panel.

Trigger Delay Range: 0–399 s, resolution of 2.5 ns.

Trigger Delay Accuracy: ±0.01% of delay, ±0.1% of unzoomed time/div, ±700 ps.

Pre-Trigger: 0% to 100% of sweep in 0.2% steps.

TRIGGER TOOLS (options 128)

A trigger is generated when the selected signal conditions are met.

TV: Trigger on user specified line number for NTSC, PAL SECAM TV standards.

Pulse Width: Greater than, less than (time) from 2.5 ns to 1000 s in 2.5 ns increments. Rearm time 7.5 ns

Frequency /Period: Period limits and rearm time as for pulsewidth. Minimum frequency 0.45 Hz, maximum 125 MHz.

Skew: Time difference between A and B trigger events. Limits and rearm as for pulse width.

Slew Rate: Greater then, less than (time) to pass through pre–defined A and B voltage levels. Limits and rearm as for pulse width.

Missing Event: Trigger if B event does not occur within selected time after A event.

Combination: Combination of input signals valid for selectable time causes a trigger. Limits and rearm as for pulse width.

Band: Trigger when signal enters or leaves voltage band between levels A and B.

Runt: Trigger when input signal, which ordinarily crosses both levels A and B, crosses only one level. (Not option 133).

A Delayed by N Gates B: Delay limits 1 to 999 counts.

B Gates A Delayed by N: Delay limits 1 to 999 counts.

Delay by N: Trigger after N selected events.

Divide by N: Trigger every N events, synchronous with the input signal: 2–9999. Phase slip capability to position area of interest ± 1 count.

DISPLAY MODES

TruTrace®: Multi–intensity, grey–scale trace compression mode. Shows trace detail comparable to analog oscilloscope display even for 200 k memory length.

Refresh: Stored data and display updated by triggered sweep.

A2

Roll: Stored data and display scrolled from right, updated continuously for timebases 50 ms/div to 200 s/div. Trigger stops the updating process. For timebases faster than 50 ms/div roll operates as refresh.

Persistence: Displays all captured signals over a number of acquisitions (10 to 500) or a time period (500 ms to 90 s or infinite).

Dot Join: Dots are joined by vertical lines. Linear dot interpolation is provided when the trace is X-expanded. Independent selection of persistence dot join.

X-Y: X-Y display is 8 × 8 divisions. Stored data and display are updated by triggered sweep. CH1 is used as the X and CH2, CH3 and CH4 are used as the Y deflection. X and Y display resolution is 7 bit (15 levels/div) and data resolution is 8 bit.

Traces: Up to eight traces at any one time.

Single Shot: Arms the instrument for a single triggered sweep and freezes the store at the end of the sweep.

Multi–Shot: Acquisition into sections of segmented store with rapid rearm between each. Display as in–line sections with real time preserved between sections.

Display Trace Hold (All): Freezes the display immediately. Persisted count is stopped.

Channel Trace Hold: Freezes individual channel immediately. Persisted count is stopped if all channels are held and will continue if any channel is released.

Limits Testing: Two acquisition modes. Stop on fail or display test limit failed message if signal goes outside defined test band. Automatic tolerance band generation can be selected.

Averaging: Averages can be set from 2 to 1024 in binary sequence, selected from menu system. Averaging operates continuously (weighted average) or, using single shot for the set number of acquisitions.

MEMORY

Three internal non–volatile memory devices for recording traces, instrument setups or test sequences. Stored data is time stamped and identified with user defined labels. Warning displayed for disk full. Copy and backup facility available.

Internal Ram Disk (standard) : 45 kBytes, battery backed for 1 month.

Internal RAM disk (option 137): 1 MB, battery backed for 1 month.

Floppy Disk (standard): 3.5" high density, 1.44 MByte. MSDOS™ format.

Hard Disk (option 113-3): Internal 500 MByte Disk drive.

CURSOR and ALPHANUMERIC DISPLAY

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

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

Cursor Measurement Display: ΔVoltage and ΔTime displayed on screen.

Alphanumerics: Display on screen to indicate vertical sensitivity and invert status for each channel, Bandwidth limit, timebase speeds, zoom amount, pre-trigger or trigger delays. Arrow for off screen indication of trigger point and traces. While running long delays (> 4 s) count–down time is shown.

YT MEASUREMENTS

Up to 50 measurements can be made simultaneously. Standard pulse measurements can be performed with the 10%, 50% and 90% levels as defined in IEEE 194–1977, IEEE Standard Pulse Terms and Definitions, or bounds defined by datum and cursor or other measurements. Measurements can also be assigned to any trace and made with respect to ground or the datum.

Parameters Measured

Risetime, falltime, frequency, period, duty–cycle, pulse width, overshoot, preshoot, peak–to–peak, area, root mean square (RMS), voltage, time, amplitude (top and base).

CUSTOM MEASUREMENTS (option 126)

Allows detailed measurement requirements to be programmed and scaled to meet almost any application.

Parameters Measured

Rising crossing, falling crossing, knee, trigger (relative time and amplitude of signal), count, FFT harmonic, mean, dimensioned constant.

Operators

These math operators can be applied to measurement results: Sum, delta, multiply, divide, average, mean.

Functions

These functions can be used within math expressions involving measurements and operators: Constant, Cos (), Log (), Antilog ().

X–Y MEASUREMENTS (option 120)

Up to three measurements can be displayed simultaneously.

Parameters Measured

Angle in degrees, radius, ΔY, ΔX in volts, ΔT in seconds, area in V^2 (area enclosed by the the X–Y trace). Integration with respect to X in V^2 (area enclosed by datum lines, trace and cursor).

ANALYSIS

Selected analysis functions processed at high speed and displayed live.

Invert

Inverts the trace about the ground.

Trace Math

+, –, ×, and ÷ two traces. Multiplication scaling ×01, ×0.2, ×0.5 and ×1. Division scaling ×1, ×2, ×5 and ×10.

ADVANCED ANALYSIS (option 121)

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

Integrate
Calculates the indefinite integral and displays the resultant waveform. A scaling factor of ×1, ×0.5 , ×0.2 or ×0.1 can be applied to the integrated waveform.

Differentiate
Calculates the differential and displays the resultant waveform. A scaling factor of ×0.5, ×1, ×2, ×5, ×10, ×20 or ×50 can be applied to the integrated waveform.

Graph
Produces a display of measurement results against time as a trace graph.

Vertical Result Display Range: $\pm 999 \times 10^{36}$. Individual setting for maximum and minimum scaling values.

Display Update Rate: 1, 2, 5, 10, 20, 50, 100 seconds or maximum rate defined by the acquisition system.

Display Time: 50 × display update rate/division. Display rolls when full time scale is reached.

Display Reading: The cursor will read the result value and the time of the occurrance from the start of graphing.

Histogram
Produces a display of results accumulated from a measurement against time.

Display Range: Auto scale.

Display Update Rate: 1, 2, 5, 10, 20, 50, 100 seconds or maximum rate defined by the acquisition system.

Display Bins: Equally divided between maximum and minimum scaling values by 10, 20, 50, 100, 200 or 500.

Display Reading: The cursor will read the bin result size and the number of occurrances in the allowed run time.

FFT
Calculates the FFT of the selected trace. Hanning or rectangular windows, log or linear scaling. Cursor measurement in Hz relative to datum or multiple of freqency at dataum. FFT performed on up to 16 k data points.

SCALING

Individual scaling is available for each input channel. Scaling affects measurements: Volts, amplitude, peak–to–peak, pulse width, period, duty cycle, RMS, frequency, rise/fall time, time, 1/time, ΔX, ΔY, ΔT. The horizontal axis (timebase) may also be scaled to preset datum and cursor positions.

Engineering Units Annotation
Four character entry user scaling for each channel and time measurement.

Scale Factor and Zero Offset Range
$\pm 999 \times 10^{36}$.

SETUP AIDS

Auto Setup: Automatically sets the front panel controls to display any applied repetitive input signals for frequencies greater than 40Hz. Trigger and timebase priority is CH1 through to CH4.

Calibrator: 1 V peak to peak ± 1%, frequency approximately 1 kHz calibration signal on front panel.

Ground: Front panel ground reference.

I/O

The instrument is fitted a RS423 and Centronics interface and optionally with an IEEE-488 interface (option 103).

IEEE-488 I/O (option 103)

Parallel data interface which can be used as a control or plotter port and permits all front panel controls except POWER On/Off to be programmed.

Interface Capabilities: SH1, AH1, T5, L4, SR1, RL1, DC1, C0, E2, PP0, DT1.

Data Rate: 50 k bytes/sec burst.

Address: menu selectable 01 to 31.

RS423 I/O

Serial interface which can be used as a control or plotter port and permits all front panel controls except POWER On/Off to be programmed and is a bi-directional port for the transfer of trace data and associated range parameters.

Baud Rate: 110, 300, 600, 1200, 2400, 4800, 9600, 38400.

Data Bits: 7 or 8.

Parity: Odd, even, mark, space or none.

Start/Stop: One start bit (fixed), one or two stop bits (selectable).

Handshake: XON/XOFF, CTS/RTS, Off.

Echo & prompt: On or Off.

DIGITAL PLOTTER INTERFACE

The instrument can directly output to suitable HPGL format plotters via the RS423 or IEEE interface port or to an internal thermal plotter if fitted. Centronics port for PCL format output to raster plotters; e.g. DeskJet ®.

Plot Mode: Manual or auto selection to output a stored trace.

Annotation: Range and scaling annotation, graticule, time and date information, cursors, cursor readout and measurement feature set output can all be included in the plot output.

Color: Colored pens automatically selected when available.

THERMAL PLOTTER (optional)

Weight: Increases weight of DSO by 1.0 kg (2.2lb).

Paper type: see optional accesories.

Paper length: 30 meters, equivalent to approximately 250 plots.

Print Head: Thermal dot line array, 640 dots per line.

REAL TIME CLOCK

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

ENVIRONMENTAL

Temperature: Operating 0 °C to +50 °C (+35 °C for thermal plotter).
Full specification + 15 °C to +35 °C.
Storage -40 °C to +70 °C.

Humidity: Operating IEC 68-2-Ca at 40 °C with 95% RH.
Non-operating IEC 68-2-Db cycling +25 °C to +45 °C with 95% RH, 6 cycles (144 hours).

Vibration: MIL spec 810D. Random frequency vibrations of 5-500 Hz at 1 g RMS for 15 minutes.
IEC 68-2-6 Test Fc. 15 cycles of 1 minute duration 10 Hz to 55 Hz at 0.6 mm peak to peak displacement in each of the three major axis (4 g at 55 Hz).

Shock: Operating: 3 shocks of 30 g peak, half-sine, 11 ms duration on each of three major axes.

Altitude: Operating 5250 m @ +40 °C.
Non-operating 15000 m @ +20 °C.

Safety: Compliant with EN 61010-1:1993 (AMD A2:1995).

EMC:

Emission: EN50081-1:1992, EN61000-3-2:1995, EN61000-3-3:1994, FCCpt15 class A.

Immunity: EN50082-1:1992, EN61000-4-8:1994 @ 30 A/m.

ENVIRONMENTAL (Floppy and Hard Disk)

Temperature: Operating +5 °C to +45 °C.
Storage -40 °C to +60 °C.

Humidity: Operating IEC 68-2-Ca at 40 °C with 60% RH.

Vibration: MIL spec 810D. Random frequency vibrations of 5 Hz to 500 Hz at 0.3 g RMS for 15 minutes.
IEC 68-2-6 Test Fc.

Shock: Operating: 3 shocks of 10 g peak, half-sine, 11 ms duration on each of three major axes.

Altitude: Operating: 3300 m at +40 °C.
Non-operating: 13300 m at +20 °C.

POWER REQUIREMENTS

Voltage and Frequency:
90–132 V 45 Hz to 400 Hz.
180–265 V 45 Hz to 65 Hz..

Power: 250 W, 350 V·A, maximum, 150 W typical.

WEIGHT: 12.2 kg (27lb) approx.

DIMENSIONS:

180 mm height × 390 mm width × 480 mm depth (7 1/4 × 15 1/2 × 19 inches) excluding handle.

ACCESSORIES SUPPLIED

Operating Manual.
Line Cord.
4 probes.

OPTIONS and ACCESSORIES

GPIB IEEE-488 interface	103
Internal Thermal Plotter	108-2
500 Mb Internal Hard Disk	113-3
X-Y Measurement Software	120
Analysis Software	121
Sequence Software	122
Custom Measurement Software	126
Trigger Tools Software (Non USA)	128
Trigger Tools Software (USA only)	133
50 k memory	134
200 k memory	136
1 Mbyte RAM disk	137
Color Display	138
1 M memory	139
Carrying case (soft)	201
Transit case (hard)	204
Rack mounting kit	211
Thermal plotter paper, 8 roll pack	4101251
Probe DC-250 MHz, 1200 V, ×100	PB17
Probe DC-250 MHz, ×1, ×10 switchable	PB20
Probe DC-100 MHz, 40 kV max, ×1000	PHV4000
Active FET probe DC-500 MHz, ×10	PB52
Active FET probe DC-500 MHz, ×1, ×10 switchable	PB53
Differential probe DC-350 MHz, 40 V CMV	PB54
Differential probe DC-100 MHz, 1 kV CMV	PB58
Differential probe DC-25 MHz, 1400 V DC or 1000 V RMS Cat III	ADF25
Differential probe DC-25 MHz, 700 V DC or 500 V RMS Cat III	ADF25A
Fuse 2 A (2.5 A) – 230 V operation	461887
Fuse 4 A (5 A) – 115 V operation	457456

Appendix 3 Glossary of terms

Alias
A false image caused when the signal is very much faster than the sample rate see section 1.6.2.

An effect that occurs when an analog signal is sampled digitally at a sampling frequency less than twice the signal frequency: a signal is retrieved from the sample information that differs from the original input signal.

ANSI
American National Standards Institute.

BSI
British Standards Institute.

CMRR
Common Mode Rejection Ratio. The measure by which the ability of the instrument to ignore signals common to both the signal input and ground terminals is determined.

$$20 \text{ Log}_{10} \frac{\text{Displayed signal on screen}}{\text{Signal on common}}$$

Data points
The individual samples of the input waveform.

DSO
Digital Storage Oscilloscope.

ETS
Equivalent Time Sampling. For repetitive signals which require multiple sweeps, samples are taken at random, varying, times relative to the trigger point to eventually capture the entire input waveform. This technique extends the useful operating frequency of a DSO from its single sweep sampling limit.

IEE
Institution of Electrical Engineers.

IEEE
Institute of Electrical and Electronics Engineers, Inc.

GPIB
General Purpose Interface Bus. Another more common name for the IEEE–488 interface bus defined by ANSI/ IEEE Standard 488–1978.

LCD
Liquid Crystal Display. The display device in the instrument.

Sampling theorem
This states that if an input signal contains no frequency components higher than f, the signal can be captured and displayed without distortion if it is sampled at a rate greater than $2f$. f is referred to as the Nyquist Frequency.

Real Time Sampling
Used for single sweep acquisitions. The signal is sampled so that all the data points are acquired at equal time intervals sequentially from the start to finish of a single sweep.

RS423
Interface standard set by the Electronic Industries Association (EIA).

Sample Rate
The rate at which the instrument records the signal levels of the input waveform to produce the data points.

A3

APPENDIX 4

Interfacing the DSO to an IBM-PC via the RS423 (RS232)

There are a number of points worth noting when interfacing the DSO to an IBM-PC or AT via the RS423 port.

1. The cable should be wired as follows:

DSO 25 way male	IBM-PC 9 way female	DSO 25 way male	IBM-AT 25 way female
2	3	2	2
3	2	3	3
5	7	5	5
7	4	7	7
8	5	8	8

2. In most cases Echo should be OFF

   This is only for use with dumb terminals, and echoes back every character as it is received. This is unnecessary when using a PC as a controller, and can cause problems if the software is not expecting to receive the echoed characters.

4. To test the interface and connections the following short BASIC program can be run:

```
10 OPEN "COM1:9600,N,8,1,DS0,LF" AS #1
20 PRINT #1,"CHAN1:COUP?"
30 INPUT #1,X$
40 PRINT X$
50 CLOSE #1
```

This uses the COM1 port on the IBM, and sets up the interface to 9600 baud, no parity, 8 data bits, 1 stop bit, no DSR-DTR handshaking and Line Feed as a terminator. The program then requests the vertical coupling of channel 1, inputs the response from the DSO, and prints it on the screen. For example if channel 1 is AC coupled the program should print CHAN1:COUP AC, and leave the instrument in RS423 Remote Mode.

Appendix 5 Connector Pinouts and Driver Circuits

Driving the External Clock Input

The external clock input is a TTL level input. The input is designed to expect a drive signal from bus and line drivers such as the 74XX244.

For low frequency operation, i.e. below 100 kHz, it can be driven by all TTL logic families using up to approximately a 1 meter line length.

At frequencies above 100 kHz, it is recommended that the input is driven with the circuit shown below to ensure correct operation.

External Clock

The maximum input frequency is 5 MHz and in refresh mode the DSO will function perfectly at up to 5 MHz.

However, the maximum recommended frequency for the external clock in roll mode is 100 kHz. Limiting external clock to this frequency in roll mode ensures that the DSO behaves in the same way as when it is using its own internal timebase clock.

+5 V on I/O Connector

The +5 V rail available on the Miscellaneous I/O connector is internally connected to the +5 V supply through a 37 Ω resistance. This voltage will therefore be capable of powering about 3 or 4 TTL devices so that a simple Clock or Trigger generator circuit can be powered by the instrument.

Probe Power (6500 & 9500 only)

If probe power is fitted to the instrument, the eight way mini-din, probe power socket(s) provide approximately ±11 V at up to 800 mA. This supply is suitable only for powering a maximum of 4 Gould active probes and should not be used for any other purpose.

An accessory kit consisting of a two way adaptor and an extension lead is available.

Video Output Option

On the rear panel of the instrument is a 15way high density D-type connector conforming to standard VGA pinout configuration. The output signal is a standard 800 × 600 pixel Super VGA signal with the colors the same as on the oscilloscope's display. The vertical resolution is 2 dots per ADC level on the display and horizontal resolution is 1:1 i.e. 500 dots.

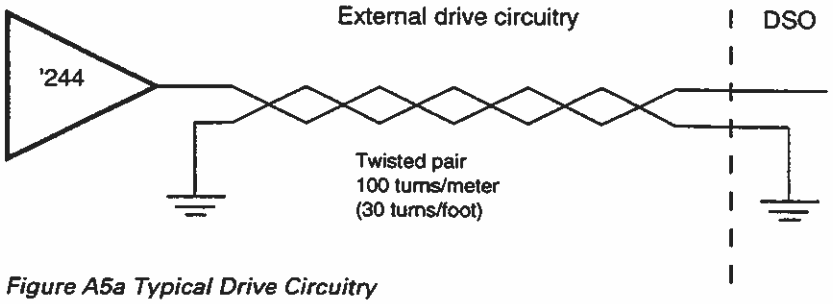
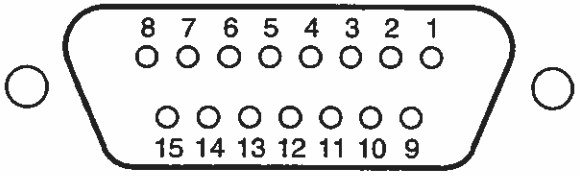
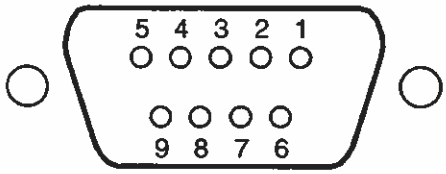


Figure A5a Typical Drive Circuitry



Pin	Signal	Pin	Signal
1	Spare	9	Sample Clock Output
2	Spare	10	Trigger Output
3	Event In	11	Spare
4	Event Out	12	Ground
5	Spare	13	+5V
6	External Clock Input	14	Spare
7	Ground	15	Spare
8	Spare		

Figure A5b Miscellaneous I/O Connector



Pin	Signal	Description
2	TXD	Transmit Data
3	RXD	Receive Data
5	GND	Signal Ground
7	CTS	Clear to Send
8	RTS	Request to Send

Figure A5c RS423 Interface Connector

A5

About this Appendix

This Appendix contains information on the operation of the power Analyzer section of your 7100 instrument.

Section 1 contains operation infromation.

Section 2 contains some typical reults from a lamp dimmer under various conditions.

The other sections contain technical notes and background information which may help to understand some of the principles and requirements of testing.

Introduction

About the 7100 Power Analyzer

If you're involved in power supplies, keeping track of current harmonics is a must these days. But measuring to CE Standards can be a time-consuming and costly business. Fortunately that could now be a thing of the past with the introduction of the Gould 7100 Power Analyzer – the single, portable unit solution for pre-compliance testing. Regulations to be introduced in the near future will require engineers to show compliance to EN61000-3-2 for the purpose of CE marking. The 7100 has been specifically designed to enable pre-compliance tests to be completed quickly and accurately, and provide peace of mind.

Three instruments in a single unit

By utilising the functions of three instruments in a single unit – Harmonic Analyzer, Power Factor Meter and Digital Storage Oscilloscope – the 7100 Power Analyzer provides all the pre-compliance measurement capability to enable an engineer to design a power supply, to meet EN61000-3-2 (IEC1000-3-2).

6

Unique features, real-time test tool

The unique combination of features incorporated into the 7100 provide live visual information of current harmonics, voltage, current, power and power factor. In addition to meeting the requirements of EN61000-3-2, the 7100 provides the power supply designer with a real-time test tool which allows quick and accurate evaluation and verification of his design with the minimum of fuss.

Displaylive harmonics

The 7100 displays live on-screen current harmonics against the standard limit line, for real-time visual verification of harmonic performance. And because the limits conform to the requirements of EN61000-3-2 for class A, B, C and D devices, they are automatically selected dependent on the supply under test load conditions.

Displaylive Voltage, Current and Power waveforms

The Gould 7100 Power Analyzer measures Voltage and Current and calculates Real Power, Apparent Power and Power Factor whilst displaying live Voltage, Current and Power waveforms. By providing information in real time, the 7100 helps power supply designers to verify their designs.

Fault finding PLUS with the 7100

As well as providing the solution to the requirements of CE marking to meet EN61000-3-2, the 7100 is also a powerful 4 channel, 200 MHz digital storage oscilloscope. As a DSO it can be used to support the design of your power supply – from fault finding to design verification. All this adds up to a very attractive test solution.

Meeting CE Requirements

New requirements for suppliers of electrical and electronic equipment to the European union as part of the ongoing introduction of regulations for CE marking will soon be introduced. On this occasion power supply manufacturers and equipment manufacturers who incorporate power supplies into their products will be required to show conformance on the level of current harmonics their equipment introduces back into the source supply. The specification they are required to meet is EN61000-3-2 (Current Harmonics), equivalent to IEC1000-3-2.

The Complete Integrated Solution

Using a high performance digital storage oscilloscope as its base Gould have developed an integrated solution to EN61000-3-2 by incorporating the functions of three instruments into one compact tester. The Gould 7100 Power Analyzer has the functions of a Harmonic Analyzer, Power Factor meter and Digital Storage Oscilloscope and provides the complete pre-compliance solution to the requirements of EN61000-3-2. The unique combination of features were specifically designed to provide live visual information of current harmonics, voltage, current, power and power factor, intended to allow the power supply design engineer to evaluate and verify his design quickly, accurately and without unnecessary fuss. The system is completed by providing a high performance differential voltage and current probe and incorporating an internal thermal plotter for printing results and waveforms.

LiveCurrent Harmonic Waveforms

Hit the Harmonics soft key and enter directly into the harmonics display. You can instantly see the first forty current harmonics displayed and updated in real time. Having previously selected the class of power supply you want to test, the limit lines are automatically selected, meeting EN61000-3-2, and displayed alongside your test harmonics. Immediately you are able to see in real time which harmonics are outside specification and require further attention. You now have the ability to make changes to your power supply design whilst getting an immediate update of any improvement in the current harmonics. If you need to measure the level of any of the harmonics just use the 'next peak' and 'prev peak' keys to step through the harmonics and read the actual current and frequency directly off the display.

Dynamic Test Limits

The test limits required by EN61000-3-2 change dependent on the load conditions of the power supply being tested. The Gould 7100 Power Analy-zer takes care of this too. As the load of the device under test changes, the Gould power analyzer automatically senses the change and recalculates the test limit line, presenting the user with the new limit line on the display. Change the load again and the Gould power analyzer recalculates again. The result is the user gets a visual real time feel of the changing specifications, which he can quickly compare with the test harmonics, allowing him to verify his design more quickly, easily and accurately.

LiveVoltage, Current and Power Waveforms

Need to look at the Voltage, Current and Power waveforms? Hit the Power Factor soft key and The Gould 7100 Power Analyzer measures Voltage and Current and calculates Real Power, Apparent Power and Power factor whilst displaying live Voltage, Current and Power waveforms.

Print Test Results

Having completed your testing you would now like to produce a hard copy of the test results – an easy task for this instrument. The Gould 7100 Power Analyzer prints a complete test report showing the 1st to the 40th harmonic displaying current level, specification limit and pass/fail status. The report can be printed to the power analyzer's internal thermal plotter, or to an external printer.

Pure Power Source option

EN61000-3-2 requires that the source supply provides a pure current waveform to the unit under test. The Gould PowerSource 1000 is an innovative product which provides a pure current waveform for the purposes of pre compliance testing your power supplies' performance to EN61000-3-2. The PowerSource 1000 is rated up to 1000V ·A for 230 V operation.

Powerful 4 Channel 200 MHz DSO

The Gould 7100 Power Analyzer has as its base a powerful 4 channel 200MHz digital storage oscilloscope. So when you're not using the analyzer to test your power supply design to EN61000-3-2 it can be used in DSO mode. For example, switching times and pulse risetimes can be measured using high performance differential probes to observe gate drive waveforms riding on high common mode signals. Similarly, the current and ground voltages and the rms or peak power dissipated in individual components can be measured. Or, using the long memory capture, analyzing the whole start up or power down performance. TruTrace®, a patented data compression technique, will highlight any abnormalities in the drive waveforms and the extended plot will output detail of the whole memory which enables small variations in switching performance to be viewed.
So you can see how, in DSO mode, the 7100 can be used to support the design of your power supply – from fault finding to verification of your design.

A6.1 Using the 7100 Power Analyzer:

A6.1.1 Connecting

The 7100 Power Analyzer needs a current and a voltage input in order to calculate the power factor and the harmonics. Supplied with the instrument are the two probes that are needed to provide the required inputs.

When connecting the probes, ensure that the AC supply is switched off and that no live conductors are exposed to accidental contact.

Connect the differential voltage probe to the live and neutral conductors of the AC supply to the unit under test. Red to live and Black to neutral. Connect the output of the differential voltage probe to channel 1 on the 7100 power Analyzer.

Clip the PR30 current probe around the live conductor of the AC supply to the unit under test. Do not clip it around the complete power cable because the live and neutral currents will cancel each other out. Make sure that the current flow is in the direction of the arrow on the side of the probe. Connect the output of the current probe to channel 2 on the 7100 Power Analyzer.

Figure A6.1 shows a typical set up using a purpose made breakout box for the current and voltage connections.

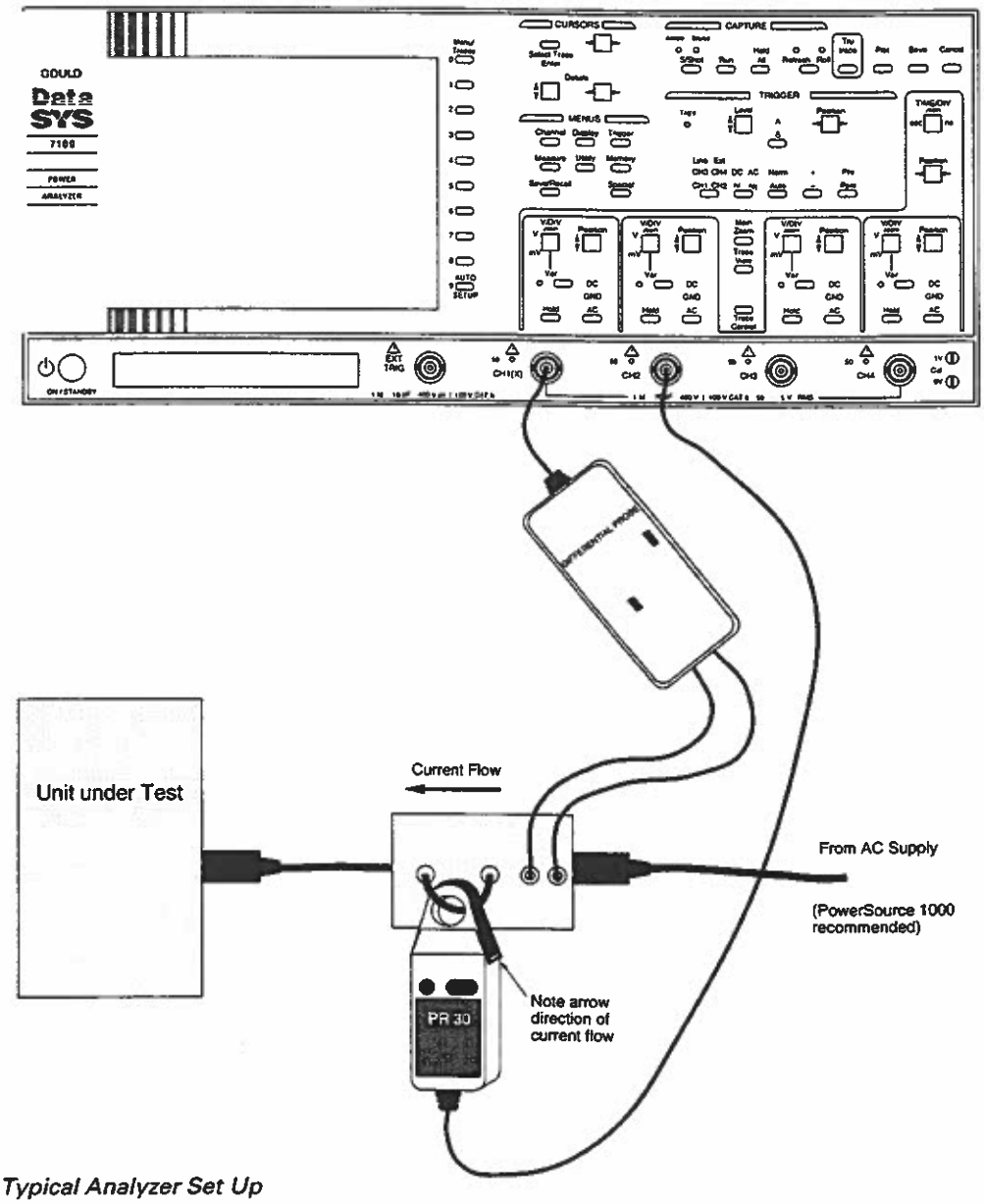


Figure A6.1. Typical Analyzer Set Up

A6.1.2 Checking the AC Supply

The AC supply to the unit under test must be a pure sinewave so that true results are obtained. Any distortion on the supply will give lower harmonic currents and may indicate a pass where in fact the unit would fail with a clean supply. It is recommended that a Gould PowerSource 1000 is used to provide the AC supply. See Technical Note 129 in Appendix A for further explanation of this point.

To check the qulity of the incoming AC supply, the Supply test setup which is on the application disk supplied with the instrument can be used. Insert the disk into the 7100 power analyzer and recall both traces and setup from the Supply:Test:001 directory.

Switch on the differentail voltage probe and the AC supply. Ensure that the trace control control is set to 5–8 and line up the top of the fundamental peak with the top of the limits using the CH1 V/div control. All other harminics will be within the shaded limits on an acceptable supply.

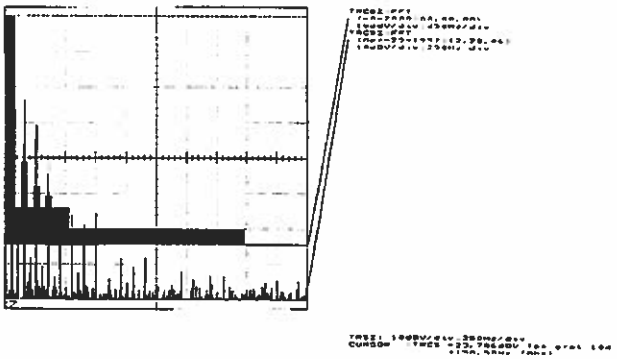


Figure A6.1.2a. An Inadequate AC supply

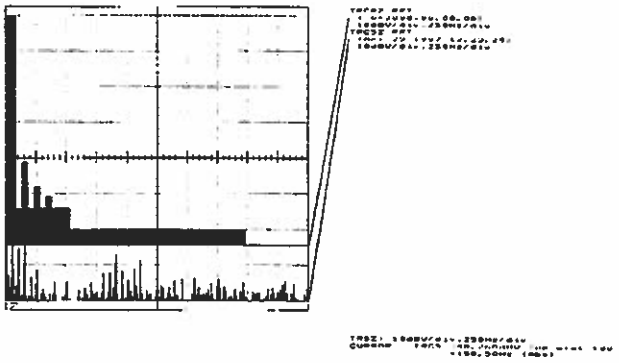


Figure A6.1.2b. An Acceptable AC supply

Continue harmonics testing by switching on both probes, the unit under test and the PowerSource 1000.

A6.1.3 Setting the Instrument

To use the Power Analyzer, the first step is to change the instrument from DSO to Analyzer Mode. This is achieved by pressing the Special Menu button and then selecting Analyzer on Line 2. See Figure A6.1.3.

When the instrument is in Analyzer mode many of the front panel controls are locked out so that the instrument remains an analyzer.

```
                ANALYZER MENU
                                        Return

Instrument Mode:  DSO ANALYZER ..........

Harmonics ..............................

Power Factor ...........................

Apparatus Class:  A B C D ...............

Display Limit Trace: OFF ON ............

Average Harmonics: OFF ON ..............

Note: Volts CH1 Amps CH2
```

Figure A6.1.3. The Analyzer Menu

Next, select the limits class required, either A, B, C or D, by pressing button 5 until the required Class is highlighted.

Now simply press the appropriate button for the test required: Button 3 for harmonic testing or button 4 for power factor.

To turn the display of the class limits on and off, press numeric button 6.

Use button 7 to turn harmonics averaging off for a faster testing response for example while making adjustments to a circuit..To reduce the noise floor once adjustments are complete, averaging should be turned back on again using button 7.

A6.1.4 Classes

The classifications are:

Class A Balanced three phase equipment and all other equipment except those which fall into one of the other three classes.

Class B Portable tools.

Class C Lighting equipment including dimming devices.

Class D Equipment having an input current with a "special waveshape" as defined below and an active power of less than or equal to 600 W. Whatever the waveshape of the input current, Class B, Class C and, provisionally, motor driven equipment (with phase angle control) are not considered as Class D equipment.

Note: The exception of motor driven equipment with phase angle control should in future be reconsidered in relation to the effective coincidence factor of motor driven appliances.

Equipment is deemed to be Class D if the input current waveshape of each half cycle referred to its peak value is within the envelope shown in figure A6.1.4a for at least 95% of the duration of each half cycle. Line M coincides with the peak value of the input current. Because of the 95% factor, waveforms that have small peaks outside the envelope are considered to fall within the envelope.

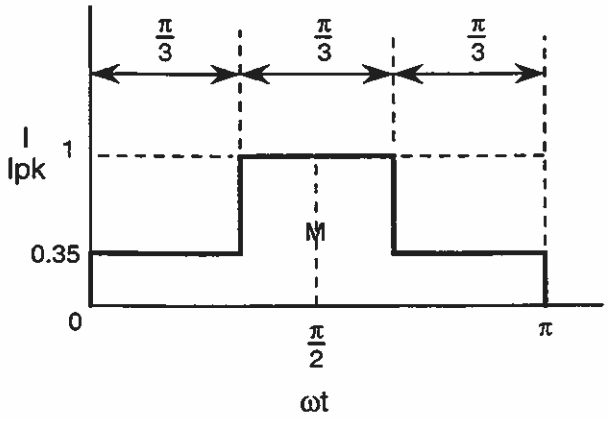


Fig A6.1.4a. Special Waveshape Envelope for Class D

The flow chart shown in figure A6.1.3b summarizes the classification of equipment.

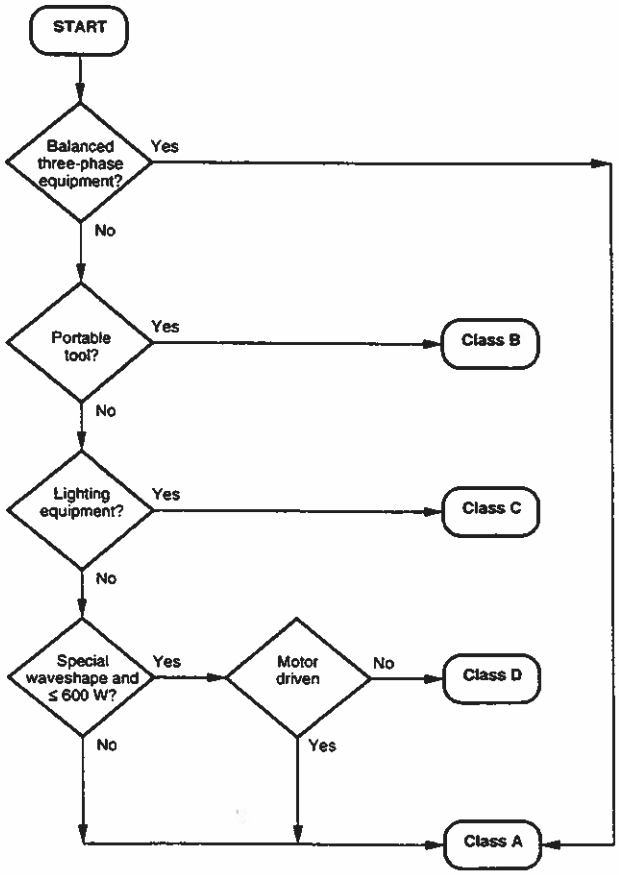


Fig A6.1.4b. Equipment Classification

A6.1.5 Power Factor

The power factor screen shows the voltage and the current waveforms. This allows the shape to be seen so that shows any distortion in the current waveform can be easily seen.

The instrument ranging is automatically set to 200 V/div for the voltage and 500 mA/div for the current. If the current waveform appears to be clipping or is very low, the Amps/division will need to be adjusted before any meaningful results can be obtained. To adjust the Amps/div, ensure that the instrument is displaying main traces only (by pressing the Main/Zoom button until only Main is lit) and then adjust channel 2's V/div paddle until the whole waveform is included.

At the bottom of the display, the Real and Apparent Power together with the Power Factor are automatically calculated and displayed. This numbers are continuously calculated so that any modifications to the unit under test or its power factor correction can be immediately seen.

If more detail is required, both X and or Y zoom can be applied to the waveforms. To obtain a plot of the display simply press the plot button.

A6.1.6 Harmonics

Pressing button 3 from the Analyzer menu will result in a screen display showing a shaded area representing the harmonic limits for the class selected overlaid on the actual harmonics from the unit under test. If the harmonics are above the limits (i.e. outside the shaded area) the unit has failed.

To examine a particular harmonic, the cursor can be moved from one to the next by pressing the next and previous buttons (2 and 3). The exact frequency and amplitude of the selected harmonic is shown at the bottom of the display.To obtain a plot of the display simply press the plot button. From this display press button 4 to see a complete list of the results for all 40 harmonics.

A6.1.7 Results

The results screen shows the results for 10 of the 40 harmonics that are tested. The particular set of 10 is selected by pressing button until the required set is shown.

For each harmonic the frequency, permitted limit, actual level and whether it has passed or failed is shown.

Button 1 returns the display to the harmonics limits display.

To plot out the results, press button 7 and a complete list of all 40 harmonics and their results will be printed regardless of which set of 10 harmonics is currently displayed.

A6.2 Typical Analyzer Results

The tests were made using a lamp dimmer using phase control to switch the input current. There are three different test shown. The first test shows 46 watts into a 100 watt lamp supplied from a PowerSource 1000. The second test shows the same lamp at full power supplied from a PowerSource 1000, and the third test again shows the lamp at full power but supplied from the un–corrected ac supply from the wall socket.

A6.2.1 Test 1

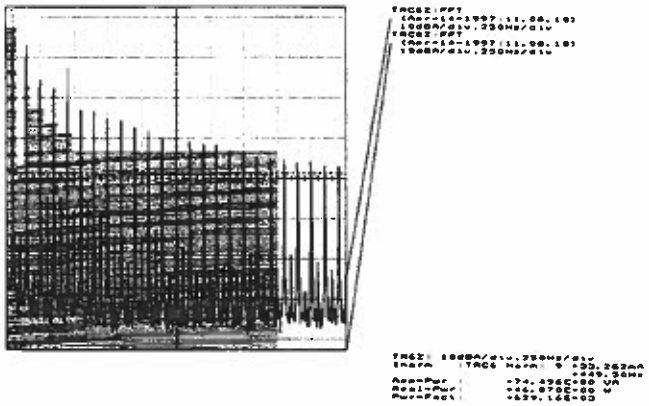


Figure A6.2.1a. The voltage and current waveforms for 46 watts into a 100 watt lamp. The supply is from a PowerSource 1000.

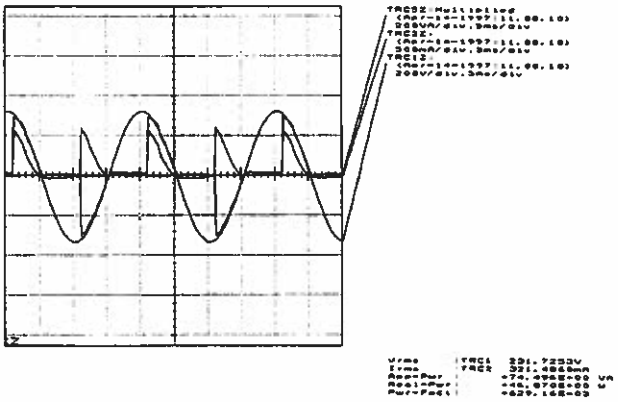


Figure A6.2.1b. The harmonic waveform showing a large number of failures with the cursor on the 9th harmonic. The test limits are set to class C.

HARMONIC RESULTS

Apr-14-1997:11.10.52

Apparatus Class: C

No.	Freq (Hz)	Level (A)	Limit (A)	Pass/ Fail
1	5.05E+01	2.54E-01	2.54E-01	PASSED
2	1.01E+02	7.72E-04	5.09E-03	PASSED
3	1.51E+02	1.60E-01	4.80E-02	FAILED
4	-----	-----	-----	OFF
5	2.51E+02	6.04E-02	2.54E-02	FAILED
6	-----	-----	-----	OFF
7	3.51E+02	4.68E-02	1.78E-02	FAILED
8	-----	-----	-----	OFF
9	4.50E+02	3.33E-02	1.27E-02	FAILED
10	-----	-----	-----	OFF
11	5.50E+02	2.56E-02	7.63E-03	FAILED
12	-----	-----	-----	OFF
13	6.50E+02	2.39E-02	7.63E-03	FAILED
14	-----	-----	-----	OFF
15	7.50E+02	1.99E-02	7.63E-03	FAILED
16	-----	-----	-----	OFF
17	8.50E+02	1.90E-02	7.63E-03	FAILED
18	-----	-----	-----	OFF
19	9.50E+02	1.53E-02	7.63E-03	FAILED
20	-----	-----	-----	OFF
21	1.05E+03	1.41E-02	7.63E-03	FAILED
22	-----	-----	-----	OFF
23	1.15E+03	1.14E-02	7.63E-03	FAILED
24	-----	-----	-----	OFF
25	1.25E+03	1.07E-02	7.63E-03	FAILED
26	-----	-----	-----	OFF
27	1.35E+03	1.02E-02	7.63E-03	FAILED
28	-----	-----	-----	OFF
29	1.45E+03	9.61E-03	7.63E-03	FAILED
30	-----	-----	-----	OFF
31	1.55E+03	9.41E-03	7.63E-03	FAILED
32	-----	-----	-----	OFF
33	1.65E+03	8.11E-03	7.63E-03	FAILED
34	-----	-----	-----	OFF
35	1.75E+03	7.78E-03	7.63E-03	FAILED
36	-----	-----	-----	OFF
37	1.85E+03	6.56E-03	7.63E-03	PASSED
38	-----	-----	-----	OFF
39	1.95E+03	6.17E-03	7.63E-03	PASSED
40	-----	-----	-----	OFF

```
Vrms      :TRC1   231.7253V
Irms      :TRC2   321.4860mA
App-Pwr   :       +74.496E+00 VA
Real-Pwr  :       +46.870E+00 W
Pwr-Fact  :       +629.16E-03

End of harmonic results.
```

Figure A6.2.1c. A plot of all 40 harmonics with frequency measured, limit level and a pass or fail message.

A6.2.2 Test 2

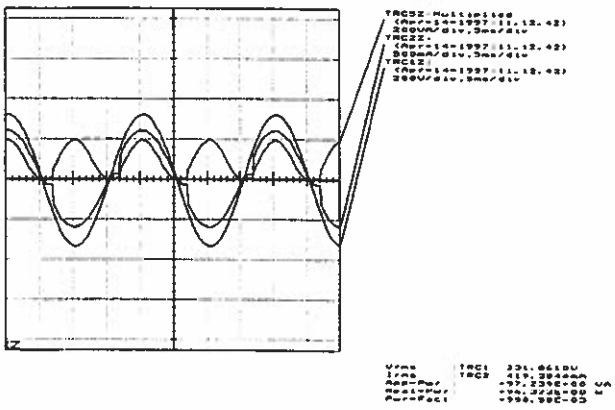


Figure A6.2.2a The voltage and current waveforms for full power showing an improved wave shape. The supply is from a PowerSource 1000.

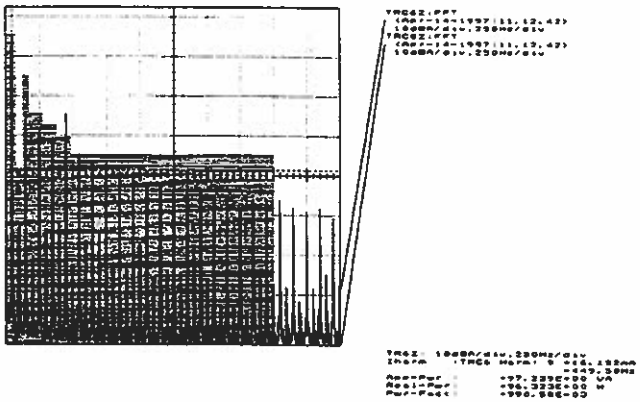


Figure A6.2.2b The harmonic waveform showing a failure at the 11th harmonic. The cursor is on the 9th harmonic. The test limits are set to class C.

HARMONIC RESULTS

Apr-14-1997:11.14.58

Apparatus Class: C

No.	Freq (Hz)	Level (A)	Limit (A)	Pass/ Fail
1	5.05E+01	3.89E-01	3.89E-01	PASSED
2	1.01E+02	1.43E-03	7.79E-03	PASSED
3	1.51E+02	3.95E-02	1.16E-01	PASSED
4	-----	-----	-----	OFF
5	2.51E+02	2.47E-02	3.89E-02	PASSED
6	-----	-----	-----	OFF
7	3.51E+02	1.87E-02	2.73E-02	PASSED
8	-----	-----	-----	OFF
9	4.50E+02	1.62E-02	1.95E-02	PASSED
10	-----	-----	-----	OFF
11	5.50E+02	1.19E-02	1.17E-02	FAILED
12	-----	-----	-----	OFF
13	6.50E+02	9.67E-03	1.17E-02	PASSED
14	-----	-----	-----	OFF
15	7.50E+02	8.90E-03	1.17E-02	PASSED
16	-----	-----	-----	OFF
17	8.50E+02	6.32E-03	1.17E-02	PASSED
18	-----	-----	-----	OFF
19	9.50E+02	6.32E-03	1.17E-02	PASSED
20	-----	-----	-----	OFF
21	1.05E+03	4.93E-03	1.17E-02	PASSED
22	-----	-----	-----	OFF
23	1.15E+03	5.03E-03	1.17E-02	PASSED
24	-----	-----	-----	OFF
25	1.25E+03	4.99E-03	1.17E-02	PASSED
26	-----	-----	-----	OFF
27	1.35E+03	4.73E-03	1.17E-02	PASSED
28	-----	-----	-----	OFF
29	1.45E+03	4.33E-03	1.17E-02	PASSED
30	-----	-----	-----	OFF
31	1.55E+03	3.61E-03	1.17E-02	PASSED
32	-----	-----	-----	OFF
33	1.65E+03	3.55E-03	1.17E-02	PASSED
34	-----	-----	-----	OFF
35	1.75E+03	2.44E-03	1.17E-02	PASSED
36	-----	-----	-----	OFF
37	1.85E+03	3.11E-03	1.17E-02	PASSED
38	-----	-----	-----	OFF
39	1.95E+03	3.27E-03	1.17E-02	PASSED
40	-----	-----	-----	OFF

```
Vrms     :TRC1   231.8610V
Irms     :TRC2   419.3844mA
App-Pwr  :       +97.239E+00 VA
Real-Pwr:        +96.323E+00 W
Pwr-Fact:        +990.58E-03

End of harmonic results.
```

Figure A6.2.2c A plot of all 40 harmonics with frequency measured, limit level and a pass or fail message.

A6

A6.2.3 Test 3

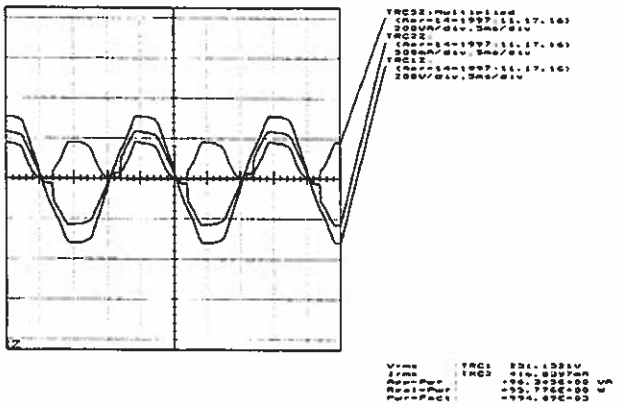


Figure A6.2.3a. The voltage and current waveforms for full power into a 100 watt lamp supplied from a wall socket. The distortion seen by the flat top causes less harmonic current.

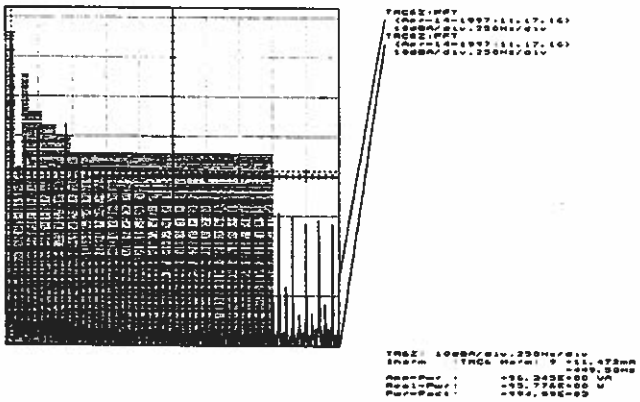


Figure A6.2.3b. The harmonic waveform showing a pass due to the distortion in the input waveform causing less harmonic current. The cursor is on the 9th harmonic. The test limits are set to class C.

HARMONIC RESULTS

Apr-14-1997:11.19.24

Apparatus Class: C

No.	Freq (Hz)	Level (A)	Limit (A)	Pass/ Fail
1	5.05E+01	4.01E-01	4.01E-01	PASSED
2	1.01E+02	5.22E-04	8.02E-03	PASSED
3	1.51E+02	2.04E-02	1.20E-01	PASSED
4	-----	-----	-----	OFF
5	2.51E+02	2.61E-02	4.01E-02	PASSED
6	-----	-----	-----	OFF
7	3.51E+02	8.24E-03	2.81E-02	PASSED
8	-----	-----	-----	OFF
9	4.50E+02	1.15E-02	2.01E-02	PASSED
10	-----	-----	-----	OFF
11	5.50E+02	1.09E-02	1.20E-02	PASSED
12	-----	-----	-----	OFF
13	6.50E+02	7.94E-03	1.20E-02	PASSED
14	-----	-----	-----	OFF
15	7.50E+02	6.25E-03	1.20E-02	PASSED
16	-----	-----	-----	OFF
17	8.50E+02	4.14E-03	1.20E-02	PASSED
18	-----	-----	-----	OFF
19	9.50E+02	4.90E-03	1.20E-02	PASSED
20	-----	-----	-----	OFF
21	1.05E+03	3.92E-03	1.20E-02	PASSED
22	-----	-----	-----	OFF
23	1.15E+03	3.52E-03	1.20E-02	PASSED
24	-----	-----	-----	OFF
25	1.25E+03	3.44E-03	1.20E-02	PASSED
26	-----	-----	-----	OFF
27	1.35E+03	3.55E-03	1.20E-02	PASSED
28	-----	-----	-----	OFF
29	1.45E+03	3.12E-03	1.20E-02	PASSED
30	-----	-----	-----	OFF
31	1.55E+03	2.86E-03	1.20E-02	PASSED
32	-----	-----	-----	OFF
33	1.65E+03	2.42E-03	1.20E-02	PASSED
34	-----	-----	-----	OFF
35	1.75E+03	2.41E-03	1.20E-02	PASSED
36	-----	-----	-----	OFF
37	1.85E+03	2.26E-03	1.20E-02	PASSED
38	-----	-----	-----	OFF
39	1.95E+03	2.40E-03	1.20E-02	PASSED
40	-----	-----	-----	OFF

Vrms :TRC1 231.1321V
Irms :TRC2 416.8397mA
App-Pwr : +96.345E+00 VA
Real-Pwr: +95.776E+00 W
Pwr-Fact: +994.09E-03

End of harmonic results.

Figure A6.2.3c. A plot of all 40 harmonics with frequency measured, limit level and a pass or fail message.

6

Technical Note TN129

Pre-Compliance Measuring to EN61000-3-2 (IEC1000-3-2) Using The Gould DataSYS 7100 Power Analyzer

Since 1982 household appliances have been subject to certain CE standards regarding the amount of interference which the appliance produces on the supply line in terms of

- Current harmonics
- Voltage Fluctuations and Flicker

From June 1998 the European standards EN61000-3-2 (Current Harmonics) and EN61000-3-3 (Voltage Fluctuations) come into force. Both these standards will apply to all equipment rated up to 16 A per phase and as such will apply to almost all electrical equipment manufacturers since a great deal of modern electronic products employ power systems which draw non-sinusoidal currents and therefore produce current harmonics.

This document deals with the measurement of injected current harmonics and also the measurement of the power factor of an appliance using the Gould DataSYS 7100 Power Analyzer and therefore the measurements required for EN61000-3-2 testing. It should however be noted that the use of the technique described in this document is only for pre-compliance checking and is therefore only a guide to show if the equipment under test is close to the standard.

Harmonic Current Emissions

When an appliance is connected to the mains supply, depending on the power system employed within the equipment, currents may be generated which are at multiples of the 50 Hz supply which impose themselves on the supply line if the current which is drawn is not sinusoidal in shape. These are known as harmonic currents and are classified as interference. There are limits to these currents which must be met in order to pass EMC testing. (See Appendix A)

Fast Fourier Transform (FFT) techniques make it possible to measure the amplitude of these harmonics and using the features of the DataSYS 7100 makes measuring these harmonics simple.

The amount of noise present in the FFT of the current is kept to an acceptably low level by use of the averaging feature although this does mean that it is only possible to measure equipment which produces steady state harmonics and not transient harmonics.

Power Factor

If the power system within a piece of electrical equipment introduces a phase shift between the voltage supplied and the current drawn, then depending on the phase difference between the two waveforms, the current will have a real and an imaginary component. Useful power consumed by the load will be the power calculated using the real component of current and is known as real power. The imaginary component is reflected back into the distribution network and simply results in heating of the cables. Apparent power is the power that is calculated by multiplying the RMS values of voltage and current together and does not take into account the phase difference between these two quantities.

Power factor is simply the ratio of real power to apparent power and will always be between the values of 1 and 0 for any equipment which is drawing power. If the power factor is equal to 1 the voltage is completely in phase with the current so there is no imaginary current component and when the power factor is equal to 0 the voltage is exactly 90 degrees out of phase with the current so there is no real current component, only an imaginary component. For the most efficient use of electricity the power factor should be as close to 1 as possible. Current harmonics will also result in a low power factor since the RMS current in a distorted waveform is a result of all the frequency components in the waveform but the only harmonic which can deliver real power to the equipment is the fundamental. This means that the harmonic currents increase the apparent power whilst the real power remains unchanged thus reducing the power factor.

By using the DataSYS 7100 Power Analyzer the power factor can be automatically calculated and displayed.

Making The Measurements using the DataSYS 7100 Power Analyzer

In order to make the measurements for harmonic currents and the power factor of the equipment under test the following equipment is required.

- DataSYS 7100 Power Analyzer
- PB60 (×100) Voltage probe on CH1
- PR30 Current clamp on CH2

The Power Analyzer has two modes. Analyzer Mode and DSO Mode. The 7100 should be in Analyzer Mode before making measurements.

Obtaining The Results

Once the machine is switched on press the Special menu button and select the option marked Analyzer. Here you are faced with a number of options but first you will need to set the Class of equipment to be tested. Pressing the button marked Select Class allows you to cycle through the four classes. Once you have selected the correct class you can make measurements of the Power Factor whilst displaying the Voltage and Current waveforms, look at the harmonic content of the Current along with the limits for the standard in that Class of equipment, or show on screen and print out a test report page showing each of the measured Harmonic values and the limits for the standard in that Class of equipment along with an automatic PASS/FAIL rating. Just press the button for the measurement which you wish to make.

Power Factor

This screen shows the Voltage and Current waveforms so that you can actually see the shape of these and allows the distortion of the Current waveform to be easily seen. At the same time the values of Real and Apparent Power and the Power Factor are automatically calculated and displayed so that the effects of any Power Factor Correction which you apply can be seen immediately by its effect on the waveforms themselves and the value of the Power Factor calculated. By adjusting the zoom (both x and y) you can look in detail at the waveforms.

Harmonics

Pressing this button takes you to the screen showing the Current harmonics with the limit line. The limit line which is shown is the standard for the particular Class of equipment under test as selected previously and is calculated live according to the standard (See Appendix A) so that as the Voltage and Current changes due to any adjustments made, the limit line will remain true to the standard. Any harmonic which is within the standard will appear below the line within the shaded area and any harmonic which is outside the standard (i.e. causes the equipment to fail the test) will show above the shaded area. Pressing the Next Peak and Previous Peak buttons allow you to quickly step through the harmonic peaks with the cursor so if one particular harmonic is of interest the exact amplitude and frequency of this harmonic can be analysed and shown. The zoom facility is again available in order to give closer inspection of the harmonic content of the Current. The values of Real and Apparent Power and Power Factor are again calculated and displayed live so the link between Current Harmonics and Power Factor can be seen.

Test Results

This button takes you to the Test Results screen which shows a table of results of the Current harmonics test (i.e. the measured values at each harmonic, the limit for this value to meet the standard, and an automatic PASS/FAIL rating) complete with the Class of Instrument which this test was for and the Real Power being used by the unit under test. The table is split across four pages with ten harmonics on each page and pressing the button marked with the harmonic numbers group allows you to step through the pages, 1-10, 11-20, 21-30, 31-40.

By pressing the **Plot** button at any time in the Power Factor, Harmonics or test result screen, the display shown at this time will be plotted to the internal plotter or the external printer depending on the plot configuration. When the Test Results screen is showing, hitting the 'Plot Results' soft key allows the information on all four Test Result pages to be printed in a long table for easy viewing and archiving (i.e. 1 - 40th Harmonics).

6

Appendix A

Harmonic Current Limits According to EN61000-3-2

Limits for Class A equipment

Harmonic order	Maximum permissible harmonic current
n	A
Odd Harmonics	
3	2.30
5	1.14
7	0.77
9	0.40
11	0.33
13	0.21
$15 \le n \le 39$	0.15 (15/n)
Even Harmonics	
2	1.08
4	0.43
6	0.30
$8 \le n \le 40$	0.23 (8/n)

Limits for Class B equipment

Class B limits are set at 1.5 × Class A limits

Limits for Class C equipment

Harmonic order	Maximum value expressed as a percentage of the fundamental input current of luminaries
n	%
2	2
3	30 λ
5	10
7	7
9	5
$11 \le n \le 39$ (odd harmonics only)	3

Where λ = Power Factor of the circuit

Limits for Class D equipment

Harmonic order	Maximum permissible harmonic current per watt	Maximum permissible harmonic current
n	mA/W	A
3	3.4	2.30
5	1.9	1.14
7	1.0	0.77
9	0.5	0.40
11	0.35	0.33
$13 \le n \le 39$ (odd harmonics only)	$\frac{3.85}{n}$	See limits for class A equipment

GOULD INSTRUMENT SYSTEMS Roebuck Road, Hainault, Ilford, Essex IG6 3UE, England.
Tel: (0181) 500 1000 Fax: (0181) 501 0116 Email: helpline@gould.co.uk Website: http://www.gould.co.uk

GOULD
Instrument Systems

FRANCE:
Gould Instruments S.A. Tel: (01) 69.10.22.40 Fax: (01) 69.34.20.73
ITALY:
Gould Instrument Systems Filiale Italia Tel: (02) 92.10.74.61 Fax: (02) 92.10.74.56

GERMANY:
Gould Nicolet Messtechnik GmbH Tel: 06074 4908-0 Fax: 06074 4908-48
USA:
Gould Instruments Systems, Inc. Tel: (216) 328 7000 Fax: (216) 328 7400

And other Gould Representatives and Distributors worldwide.

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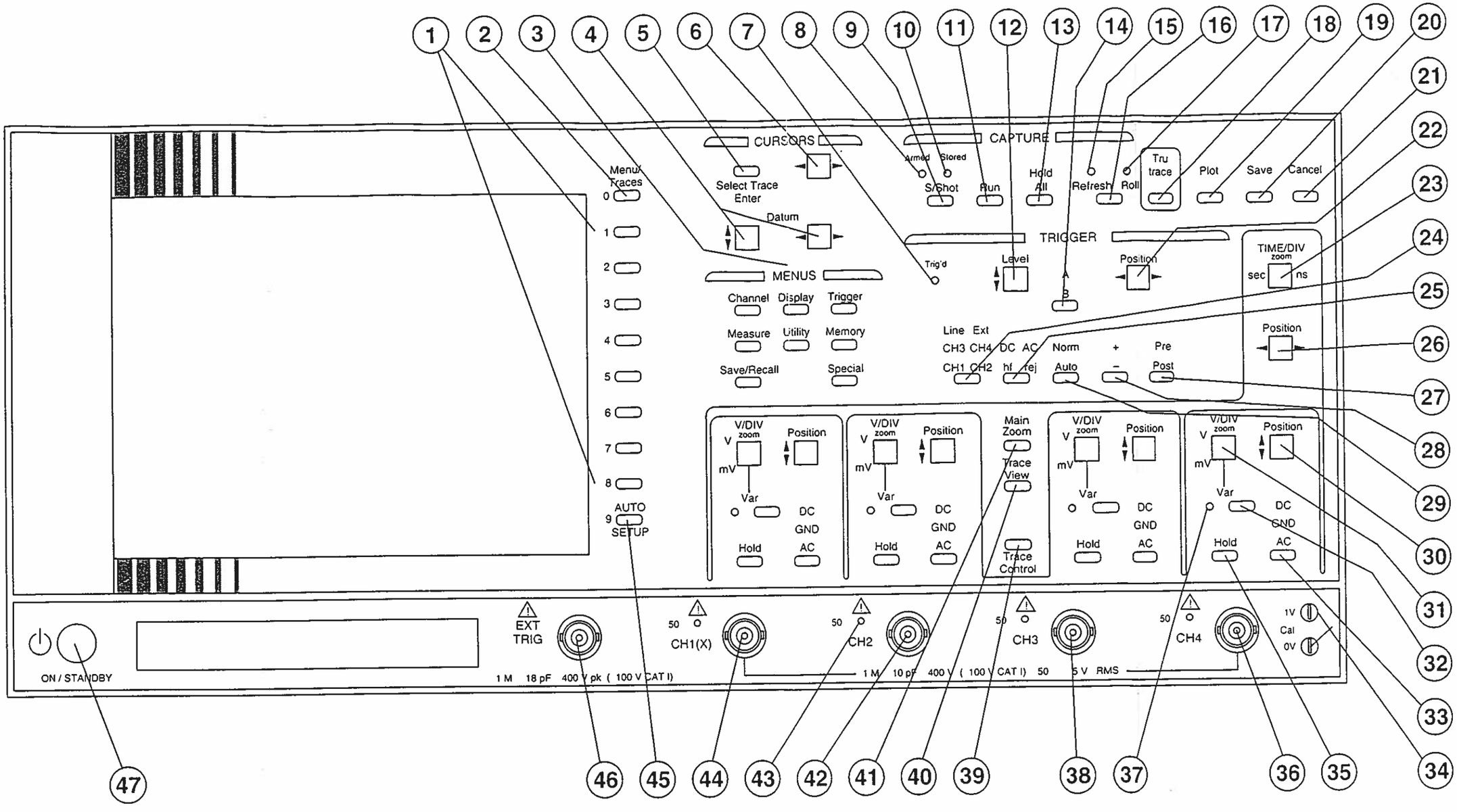
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109

Service Facilities

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

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

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

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

PRINCIPAL GOULD SERVICE OFFICES

www.gould.co.uk

UNITED KINGDOM
Gould Nicolet Technologies,
Roebuck Road, Hainault,
Ilford, Essex, IG6 3UE
Telephone (0181) 500 1000
Fax (0181) 501 0116
e–mail helpline@gould.co.uk

GERMANY
Gould Nicolet Messtechnick GmbH,
Beethovenstrasse 26, 63526 Erlensee.
Telephone (06183) 9205-0.
Fax (06183) 9205-48
e–mail gould_nicolet@compuserve.com

FRANCE
Gould Nicolet Technologies S.A.
Parc Hightec 6,
9 Avenue du Canada, Les Ulis,
91966 Court Aboeuf, Cédex.
Telephone (01) 64 86 45 45.
Fax (01) 64 86 45 46

USA
Gould Instrument Systems, Inc
5225-4 Verona Road
Madison, WI 53711.
Telephone (608) 327 6600
Fax (608) 273 5061

ITALY
Gould Instrument Systems Filiale Italiana,
Via Torino 25,
20063 Cernusco S/N (MI).
Telephone (02) 9210 7461
Fax (02) 9210 7456