AIM & THURLBY THANDAR INSTRUMENTS

TGR1040

1GHz Synthesised RF Signal Generator

INSTRUCTION MANUAL

Aim-TTi

Introduction

This low cost, synthesised RF signal generator features a wide amplitude range, low noise and inherently good frequency stability. The generator also features internal and external FM. The instrument can be operated manually via the front panel or remotely controlled via the RS232 (standard) or GPIB (optional) interfaces. It is suitable for FM radio receiver sensitivity measurements, system gain measurements, oscillator substitutions, EMC/antenna/field strength measurements and as a signal source for many other RF circuit and system development tasks. In addition, the generator's low cost, ease of use and remote control make it eminently suitable for most production and development applications where a basic, stable signal source is required.

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Specifications

Specifications apply after 30 minute warm-up in an ambient of 5°C to 40°C

FREQUENCY

Frequency Range:	10 MHz to 1000 MHz
Setting Resolution:	1 kHz by direct keyboard entry, or in user-set increments of 1kHz to 999.999 MHz by rotary control or increment–decrement keys.
Display Resolution:	1 kHz
Accuracy:	± 2 ppm over the temperature range 5°C to 40°C.
Stability:	<1ppm/year ageing.
Phase Noise:	<–110dBc/Hz at 25 kHz offset, 500 MHz carrier.
Residual FM: (FM Off)	Equivalent peak deviation in a 300 Hz to 3.4 kHz bandwidth: 12 Hz at 100 MHz carrier 25Hz at 500 MHz carrier 60 Hz at 1000 MHz carrier

OUTPUT LEVEL

Output Level Range:	–127dBm to +7dBm (0.1µV to 500 mV into 50Ω).
Setting Resolution:	0.1dB (or 0.01µV to 1mV) by direct keyboard entry, or in user-set increments of 0.1dB to 100dB (or 0.01µV to 100mV) by rotary control or increment–decrement keys.
Accuracy:	Better than ± 2dBm, except for output levels <–70dBm at 500 -1000 MHz, ± 3dBm.
Harmonics:	Typically <–25dBc, maximum –20dBc, any carrier frequency, output level ≤0dBm.
Non-Harmonic Spurii:	≤ – 60dBc at ≥ 8kHz offset.
Carrier Leakage:	≤ 0.5µV generated in a 50Ω load by a 2 turn 25mm diameter loop, 25mm from the generator, with the output set to ≤ –10dBm into a 50Ω sealed load.
Output Impedance:	50Ω
Output Connector:	TYPE N
Output Switch:	RF OUT on-off switch with LED showing ON status.

FM MODULATION

Peak Deviation:	0.5 kHz to 100 kHz.
Setting Resolution:	0.5 kHz by direct keyboard entry, rotary control or increment–decrement keys.
Modulation Frequency:	Internal 1kHz; External 300 Hz to 50 kHz
Deviation Accuracy:	<±15% of setting ± 0.5kHz, excluding residual FM, for 1 kHz modulation, internal or 1Vrms external.
External Modulation Frequency Response:	± 1dB from 300 Hz to 50 kHz relative to 1 kHz.
Distortion:	<2% total harmonic distortion at 1 kHz modulating frequency, 100 kHz deviation and 500 MHz carrier.
Input Impedance:	100kΩ
Input Connector:	BNC

INTERFACES

Full remote control facilities are available through the RS232 (standard) or optional GPIB interfaces.

RS232:	Variable Baud rate, 19200 Baud maximum, 9-pin D-connector. Fully compatible with Thurlby Thandar ARC (Addressable RS232 Chain) system.
IEEE-488:	Conforming with IEEE488.1 and IEEE488.2.

GENERAL

Display:	20 character x 4 row backlit alphanumeric LCD
Data Entry:	Keyboard selection of frequency, amplitude, etc.; value entry direct by numeric keys or by rotary control.
Stored Settings:	Up to 9 complete instrument set-ups may be stored and recalled from battery-backed memory. Typical battery life is 5 years.
Size:	3U (130mm) height; half-rack (212mm) width; 330mm long.
Weight:	4.6 kg. (10 lb)
Power:	100V, 110V-120V or 220V-240V AC ±10%, 50/60Hz, adjustable internally; 30VA max. Installation Category II.
Operating Range:	+5°C to 40°C, 20-80% RH.
Storage Range:	–20°C to + 60°C.
Environmental:	Indoor use at altitudes up to 2000m, Pollution Degree 2.
Options:	IEEE-488 interface; 19 inch rack mounting kit.
Safety & EMC:	Complies with EN61010-1 & EN61326-1. For details, request the EU Declaration of Conformity for this instrument via http://www.aimtti.com/support (serial no. needed).

Safety

This instrument is Safety Class I according to IEC classification and has been designed to meet the requirements of EN61010-1 (Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use). It is an Installation Category II instrument intended for operation from a normal single phase supply.

This instrument has been tested in accordance with EN61010-1 and has been supplied in a safe condition. This instruction manual contains some information and warnings which have to be followed by the user to ensure safe operation and to retain the instrument in a safe condition.

This instrument has been designed for indoor use in a Pollution Degree 2 environment in the temperature range 5°C to 40°C, 20% - 80% RH (non-condensing). It may occasionally be subjected to temperatures between +5°C and –10°C without degradation of its safety. Do not operate while condensation is present.

Use of this instrument in a manner not specified by these instructions may impair the safety protection provided. Do not operate the instrument outside its rated supply voltages or environmental range.

WARNING! THIS INSTRUMENT MUST BE EARTHED

Any interruption of the mains earth conductor inside or outside the instrument will make the instrument dangerous. Intentional interruption is prohibited. The protective action must not be negated by the use of an extension cord without a protective conductor.

When the instrument is connected to its supply, terminals may be live and opening the covers or removal of parts (except those to which access can be gained by hand) is likely to expose live parts. The apparatus shall be disconnected from all voltage sources before it is opened for any adjustment, replacement, maintenance or repair.

Any adjustment, maintenance and repair of the opened instrument under voltage shall be avoided as far as possible and, if inevitable, shall be carried out only by a skilled person who is aware of the hazard involved.

If the instrument is clearly defective, has been subject to mechanical damage, excessive moisture or chemical corrosion the safety protection may be impaired and the apparatus should be withdrawn from use and returned for checking and repair.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and the short-circuiting of fuse holders is prohibited.

This instrument uses a Lithium button cell for non-volatile memory battery back-up; typical life is 5 years. In the event of replacement becoming necessary, replace only with a cell of the correct type, i.e. 3V Li/$Mn0_2$ 20mm button cell type 2032. Exhausted cells must be disposed of carefully in accordance with local regulations; do not cut open, incinerate, expose to temperatures above 60°C or attempt to recharge.

Do not wet the instrument when cleaning it and in particular use only a soft dry cloth to clean the LCD window. The following symbols are used on the instrument and in this manual:-

Caution -refer to the accompanying documentation, incorrect operation may damage the instrument.

terminal connected to chassis ground.

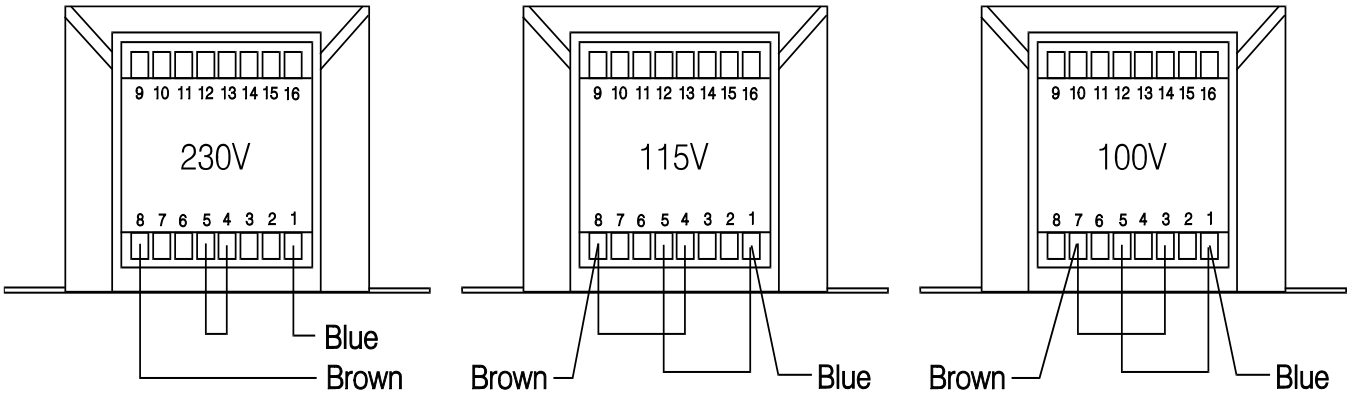
mains supply OFF.

mains supply ON.

alternating current.

Check that the instrument operating voltage marked on the rear panel is suitable for the local supply. Should it be necessary to change the operating voltage, proceed as follows:

1) Disconnect the instrument from all voltage sources.
2) Remove the screws which retain the top cover and lift off the cover.
3) Change the transformer connections following the appropriate diagram below:



4) Refit the cover and the secure with the same screws.
5) To comply with safety standard requirements the operating voltage marked on the rear panel must be changed to clearly show the new voltage setting.
6) Change the fuse to one of the correct rating, see below.

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Fuse

Ensure that the correct mains fuse is fitted for the set operating voltage. The correct mains fuse types are:

for 230V operation:	250 mA (T) 250 V HRC
for 100V or 115V operation:	500 mA (T) 250 V HRC

To replace the fuse, disconnect the mains lead from the inlet socket and release the fuse drawer below the socket pins by depressing both clips together, with miniature screwdrivers, so that the drawer can be eased open. Change the fuse and replace the drawer.

The use of makeshift fuses or the short-circuiting of the fuse holder is prohibited.

Mains Lead

When a three core mains lead with bare ends is provided it should be connected as follows:-

Brown -	**Mains Live**
Blue -	**Mains Neutral**
Green / Yellow -	**Mains Earth**

WARNING! THIS INSTRUMENT MUST BE EARTHED

Any interruption of the mains earth conductor inside or outside the instrument will make the instrument dangerous. Intentional interruption is prohibited. The protective action must not be negated by the use of an extension cord without a protective conductor.

Mounting

This instrument is suitable both for bench use and rack mounting. It is delivered with feet for bench mounting. The front feet include a tilt mechanism for optimal panel angle.

A rack kit for mounting one or two of these Half-width 3U high units in a 19” rack is available from the Manufacturers or their overseas agents.

Front Panel Connections

RF OUT

This is the 50Ω generator output. The maximum output is 500mVrms (+7dBm) into 50Ω. It can tolerate a short circuit indefinitely.

Do not apply an external voltage to this output.

The Type N connector is a precision component that should be protected from excessive wear to ensure that its RF characteristics (impedance and VSWR) are accurately maintained. If the instrument is used in a manner that demands many connections/disconnections to and from the RF OUT it is good practice to fit a male–to–female adaptor to the socket which can be replaced periodically.

MOD IN

This is the external FM input. Input frequency range is 300Hz to 50kHz and input impedance is nominally 100kΩ.

Do not apply external voltages exceeding ± 10V peak to this input.

Rear Panel Connections

RS232

9-pin D-connector compatible with the Thurlby Thandar ARC (Addressable RS232 Chain) system. The pin connections are shown below:

Pin	Name	Description	
1	-	No internal Connection	
2	TXD	Transmitted data from instrument	
3	RXD	Received data to instrument	
4	-	No internal connection	
5	GND	Signal ground	
6	-	No internal connection	
7	RXD2	Secondary received data	(ARC use only)
8	TXD2	Secondary transmitted data	(ARC use only)
9	GND	Signal ground	(ARC use only)

Pins 2, 3 and 5 may be used as a conventional RS232 interface with XON/XOFF handshaking. Pins 7,8 and 9 are additionally used when the instrument is connected to the ARC system. Signal grounds are connected to instrument ground. The ARC address is set from the front panel using the Utilities menu.

GPIB (IEEE-488)

The GPIB interface is an option. It is not isolated; the GPIB signal grounds are connected to the instrument ground.

The implemented subsets are:

SH1 AH1 T6 TE0 L4 LE0 SR1 RL1 PP1 DC1 DT0 C0 E2

The GPIB address is set from the front panel using the Utilities menu.

General

This section is a general introduction to the operation of the generator, intended to be read before using the instrument for the first time.

Switching On

The power switch is located at the bottom left of the front panel.

At power up the generator displays the installed software revision for 2 seconds before reverting to the main menu; the RF OUT output is off but all the other settings are the same as when the instrument was last powered down. Should an error with the battery-backed RAM be encountered at power up a message will be displayed, see the Error Messages section.

The basic generator parameters can all be set from this main menu as described in the following sections. The output is switched on with the RF OUT key; the ON lamp will light to show that the output is on.

Keyboard Principles

The keys can be considered in the following groups:

- The numeric/unit keys permit direct entry of a value for the parameter currently selected (indicated by the ▶ cursor beside the parameter). Thus, with frequency selected, 123.456 MHz is set by keying 1, 2, 3, • , 4, 5, 6 MHz. The parameter actually changes only when the units key (dB, MHz, etc.) is pressed.

  FREQUENCY can be entered in kHz or MHz but will always be displayed in MHz. LEVEL can be entered in dBm, mV or µV; mV values below 1.00mV will be displayed in µV and µV values above 1000µV will be displayed in mV. With the ▶ cursor set to LEVEL the value displayed can be switched from dBm to µV/mV and vice-versa by pressing the appropriate key.

  To enter negative numbers (for dB) the ± key can be used at any time during the number entry.

  ESCAPE aborts the entry and leaves the parameter at its previous setting.

- To the left of the numeric keys are the 5 parameter keys which select the parameter to be changed; the ▶ cursor moves to the selected parameter and that parameter can then be changed as described above.

  Next to the MODULATION SELECT key is the MODULATION ON/OFF key which turns modulation on and off with alternate presses; the MODULATION lamp lights when modulation is on.

- The FIELD keys provide an alternative means of moving the ▶ cursor between parameters on a menu. The rotary control and the ▲ ▼ keys below it provide alternative means of incrementing/decrementing the value of the currently selected parameter (for FREQUENCY and LEVEL) or stepping through the parameter settings (for ADDRESS, etc.). When incrementing/decrementing frequency and level the parameter value changes in steps set up on the STEP SIZE menu, see Step Size section. During numeric entries the ▼ key also acts as a backspace/delete.

- The UTILITIES key selects the Utilities menu which gives access to the stored set-ups and remote control parameters. The LOCAL key returns the instrument to local (keyboard) control from remote control.

- The EXECUTE key is used to confirm operations other than numeric parameter entries, e.g. during store and recall of set-ups.

Step Size

When changing the FREQUENCY or LEVEL using the rotary control or ▲ ▼ keys the size of each step change will be that previously set on the Step Size menu. The default FREQUENCY step is 10 MHz. The defaults for the two separate LEVEL step sizes are 10dB and 10mV; the active LEVEL step size is the one currently displayed in the Step Size menu. Note that either LEVEL step setting can be used with either LEVEL display mode; i.e. mV steps can be used in a dB display and vice-versa. However, it will generally be most useful to use dB steps in a dB level display and µV/mV steps in a µV/mV display.

To change the step size, select the STEP SIZE menu and move the ▶ selection cursor to the required parameter with the FIELD keys. Alternatively, because the cursor automatically points to the step size of the most recently selected main menu parameter, pressing FREQUENCY followed by STEP SIZE will set the ▶ cursor to frequency step size and pressing LEVEL followed by STEP SIZE will set the cursor to level step size.

FREQUENCY steps can be entered directly from the keyboard in kHz or MHz but will always be displayed in MHz. The smallest step that can be set is 1kHz and this is the amount by which the step is changed if the rotary control or ▲ ▼ keys are used; large changes in step size are therefore made most quickly by direct keyboard entry.

LEVEL steps can be entered directly from the keyboard in dB or µV/mV; separate step sizes are stored for dB and µV/mV and the choice of units will determine which of the two LEVEL steps is changed. The active LEVEL step size is the one currently displayed; pressing dB or µV/mV will switch between the two without changing either. Note that mV values below 1.00mV will be displayed in µV and µV values above 1000µV will be displayed in mV. The smallest step size that can be set is 0.1dB or 0.01µV; when using the rotary control or ▲ ▼ keys to set step size the amount by which the step is changed is 0 .1dB for dB steps or 1 least significant digit for µV/mV steps.

Having set the step size, return to the main menu by pressing FREQUENCY or LEVEL, etc.

Setting Frequency

Set the ▶ cursor to FREQUENCY on the main menu by pressing the FREQUENCY key. The generator frequency can then be set directly from the keyboard, in kHz or MHz, or changed using the rotary control or ▲ ▼ keys. Refer to Keyboard Principles for further information on keyboard entries and to Step Size for setting the rotary control and ▲ ▼ key increment size.

Note that when an increment would have taken the frequency above the instrument's maximum, the setting becomes 1000 MHz. The next decrement returns the frequency to the last in-range setting and further decrements decrease the frequency by the specified step size. Similarly when a decrement would have taken the frequency below the instrument's minimum the setting becomes 10 MHz and the next increment returns the frequency to the last in-range setting, etc.

Setting Level

Set the ▶ cursor to LEVEL on the main menu by pressing the LEVEL key. The output level can then be set directly from the keyboard, in dBm or µV/mV, or changed using the rotary control or ▲ ▼ keys. Refer to Keyboard Principles for further information on keyboard entries and to Step Size for setting the rotary control and ▲ ▼ key increment size.

Note that when an increment would have taken the level above the instrument's maximum output the setting becomes +7dBm (or 500mV). The next decrement returns the level to the last in-range setting and further decrements reduce the level by the specified step size. Similarly when a decrement would have taken the level below the instrument's minimum the setting becomes –127dBm (or 0.1µV) and the next increment returns the setting to the last in-range setting, etc.

Modulation

The generator can be set for either internal or external FM. With the ▶ selection cursor in the MODULATION field of the main menu the modulation can be switched between INTERNAL and EXTERNAL with alternate presses of the SELECT MODULATION key, or by using the rotary control or ▲ ▼ keys.

Internal modulation is fixed at 1 kHz. External modulation requires a modulating signal in the range 300 Hz to 50 kHz to be applied to the EXT IN input.

Peak deviation can be set from 0.5 kHz to 100 kHz in 0.5 kHz steps. With the ▶ selection cursor in the PEAK DEVIATION field of the main menu the peak deviation can be set directly from the keyboard, in kHz or MHz, or changed using the rotary control or ▲ ▼ keys. Refer to Keyboard Principles for further information on keyboard entries. With external modulation, the specified peak deviation is achieved with a 1Vrms sinewave modulating signal.

The selected modulation source can be switched on and off at any time using the MODULATION ON/OFF key; the MODULATION lamp lights when modulation is on.

The default modulation settings are internal modulation, 50 kHz peak deviation, modulation off.

Storing and Recalling Set-ups

Complete instrument set-ups can be stored or recalled from non-volatile RAM using the STORE and RECALL facilities on the Utilities menu, accessed by pressing the UTILITIES key.

With the ▶ selection cursor in the STORE field of the Utilities menu the store to be used can be selected with the rotary control or ▲ ▼ keys. Nine stores, numbered 1 to 9 inclusive are available. Select the required store and press the EXECUTE key; the display requests that you press EXECUTE again to confirm the operation (or any other key to cancel). A set-up already in that store will be overwritten. The status of the RF OUT is ignored; when a store is recalled the RF OUT is always off.

With the ▶ cursor in the RECALL field of the Utilities menu a previously stored set-up, or the factory defaults, can be recalled. Select the required store, or DEFAULTS for factory defaults, and press the EXECUTE key; the display requests that you press EXECUTE again to confirm (or any other key to cancel). If there is no valid data in the specified store the message 'NO VALID DATA IN STORE' will be displayed and the set-up will remain unchanged.

Remote Operation

The instrument can be remotely controlled via its RS232 or GPIB interfaces. When using RS232 it can either be the only instrument connected to the controller or it can be part of an Addressable RS232 Chain (ARC) which permits up to 32 instruments to be addressed from one RS232 port.

Some of the following sections are general and apply to all 3 modes (single instrument RS232, ARC and GPIB); others are clearly only relevant to a particular interface or mode. It is only necessary to read the general sections plus those specific to the intended remote control mode.

Remote command format and the remote commands themselves are detailed in the Remote Commands chapter.

Address and Baud Rate Selection

For successful operation, each instrument connected to the GPIB or Addressable RS232 Chain (ARC) must be assigned a unique address and, in the case of addressable RS232, all must be set to the same Baud rate.

The instrument's remote address for operation on both the GPIB and RS232 interfaces is set on the Utilities menu, accessed by pressing the UTILITIES key. With the ▶ selection cursor in the ADDRESS field the address can be changed using the rotary control or ▲ ▼ keys. On this instrument addresses 0 to 30 inclusive are allowed; the factory default is address 1. The address setting is ignored in single instrument RS232 operation.

With the ▶ selection cursor in the REMOTE field, the rotary control or ▲ ▼ keys can be used to select GPIB or RS232 with Baud rates of between 300 and 19200; the factory default selection is RS232 at 9600 Baud.

Remote/Local Operation

At power-on the instrument will be in the local state with the REMOTE lamp off. In this state all keyboard operations are possible. When the instrument is addressed to listen and a command is received the remote state will be entered and the REMOTE lamp will be turned on. In this state the keyboard is locked out and remote commands only will be processed. The instrument may be returned to the local state by pressing the LOCAL key; however, the effect of this action will only remain until the instrument is addressed again or receives another character from the interface, when the remote state will once again be entered.

RS232 Interface

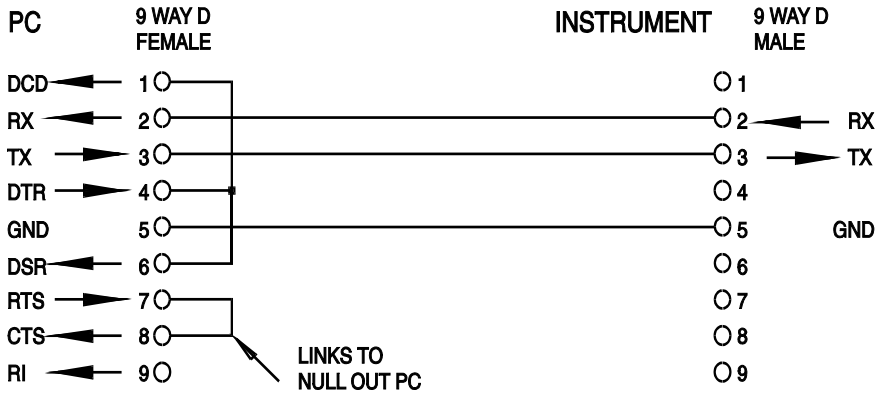
RS232 Interface Connector

The 9-way D-type serial interface connector is located on the instrument rear panel. The pin connections are as shown below:

Pin	Name	Description
1	-	No internal connection
2	TXD	Transmitted data from instrument
3	RXD	Received data to instrument
4	-	No internal connection
5	GND	Signal ground
6	-	No internal connection
7	RXD2	Secondary received data (addressable RS232 only)
8	TXD2	Secondary transmitted data (addressable RS232 only)
9	GND	Signal ground (addressable RS232 only)

Single Instrument RS232 Connections

For single instrument remote control only pins 2, 3 and 5 are connected to the PC. However, for correct operation links must be made in the connector at the PC end between pins 1, 4 and 6 and between pins 7 and 8, see diagram. Pins 7 and 8 of the instrument must **not** be connected to the PC, i.e. do not use a fully wired 9–way cable.



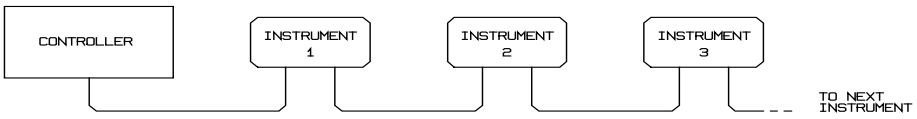
Baud Rate is set as described above in Address and Baud Rate Selection; the other parameters are fixed as follows:

Start Bits: 1 Parity: None

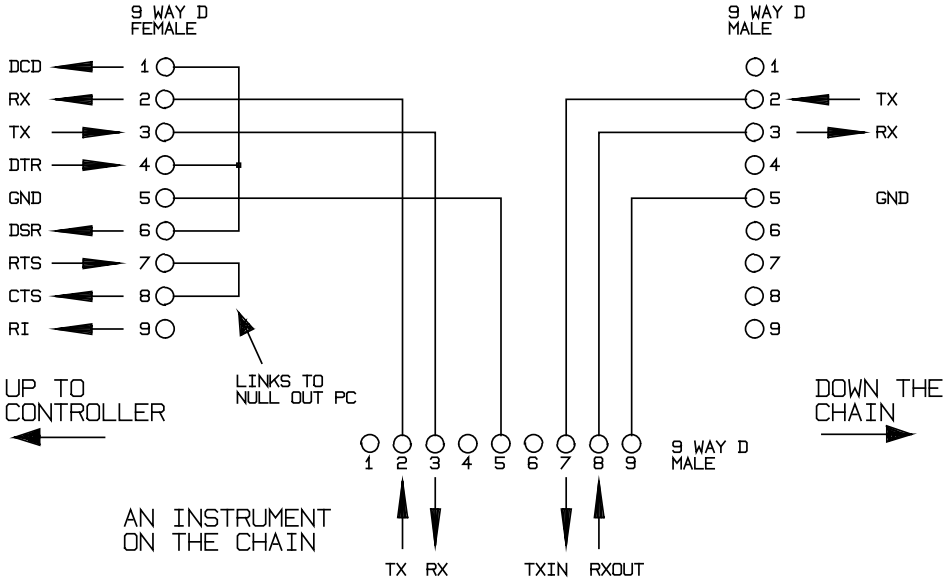
Data Bits: 8 Stop Bits: 1

Addressable RS232 Connections

For addressable RS232 operation pins 7, 8 and 9 of the instrument connector are also used. Using a simple cable assembly, a 'daisy chain' connection system between any number of instruments, up to the maximum of 32 can be made, as shown below:



The daisy chain consists of the transmit data (TXD), receive date (RXD) and signal ground lines only. There are no control/handshake lines. This makes XON/XOFF protocol essential and allows the inter-connection between instruments to contain just 3 wires. The wiring of the adaptor cable is shown below:



All instruments on the interface must be set to the same baud rate and all must be powered on, otherwise instruments further down the daisy chain will not receive any data or commands.

The other parameters are fixed as follows:

Start Bits: 1 Parity: None

Data Bits: 8 Stop Bits: 1

RS232 Character Set

Because of the need for XON/XOFF handshake it is possible to send ASCII coded data only; binary blocks are not allowed. Bit 7 of ASCII codes is ignored, i.e. assumed to be low. No distinction is made between upper and lower case characters in command mnemonics and they may be freely mixed. The ASCII codes below 20H (space) are reserved for addressable RS232 interface control. In this manual 20H, etc. means 20 in hexadecimal

Addressable RS232 (ARC) Interface Control Codes

All instruments intended for use on the ARC bus use the following set of interface control codes. Codes between 00H and 1FH which are not listed here as having a particular meaning are reserved for future use and will be ignored. Mixing interface control codes inside instrument commands is not allowed except as stated below for CR and LF codes and XON and XOFF codes.

When an instrument is first powered on it will automatically enter the Non- Addressable mode. In this mode the instrument is not addressable and will not respond to any address commands. This allows the instrument to function as a normal RS232 controllable device. This mode may be locked by sending the Lock Non-Addressable mode control code, 04H. The controller and instrument can now freely use all 8 bit codes and binary blocks but all interface control codes are ignored. To return to addressable mode the instrument must be powered off.

To enable addressable mode after an instrument has been powered on the Set Addressable Mode control code, 02H, must be sent. This will then enable all instruments connected to the ARC bus to respond to all interface control codes. To return to Non-Addressable mode the Lock Non-Addressable mode control code must be sent which will disable addressable mode until the instruments are powered off.

Before an instrument is sent a command it must be addressed to listen by sending the Listen Address control code, 12H, followed by a single character which has the lower 5 bits corresponding to the unique address of the required instrument, e.g. the codes A-Z or a-z give the addresses 1-26 inclusive while @ is address 0 and so on. Once addressed to listen the instrument will read and act upon any commands sent until the listen mode is cancelled.

Because of the asynchronous nature of the interface it is necessary for the controller to be informed that an instrument has accepted the listen address sequence and is ready to receive commands. The controller will therefore wait for Acknowledge code, 06H, before sending any commands, The addressed instrument will provide this Acknowledge. The controller should time-out and try again if no Acknowledge is received within 5 seconds.

Listen mode will be cancelled by any of the following interface control codes being received:

12H	Listen Address followed by an address not belonging to this instrument.
14H	Talk Address for any instrument.
03H	Universal Unaddress control code.
04H	Lock Non-Addressable mode control code.
18H	Universal Device Clear.

Before a response can be read from an instrument it must be addressed to talk by sending the Talk Address control code,14H, followed by a single character which has the lower 5 bits corresponding to the unique address of the required instrument, as for the listen address control code above. Once addressed to talk the instrument will send the response message it has available, if any, and then exit the talk addressed state. Only one response message will be sent each time the instrument is addressed to talk.

Talk mode will be cancelled by any of the following interface control codes being received:

12H Listen Address for any instrument.

14H Talk Address followed by an address not belonging to this instrument.

03H Universal Unaddress control code.

04H Lock Non-Addressable mode control code.

18H Universal Device Clear.

Talk mode will also be cancelled when the instrument has completed sending a response message or has nothing to say.

The interface code 0AH (LF) is the universal command and response terminator; it must be the last code sent in all commands and will be the last code sent in all responses.

The interface code 0DH (CR) may be used as required to aid the formatting of commands; it will be ignored by all instruments. Most instruments will terminate responses with CR followed by LF.

The interface code 13H (XOFF) may be sent at any time by a listener (instrument or controller) to suspend the output of a talker. The listener must send 11H (XON) before the talker will resume sending. This is the only form of handshake control supported by ARC.

Full List of Addressable RS232 (ARC) Interface Control Codes

02H Set Addressable Mode.

03H Universal Unaddress control code.

04H Lock Non-Addressable mode control code.

06H Acknowledge that listen address received.

0AH Line Feed (LF); used as the universal command and response terminator.

0DH Carriage Return (CR); formatting code, otherwise ignored.

11H Restart transmission (XON).

12H Listen Address - must be followed by an address belonging to the required instrument.

13H Stop transmission (XOFF).

14H Talk Address - must be followed by an address belonging to the required instrument.

18H Universal Device Clear.

GPIB Interface

When the GPIB interface is fitted the 24-way GPIB connector is located on the instrument rear panel. The pin connections are as specified in IEEE Std. 488.1-1987 and the instrument complies with IEEE Std. 488.1-1987 and IEEE Std. 488.2-1987.

GPIB Subsets

This instrument contains the following IEEE 488.1 subsets:

Source Handshake	SH1
Acceptor Handshake	AH1
Talker	T6
Listener	L4
Service Request	SR1
Remote Local	RL1
Parallel Poll	PP1
Device Clear	DC1
Device Trigger	DT0
Controller	C0
Electrical Interface	E2

GPIB IEEE Std. 488.2 Error Handling

The IEEE 488.2 UNTERMINATED error (addressed to talk with nothing to say) is handled as follows. If the instrument is addressed to talk and the response formatter is inactive and the input queue is empty then the UNTERMINATED error is generated. This will cause the Query Error bit to be set in the Standard Event Status Register, a value of 3 to be placed in the Query Error Register and the parser to be reset. See the Status Reporting section for further information.

The IEEE 488.2 INTERRUPTED error is handled as follows. If the response formatter is waiting to send a response message and a <PROGRAM MESSAGE TERMINATOR> has been read by the parser or the input queue contains more than one END message then the instrument has been INTERRUPTED and an error is generated. This will cause the Query Error bit to be set in the Standard Event Status Register, a value of 1 to be placed in the Query Error Register and the response formatter to be reset thus clearing the output queue. The parser will then start parsing the next <PROGRAM MESSAGE UNIT> from the input queue. See the Status Reporting section for further information.

The IEEE 488.2 DEADLOCK error is handled as follows. If the response formatter is waiting to send a response message and the input queue becomes full then the instrument enters the DEADLOCK state and an error is generated. This will cause the Query Error bit to be set in the Standard Event Status Register, a value of 2 to be placed in the Query Error Register and the response formatter to be reset thus clearing the output queue. The parser will then start parsing the next <PROGRAM MESSAGE UNIT> from the input queue. See the Status Reporting section for further information.

GPIB Parallel Poll

Complete parallel poll capabilities are offered on this generator. The Parallel Poll Enable Register is set to specify which bits in the Status Byte Register are to be used to form the ist local message The Parallel Poll Enable Register is set by the *PRE <nrf> command and read by the *PRE? command. The value in the Parallel Poll Enable Register is ANDed with the Status Byte Register; if the result is zero then the value of ist is 0 otherwise the value of ist is 1.

The instrument must also be configured so that the value of ist can be returned to the controller during a parallel poll operation. The instrument is configured by the controller sending a Parallel Poll Configure command (PPC) followed by a Parallel Poll Enable command (PPE). The bits in the PPE command are shown below:

bit 7 =	X	don't care
bit 6 =	1	Parallel poll enable
bit 5 =	1	
bit 4 =	0	
bit 3 =	Sense	sense of the response bit; 0 = low, 1 = high
bit 2 =	?	bit position of the response
bit 1 =	?	
bit 0 =	?	

Example. To return the RQS bit (bit 6 of the Status Byte Register) as a 1 when true and a 0 when false in bit position 1 in response to a parallel poll operation send the following commands

*PRE 64<pmt>, then PPC followed by 69H (PPE)

The parallel poll response from the generator will then be 00H if RQS is 0 and 01H if RQS is 1.

During parallel poll response the DIO interface lines are resistively terminated (passive termination). This allows multiple devices to share the same response bit position in either wired-AND or wired-OR configuration, see IEEE 488.1 for more information.

Status Reporting

This section describes the complete status model of the instrument. Note that some registers are specific to the GPIB section of the instrument and are of limited use in an RS232 environment.

Standard Event Status and Standard Event Status Enable Registers

These two registers are implemented as required by the IEEE std. 488.2.
Any bits set in the Standard Event Status Register which correspond to bits set in the Standard Event Status Enable Register will cause the ESB bit to be set in the Status Byte Register.

The Standard Event Status Register is read and cleared by the *ESR? command. The Standard Event Status Enable register is set by the *ESE <nrf> command and read by the *ESE? command.

Bit 7 - Power On. Set when power is first applied to the instrument.

Bit 6 - Not used.

Bit 5 - Command Error. Set when a syntax type error is detected in a command from the bus. The parser is reset and parsing continues at the next byte in the input stream.

Bit 4 - Execution Error. Set when an error is encountered while attempting to execute a completely parsed command. The appropriate error number will be reported in the Execution Error Register.

Bit 3 - Not used.

Bit 2 - Query Error. Set when a query error occurs. The appropriate error number will be reported in the Query Error Register as listed below.

1. Interrupted error
2. Deadlock error
3. Unterminated error

Bit 1 - Not used.

Bit 0 - Operation Complete. Set in response to the *OPC command.

Status Byte Register and Service Request Enable Register

These two registers are implemented as required by the IEEE std. 488.2.
Any bits set in the Status Byte Register which correspond to bits set in the Service Request Enable Register will cause the RQS/MSS bit to be set in the Status Byte Register, thus generating a Service Request on the bus.

The Status Byte Register is read either by the *STB? command, which will return MSS in bit 6, or by a Serial Poll which will return RQS in bit 6. The Service Request Enable register is set by the *SRE <nrf> command and read by the *SRE? command.

Bit 7 - Not used.

Bit 6 - RQS/MSS. This bit, as defined by IEEE Std. 488.2, contains both the Requesting Service message and the Master Status Summary message. RQS is returned in response to a Serial Poll and MSS is returned in response to the *STB? command.

Bit 5 - ESB. The Event Status Bit. This bit is set if any bits set in the Standard Event Status Register correspond to bits set in the Standard Event Status Enable Register.

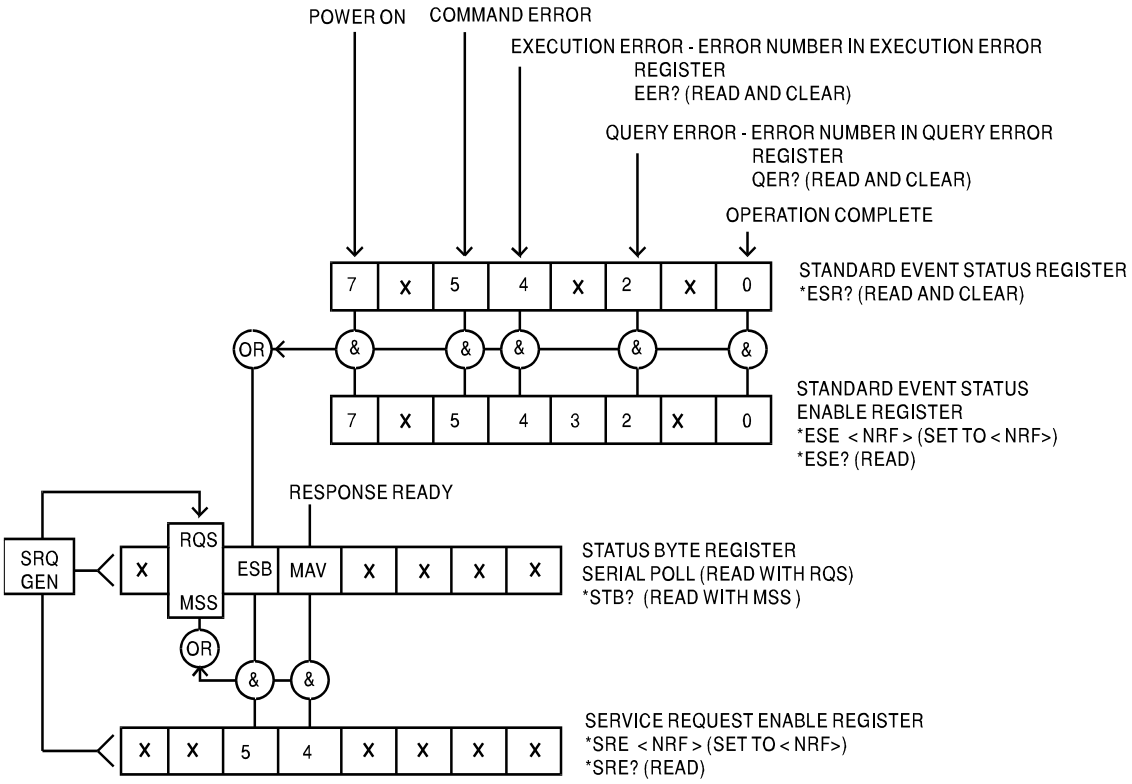
Bit 4 - MAV. The Message Available Bit. This will be set when the instrument has a response message formatted and ready to send to the controller. The bit will be cleared after the Response Message Terminator has been sent.

Bit 3 - Not used.

Bit 2 - Not used.

Bit 1 - Not used.

Bit 0 - Not used.



Status Model

Power on Settings

The following instrument status values are set at power on:

Status Byte Register	= 0
Service Request Enable Register ›	= 0
Standard Event Status Register	= 128 (pon bit set)
Standard Event Status Enable Register ›	= 0
Execution Error Register	= 0
Query Error Register	= 0
Parallel Poll Enable Register ›	= 0

› Registers marked thus are specific to the GPIB section of the instrument and are of limited use in an RS232 environment.

The instrument will be in local state with the keyboard active.

The instrument parameters at power on are the same as at last switch off with the exception of RF OUT which is always off.

If for any reason an error is detected at power up in the non-volatile ram a warning will be issued and all settings will be returned to their default states as for a *RST command.

RS232 Remote Command Formats

Serial input to the instrument is buffered in a 256 byte input queue which is filled, under interrupt, in a manner transparent to all other instrument operations. The instrument will send XOFF when approximately 200 characters are in the queue. XON will be sent when approximately 100 free spaces become available in the queue after XOFF was sent. This queue contains raw (un-parsed) data which is taken, by the parser, as required. Commands (and queries) are executed in order and the parser will not start a new command until any previous command or query is complete. In non–addressable RS232 mode responses to commands or queries are sent immediately; there is no output queue. In addressable mode the response formatter will wait indefinitely if necessary, until the instrument is addressed to talk and the complete response message has been sent, before the parser is allowed to start the next command in the input queue.

Commands must be sent as specified in the commands list and must be terminated with the command terminator code 0AH (Line Feed, LF). Commands may be sent in groups with individual commands separated from each other by the code 3BH (;). The group must be terminated with command terminator 0AH (Line Feed, LF).

Responses from the instrument to the controller are sent as specified in the commands list. Each response is terminated by 0DH (Carriage Return, CR) followed by 0AH (Line Feed, LF).

<WHITE SPACE> is defined as character codes 00H to 20H inclusive with the exception of those which are specified as Addressable RS232 (ARC) control codes.

<WHITE SPACE> is ignored except in command identifiers. e.g. '*C LS' is not equivalent to '*CLS'.

The high bit of all characters is ignored.

The commands are case insensitive.

GPIB Remote Command Formats

GPIB input to the instrument is buffered in a 256 byte input queue which is filled, under interrupt, in a manner transparent to all other instrument operations. The queue contains raw (un-parsed) data which is taken, by the parser, as required. Commands (and queries) are executed in order and the parser will not start a new command until any previous command or query is complete. There is no output queue which means that the response formatter will wait, indefinitely if necessary, until the instrument is addressed to talk and the complete response message has been sent, before the parser is allowed to start the next command in the input queue.

Commands are sent as <PROGRAM MESSAGES> by the controller, each message consisting of zero or more <PROGRAM MESSAGE UNIT> elements separated by <PROGRAM MESSAGE UNIT SEPARATOR> elements.

A <PROGRAM MESSAGE UNIT> is any of the commands in the remote commands list.

A <PROGRAM MESSAGE UNIT SEPARATOR> is the semi-colon character ';' (3BH).

<PROGRAM MESSAGES> are separated by <PROGRAM MESSAGE TERMINATOR> elements which may be any of the following:

NL	The new line character (0AH)
NL^END	The new line character with the END message
^END	The END message with the last character of the message

Responses from the instrument to the controller are sent as <RESPONSE MESSAGES>. A <RESPONSE MESSAGE> consists of one <RESPONSE MESSAGE UNIT> followed by a <RESPONSE MESSAGE TERMINATOR>.

A <RESPONSE MESSAGE TERMINATOR> is the new line character with the END message NL^END.

Each query produces a specific <RESPONSE MESSAGE> which is listed along with the command in the remote commands list.

<WHITE SPACE> is ignored except in command identifiers. e.g. '*C LS' is not equivalent to '*CLS'. <WHITE SPACE> is defined as character codes 00H to 20H inclusive with the exception of the NL character (0AH).

The high bit of all characters is ignored.

The commands are case insensitive.

Command List

This section lists all commands and queries implemented in this instrument. The commands are listed in alphabetical order within the function groups.

Note that there are no dependent parameters, coupled parameters, overlapping commands, expression program data elements or compound command program headers; each command is completely executed before the next command is started. All commands are sequential and the operation complete message is generated immediately after execution in all cases.

The following nomenclature is used:

<rmt>	<RESPONSE MESSAGE TERMINATOR>
<nrf>	A number in any format. e.g. 12, 12.00, 1.2 e1 and 120 e-1 are all accepted as the number 12. Any number, when received, is converted to the required precision consistent with the use then rounded up to obtain the value of the command.
<nr1>	A number with no fractional part, i.e. an integer.

The commands which begin with a ***** are those specified by IEEE Std. 488.2 as Common commands. All will function when used on the RS232 interface but some are of little use.

Output Parameters

FREQ <nrf>	Set the output frequency to <nrf> kHz
DBMLEV <nrf>	Set the output level to <nrf> in dBm
MVLEV <nrf>	Set the output level to <nrf> in mV
UVLEV <nrf>	Set the output level to <nrf> in uV
MODON	Set modulation to ON
MODOFF	Set modulation to OFF
INTMOD	Select internal modulation source
EXTMOD	Select external modulation source
PKDEV <nrf>	Set the peak deviation to <nrf> kHz
RFON	Switch on RF output
RFOFF	Switch off RF output

Editing and Cursor Movement Commands

FSTEP <nrf>	Set the frequency step size to <nrf> kHz
DBSTEP <nrf>	Set the dB step size to <nrf> dB
MVSTEP <nrf>	Set the linear step size to <nrf> mV
UVSTEP <nrf>	Set the linear step size to <nrf> uV
STEP_UP	Performs the same function as pressing the ▲ key
STEP_DOWN	Performs the same function as pressing the ▼ key

FIELD_UP	Performs the same function as pressing the FIELD ▲ key
FIELD_DOWN	Performs the same function as pressing the FIELD ▼ key
FREQ_PTR	Moves the edit cursor to FREQUENCY and displays the appropriate menu to make FREQUENCY viewable.
LEV_PTR	Moves the edit cursor to output LEVEL and displays the appropriate menu to make output LEVEL viewable.
MOD_PTR	Moves the edit cursor to MODULATION and displays the appropriate menu to make MODULATION viewable.
PKDEV_PTR	Moves the edit cursor to PK DEVIATION and displays the appropriate menu to make PK DEVIATION viewable.
UTILS_PTR	Moves the edit cursor to the last selected parameter on the Utilities menu and displays the Utilities menu.
STEP_PTR	Moves the edit cursor to the last selected parameter on the Step Size menu and displays the Step Size menu.

System Commands

*RST	Resets the instrument to default settings with the exception of all remote interface settings.
*RCL <nrf>	Recalls the instrument set–up contained in store number <nrf>. Valid store numbers are 1–10. Recalling store 10 sets all parameters to default settings with the exception of remote interface settings. An attempt to recall from a store which has not been previously loaded with a set–up will create an execution error.
*SAV <nrf>	Saves the complete instrument set–up in store number <nrf>. Valid store numbers are 1 – 9.

Status Commands

*LRN?	Returns the complete set up of the instrument as a hexadecimal character data block approximately 84 bytes long. The syntax of the response is LRN <data><rmt>. To re–install the set–up return the block exactly as received, including the LRN header at the beginning of the block, see below. The settings in the instrument are not affected by execution of the *LRN? command.
LRN <character data>	Install data from a previous *LRN? command. Note that the LRN header is provided by the *LRN? response block.
EER?	Query and clear Execution Error Register. The response format is nr1<rmt>.
QER?	Query and clear Query Error Register. The response format is nr1<rmt>
*CLS	Clear Status. Clears the Standard Event Status Register, Query Error Register and Execution Error Register. This indirectly clears the Status Byte Register.
*ESE <nrf>	Set the Standard Event Status Enable Register to the value of <nrf>.
*ESE?	Returns the value in the Standard Event Status Enable Register in <nr1> numeric format. The syntax of the response is <nr1><rmt>
*ESR?	Returns the value in the Standard Event Status Register in <nr1> numeric format. The register is then cleared. The syntax of the response is <nr1><rmt>

*IST?	Returns **ist** local message as defined by IEEE Std. 488.2. The syntax of the response is 0<rmt>, if the local message is false or 1<rmt>, if the local message is true.
*OPC	Sets the Operation Complete bit (bit 0) in the Standard Event Status Register. This will happen immediately the command is executed because of the sequential nature of all operations.
*OPC?	Query Operation Complete status. The syntax of the response is 1<rmt>. The response will be available immediately the command is executed because of the sequential nature of all operations.
*PRE <nrf>	Set the Parallel Poll Enable Register to the value <nrf>.
*PRE?	Returns the value in the Parallel Poll Enable Register in <nr1> numeric format. The syntax of the response is <nr1><rmt>
*SRE <nrf>	Set the Service Request Enable Register to <nrf>.
*SRE?	Returns the value of the Service Request Enable Register in <nr1> numeric format. The syntax of the response is<nr1><rmt>
*STB?	Returns the value of the Status Byte Register in <nr1> numeric format. The syntax of the response is<nr1><rmt>
*WAI	Wait for Operation Complete true. As all commands are completely executed before the next is started this command takes no additional action.

Miscellaneous Commands

*IDN?	Returns the instrument identification. The exact response is determined by the instrument configuration and is of the form <NAME>,<model>, 0, <version><rmt> where <NAME> is the manufacturer's name, <model> defines the type of instrument and <version> is the revision level of the software installed.
*TST?	The generator has no self test capability and the response is always 0 <rmt>
*TRG	The generator has no trigger capability.

Calibration Specific Commands

See Service Manual for details of calibration specific commands.

Maintenance

The Manufacturers or their agents overseas will provide a repair service for any unit developing a fault. Where owners wish to undertake their own maintenance work, this should only be done by skilled personnel in conjunction with the service manual which may be purchased directly from the Manufacturers or their agents overseas.

Cleaning

If the instrument requires cleaning use a cloth that is only lightly dampened with water or a mild detergent.

WARNING! TO AVOID ELECTRIC SHOCK, OR DAMAGE TO THE INSTRUMENT, NEVER ALLOW WATER TO GET INSIDE THE CASE. TO AVOID DAMAGE TO THE CASE NEVER CLEAN WITH SOLVENTS.

Appendix 1. Error Messages

Error messages are given when a system fault is found or an illegal setting is attempted; the previous setting is retained.

Each error message has a number; only this number is reported via the remote control interfaces.

The following is a complete list of messages as they appear on the display.

Error Message No.	Message	Explanation
50	EEPROM READ ERROR To set default calibration press any key	Displayed at power up if a checksum error is encountered when reading calibration constants from EEPROM. A key press is necessary to continue operation but the instrument will almost certainly be outside specifiation.
51	EEPROM WRITE ERROR Press any key to continue	Displayed if default calibration constants could not be successfully written into the EEPROM following an EEPROM read error. A key press is necessary to continue operation but operation is unpredictable.
52	RAM READ ERROR RECALLING DEFAULT SETUP Calib. not affected	Displayed at power up if a checksum error is encountered when reading set up information from non–volatile RAM. Operation continues automatically after three seconds delay.
121	NO VALID DATA IN STORE <STORE NUMBER> Press any key	Displayed if an attempt is made to retrieve an instrument set up from a store which has not yet been programmed. In LOCAL mode a key press is necessary to continue operation. In REMOTE mode operation continues automatically after three seconds delay.
120	ERROR OUT OF RANGE	Displayed if a REMOTE command attempts to set any parameter to a value which is beyond its acceptable range of values. Operation continues automatically after three seconds.

Error message numbers are not displayed but are placed in the Execution Error Register where they can be read via the remote interfaces.

Appendix 2. Factory Defaults

The instrument will be set to the following condition if RECALL DEFAULTS is executed on the Utilities menu or if the remote commands *RST or *RCL 10 are issued.

FREQUENCY	=	600.000 MHz		
LEVEL	=	0.0 dBm	–	RF output is turned off
MODULATION	=	FM INT OFF	–	modulation is turned off
PK. DEVIATION	=	50.0 kHz		
FREQUENCY STEP	=	10.000 MHz		
LINEAR LEVEL STEP	=	10.0mV		
dB LEVEL STEP	=	10.0dB		