Introduction

This low cost synthesized RF signal generator features a wide amplitude range, low noise and inherently good frequency stability. The generator also features internal and external FM, AM and Phase Modulation. The instrument can be operated manually via the front panel or remotely controlled via the RS232 or GPIB interfaces.

It is suitable for 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.
**FREQUENCY**

- **Frequency Range:** 150kHz – 2000MHz
- **Setting Resolution:** 10Hz
- **Accuracy/Stability:** see Reference Frequency
- **Phase Noise:** <-116dBc @ 25kHz offset, 500MHz carrier.
- **Residual FM:** 15Hz @ 500MHz – equivalent peak deviation in a 300Hz to 3.4kHz bandwidth.

**REFERENCE FREQUENCY**

- **Internal Reference Accuracy:** <± 1ppm, 15ºC – 30ºC
  <± 2ppm, 5ºC – 40ºC
- **Internal Reference Stability:** <1ppm/year
- **Reference In/Out:** Rear panel BNC; can be disabled when not required for input or output.
- **External Reference IN:** 10MHz, 50Ω input impedance, 2 - 5Vpp
  Automatic detection and selection when external reference signal is present and Reference IN is selected on front panel.
  Front panel LED indication when external is active.
- **Internal Reference OUT:** 10MHz, 50Ω output impedance, >2Vpp into 50Ω
  Signal present when Reference OUT is selected on the front panel

**OUTPUT LEVEL**

- **Output Level Range:** –127dBm – +7dBm, all modes except AM
  –127dBm – +1dBm, AM mode
- **Setting Resolution:** 0.1dB, 0.01uV –1mV
- **Accuracy:** ± 2dBm
- **Harmonically Related Signals:** <-25dBc @ +7dBm
- **Sub-harmonically Related Signals:** ≤1000MHz : None
  >1000MHz: <-20dBc @ +7dBm
- **Non-harmonic Spurii:** ≥62.5MHz: <-60dBc
  <62.5MHz: <-50dBc (150kHz – 250MHz bandwidth)
- **Carrier Leakage:** <0.5µV generated into a 50Ω load by a two turn 25mm loop 25mm from the generator with the output set to ≤–10dBm into a sealed 50Ω load.
- **Output Impedance:** 50Ω
- **Output Connector:** Type N
- **Reverse Power Protection:** 50V DC, up to 25W from 50Ω source. Flashing LED indication.
- **Output Switch:** RF OUT On/Off switch with LED showing ON status
MODULATION SOURCE

Internal: 400Hz and 1kHz sine derived from reference frequency.

External: Calibrated for 1Vrms sine into 600Ω

Connector: Front Panel BNC provides modulation input when external modulation is selected and outputs internal modulation when internal is selected.

Modulation I/O Impedance: 600Ω

Output Level: 1Vrms EMF from 600Ω source impedance.

Maximum Input: 20V rms

FREQUENCY MODULATION

Max Peak Deviation:

- 800kHz, 1000MHz – 2000MHz
- 400kHz, 500MHz – 999.99999MHz
- 200kHz, 250MHz – 499.99999MHz
- 100kHz, 125MHz – 249.99999MHz
- 50kHz, 62.5MHz – 124.99999MHz
- 100kHz, 150kHz – 62.49999MHz

Setting Resolution: 0.5kHz

Deviation Accuracy: <±10% ± 0.5kHz for 1kHz Internal or 1kHz, 1Vrms External Modulation.

Modulation Signal: Internal or External 100Hz – 300kHz (±2dB relative to 1kHz)

Distortion: <2% @1kHz modulation, max. deviation (300-3.4kHz bandwidth)

PHASE MODULATION

Max Peak Deviation:

- 80.0rads 1000MHz – 2000MHz
- 40.0rads 500MHz – 999.99999MHz
- 20.0rads 250MHz – 499.99999MHz
- 10.0rads 125MHz – 249.99999MHz
- 5.0rads 62.5MHz – 124.99999MHz
- 10.0rads 150kHz – 62.49999MHz

Setting Resolution: 0.05rads <10.0rads deviation, 0.1rad >=10.0rads deviation

Deviation Accuracy: <±10% ± 0.05rads for 1kHz Internal or 1kHz, 1Vrms External Modulation.

Modulation Signal: Internal or External 100Hz – 10kHz (±2dB relative to 1kHz)

Distortion: <2% @ 1kHz modulation, max. deviation (300-3.4kHz bandwidth)

AMPLITUDE MODULATION

Max Modulation Depth: 100%, usability decreasing to 90% at 2GHz

Setting Resolution: 0.5%

Accuracy: < (5% setting +1%) for 1kHz Internal or 1kHz, 1Vrms External Modulation, <70% depth.

Modulation Signal: Internal or External 50Hz – 200kHz (±1dB relative to 1kHz)

Distortion - 150kHz – 1GHz: ≤3% @ 30% depth, ≤5% @ 70% depth

1GHz – 2GHz: ≤5% @ 30% depth, ≤10% @ 70% depth

@ 1kHz modulation, 300-3.4kHz measurement bandwidth.
### INTERFACES

<table>
<thead>
<tr>
<th>Interface</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS232</td>
<td>Variable Baud rate, 19200 Baud maximum, addressable RS232 compatible.</td>
</tr>
<tr>
<td>IEEE</td>
<td>Conforming to IEEE488-1, IEEE488-2</td>
</tr>
</tbody>
</table>

### GENERAL

<table>
<thead>
<tr>
<th>Category</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>220 - 240VAC or 110 - 120VAC ±10%, 50/60Hz, adjustable internally; 30VA max. Installation Category II.</td>
</tr>
<tr>
<td>Display</td>
<td>20 character x 4 row backlit alphanumeric LCD</td>
</tr>
<tr>
<td>Data Entry</td>
<td>Keyboard selection of all major parameters or stepping by user selected increment values using up/down keys or rotary control.</td>
</tr>
<tr>
<td>Stored Settings</td>
<td>Up to 9 complete set-ups.</td>
</tr>
<tr>
<td>Operating Range</td>
<td>+5°C to +40°C, 20 - 80% RH</td>
</tr>
<tr>
<td>Storage Range</td>
<td>−20°C to + 60°C</td>
</tr>
<tr>
<td>Environmental</td>
<td>Indoor use at altitudes up to 2000m, Pollution Degree 2.</td>
</tr>
<tr>
<td>EMC</td>
<td>Complies with EN61326</td>
</tr>
<tr>
<td>Safety</td>
<td>Complies with EN61010-1</td>
</tr>
<tr>
<td>Size</td>
<td>3U high, half rack width.</td>
</tr>
<tr>
<td>Weight</td>
<td>5.0 kg</td>
</tr>
<tr>
<td>Options</td>
<td>19 inch rack mounting kit.</td>
</tr>
</tbody>
</table>
This instrument has been designed to meet the requirements of the EMC Directive 89/336/EEC. Compliance was demonstrated by meeting the test limits of the following standards:

**Emissions**

EN61326 (1998) EMC product standard for Electrical Equipment for Measurement, Control and Laboratory Use. Test limits used were:

a) Radiated: Class B  
b) Conducted: Class B  
c) Harmonics: EN61000-3-2 (2000) Class A; the instrument is Class A by product category.

**Immunity**


Test methods, limits and performance achieved were:

a) EN61000-4-2 (1995) Electrostatic Discharge: 4kV air, 4kV contact, Performance A.  
b) EN61000-4-3 (1997) Electromagnetic Field, 3V/m, 80% AM at 1kHz, Performance A.  
c) EN61000-4-11 (1994) Voltage Interrupt, 1 cycle, 100%, Performance A.  
d) EN61000-4-4 (1995) Fast Transient, 1kV peak (AC line), 0.5kV peak (signal lines and RS232/GPIB ports), Performance A.  
e) EN61000-4-5 (1995) Surge, 0.5kV (line to line), 1kV (line to ground), Performance A.  
f) EN61000-4-6 (1996) Conducted RF, 3V, 80% AM at 1kHz (AC line only; signal connections <3m not tested), Performance A.

According to EN61326 the definitions of performance criteria are:

**Performance criterion A:** ‘During test normal performance within the specification limits.’

**Performance criterion B:** ‘During test, temporary degradation, or loss of function or performance which is self-recovering’.

**Performance criterion C:** ‘During test, temporary degradation, or loss of function or performance which requires operator intervention or system reset occurs.’

**Cautions**

To ensure continued compliance with the EMC directive the following precautions should be observed:

a) connect the generator to other equipment using only high quality, double-screened cables.  
b) after opening the case for any reason ensure that all signal and ground connections are remade correctly before replacing the cover. Always ensure all case screws are correctly refitted and tightened.  
c) In the event of part replacement becoming necessary, only use components of an identical type, see the Service Manual.
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/MnO2 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 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.

**Fuse**

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

- for 230V or 115V operation: 1A (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.
Connections

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.
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.

⚠️ Do not apply an external voltage to this output. Protected against accidental connection of up to 50VDC and reverse power of up to 25 Watts from 50Ω.

MODULATION IN/OUT
This is the external modulation input and internal modulation output. Input frequency range is 50Hz to 300kHz (depending on modulation type) and impedance is nominally 600Ω as input or output.

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

Rear Panel Connections

EXTERNAL REFERENCE IN/OUT
Can be set to be the External Reference In (10MHz, 2V to 5Vpp, 50Ω), Internal Reference Out (10MHz, 4Vpp from 50Ω) or Off.

⚠️ Do not apply external voltages exceeding ± 10Vpp to this input/output.

RS232
9-pin D-connector compatible with addressable RS232 use. The pin connections are shown below:

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>No internal Connection</td>
</tr>
<tr>
<td>2</td>
<td>TXD</td>
<td>Transmitted data from instrument</td>
</tr>
<tr>
<td>3</td>
<td>RXD</td>
<td>Received data to instrument</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>No internal connection</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Signal ground</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>No internal connection</td>
</tr>
<tr>
<td>7</td>
<td>RXD2</td>
<td>Secondary received data (addressable RS232 only)</td>
</tr>
<tr>
<td>8</td>
<td>TXD2</td>
<td>Secondary transmitted data (addressable RS232 only)</td>
</tr>
<tr>
<td>9</td>
<td>GND</td>
<td>Signal ground (addressable RS232 only)</td>
</tr>
</tbody>
</table>

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 used in addressable RS232 mode. Signal grounds are connected to instrument ground. The RS232 address is set from the front panel using the COMMS menu.

GPIB (IEEE-488)
The GPIB interface 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 COMMS 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, 123.45689 MHz is set by keying 1, 2, 3, 4, 5, 6, 8, 9 MHz. The parameter actually changes only when the units key (dB, MHz, etc.) is pressed.

  FREQUENCY can be entered in kHz, MHz, or GHz 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 TYPE 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 COMMS key selects the communications menu and allows the communication interface parameters to be set up. When the instrument is in remote control the COMMS key doubles as the LOCAL key, which returns the instrument to local (keyboard) control.
The UTILITIES key selects the Utilities menu which gives access to the stored set-up, reference socket control and buzzer 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 0.1MHz. 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, MHz or GHz but will always be displayed in MHz. The smallest step that can be set is 10Hz 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, MHz or GHz, 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 2000 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 150kHz 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 internal or external AM, FM or Phase Modulation (PM). With the selection cursor in the MODulation field of the main menu, successive presses of the TYPE key will step the generator through all available combinations of internal and external AM, FM and PM; alternatively the selection can be made by using the rotary control or ▲ ▼ keys.

**Amplitude Modulation (AM)**

The choices are INTernal at 400Hz, INTernal at 1kHz or EXTernal; with EXTernal selected the specified modulation frequency range can be applied to the MODULATION IN/OUT socket.

With AM selected the DEPTH/DEVIATION field automatically displays DEPTH. With the selection cursor in the depth field the modulation depth can be set directly from the keyboard in %, or changed using the rotary control or ▲ ▼ keys; modulation depth can be set from 0.5% to 100% in 0.5% increments.

With EXTernal modulation selected, the specified modulation depth is achieved with a 1Vrms sinewave modulation signal.

With AM selected the maximum RF output level is +1.0dBm. If a higher output level has been set (with AM and/or RF OUT off) then a warning message “+1dBm MAX WITH AM ON” will show temporarily and the RF OUT level will be reduced to +1dBm. The output level setting will remain at +1dBm when AM and/or RF OUT are turned off.

**Frequency Modulation (FM)**

The choices are INTernal at 400Hz, INTernal at 1kHz or EXTernal; with EXTernal selected the specified modulation frequency range can be applied to the MODULATION IN/OUT socket.

With FM selected the DEPTH/DEVIATION field automatically displays Peak DEVIation. With the selection cursor in the PK. DEV field the peak deviation can be set directly from the keyboard, in kHz, MHz or GHz, or changed using the rotary control or ▲ ▼ keys; peak deviation can be set to a resolution of 0.5kHz.

With EXTernal modulation selected, the specified peak deviation is achieved with a 1Vrms sinewave modulation signal.

The maximum peak deviation achievable depends on the carrier frequency, see Specification section. If a peak deviation is entered (with MOD ON) which is greater than the maximum for the set carrier frequency then a warning message “PK. DEV LIMITED BY CARRIER FREQUENCY” will show temporarily and the peak deviation will be changed to the maximum permitted for the set carrier frequency. The peak deviation frequency in the display is marked with a * to show that it differs from that entered; the entered value will be restored when FM and/or MOD ON/OFF are turned off.

The default FM settings are internal 1kHz modulation, 50kHz peak deviation, modulation off; FM is also the instrument’s default modulation setting.

**Phase Modulation (PM)**

The choices are INTernal at 400Hz, INTernal at 1kHz or EXTernal; with EXTernal selected the specified modulation frequency range can be applied to the MODULATION IN/OUT socket.

With PM selected the DEPTH/DEVIATION field automatically displays Peak DEVIation. With the selection cursor in the PK. DEV field the peak deviation can be set directly from the keyboard, in rads, or changed using the rotary control or ▲ ▼ keys; peak deviation can be set to a resolution of 0.05 rads up to 10.0 rads and to a resolution of 0.1 rads above 10.0 rads.
With EXTernal modulation selected, the specified peak deviation is achieved with a 1Vrms sinewave modulation signal.

The maximum peak deviation achievable depends on the carrier frequency, see Specification section. If a peak deviation is entered (with MOD ON) which is greater than the maximum for the set carrier frequency then a warning message “PK. DEV LIMITED BY CARRIER FREQUENCY” will show temporarily and the peak deviation will be changed to the maximum permitted for the set carrier frequency. The peak deviation frequency in the display is marked with a * to show that it differs from that entered; the entered value will be restored when PM and/or MOD ON/OFF are turned off.

The default PM settings are internal 1kHz modulation, 5.00 rads 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 will remain as previously set.

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.

Maintenance

For service repair and calibration please contact your local Tenma distributor or go to www.tenma.com

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.
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 system 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, addressable RS232 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 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 COMMS menu, accessed by pressing the COMMS 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:

<table>
<thead>
<tr>
<th>Pin</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>No internal connection</td>
</tr>
<tr>
<td>2</td>
<td>TXD</td>
<td>Transmitted data from instrument</td>
</tr>
<tr>
<td>3</td>
<td>RXD</td>
<td>Received data to instrument</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>No internal connection</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Signal ground</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>No internal connection</td>
</tr>
<tr>
<td>7</td>
<td>RXD2</td>
<td>Secondary received data (addressable RS232 only)</td>
</tr>
<tr>
<td>8</td>
<td>TXD2</td>
<td>Secondary transmitted data (addressable RS232 only)</td>
</tr>
<tr>
<td>9</td>
<td>GND</td>
<td>Signal ground (addressable RS232 only)</td>
</tr>
</tbody>
</table>
**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 Interface Control Codes**

All instruments intended for use on the addressable RS232 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 addressable RS232 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 timeout 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.

Full List of Addressable RS232 Interface Control Codes

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>02H</td>
<td>Set Addressable Mode</td>
</tr>
<tr>
<td>03H</td>
<td>Universal Unaddress control code</td>
</tr>
<tr>
<td>04H</td>
<td>Lock Non-Addressable mode control code</td>
</tr>
<tr>
<td>06H</td>
<td>Acknowledge that listen address received</td>
</tr>
<tr>
<td>0AH</td>
<td>Line Feed (LF); used as the universal command and response terminator</td>
</tr>
<tr>
<td>0DH</td>
<td>Carriage Return (CR); formatting code, otherwise ignored</td>
</tr>
<tr>
<td>11H</td>
<td>Restart transmission (XON)</td>
</tr>
<tr>
<td>12H</td>
<td>Listen Address – must be followed by an address belonging to the required instrument</td>
</tr>
<tr>
<td>13H</td>
<td>Stop transmission (XOFF)</td>
</tr>
<tr>
<td>14H</td>
<td>Talk Address – must be followed by an address belonging to the required instrument</td>
</tr>
<tr>
<td>18H</td>
<td>Universal Device Clear</td>
</tr>
</tbody>
</table>

GPIB Interface

The GPIB interface 24-way 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 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.

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 ANDeed 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:

<table>
<thead>
<tr>
<th>bit</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>X</td>
<td>don’t care</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>Parallel poll enable</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Sense</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>Sense of the response bit; 0 = low, 1 = high</td>
</tr>
<tr>
<td>2</td>
<td>?</td>
<td>bit position of the response</td>
</tr>
<tr>
<td>1</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>?</td>
<td></td>
</tr>
</tbody>
</table>

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.

System Event Status Register and System Event Status Enable Register

These two registers are implemented as device specific, event and event enable registers according to the IEEE Std. 488.2. Their purpose is to inform the controller when the reverse power protection system is operating or has operated since the last read of the System Event Status Register.

If the reverse power protection system operates the specified bit will be set in the System Event Status Register. If the corresponding bit is also set in the System Event Status Enable Register then the SYS bit will become set in the Status Byte Register.

The System Event Status Register is read and cleared by the SSR? command and the System Event Status Enable Register is set by the SSE <nrf> command.

The bits are defined as:-

Bit 7 – Bit 1 - Not used
Bit 0 - Set when the reverse power protection system operates
**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** - SYS. This bit will be set if any bits in the System Event Status Register are set and corresponding bits are set in the System Event Status Enable Register.

---

**Status Model**
Power on Settings

The following instrument status values are set at power on:

- Status Byte Register † = 0
- Service Request Enable Register † (SRE) = 0
- Standard Event Status Register (ESR) = 128 (pon bit set)
- Standard Event Status Enable Register (ESE) = 0
- Execution Error Register (EER) = 0
- Query Error Register (QER) = 0
- Parallel Poll Enable Register † = 0
- System Event Status Register (SSR) = 0
- System Event Status Enable Register (SSE) = 0

† Registers marked thus are specific to the GPIB section of the instrument and are not implemented 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.
Remote Commands

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 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.
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*<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**

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FREQ <code>&lt;nrf&gt;</code></td>
<td>Set the output frequency to <code>&lt;nrf&gt;</code> kHz</td>
</tr>
<tr>
<td>DBMLEV <code>&lt;nrf&gt;</code></td>
<td>Set the output level to <code>&lt;nrf&gt;</code> in dBm</td>
</tr>
<tr>
<td>MVLEV <code>&lt;nrf&gt;</code></td>
<td>Set the output level to <code>&lt;nrf&gt;</code> in mV</td>
</tr>
<tr>
<td>UVLEV <code>&lt;nrf&gt;</code></td>
<td>Set the output level to <code>&lt;nrf&gt;</code> in uV</td>
</tr>
<tr>
<td>MODON</td>
<td>Set modulation to ON</td>
</tr>
<tr>
<td>MODOFF</td>
<td>Set modulation to OFF</td>
</tr>
<tr>
<td>FM <code>&lt;nrf&gt;</code></td>
<td>Set the FM peak deviation to <code>&lt;nrf&gt;</code> kHz</td>
</tr>
<tr>
<td>PM <code>&lt;nrf&gt;</code></td>
<td>Set the PM peak deviation to <code>&lt;nrf&gt;</code> rads</td>
</tr>
<tr>
<td>AM <code>&lt;nrf&gt;</code></td>
<td>Set the AM depth to <code>&lt;nrf&gt;</code> %</td>
</tr>
<tr>
<td>RFON</td>
<td>Switch on RF output</td>
</tr>
<tr>
<td>RFOFF</td>
<td>Switch off RF output</td>
</tr>
<tr>
<td>MOD_TYPE <code>&lt;nrf&gt;</code></td>
<td>Select the modulation type according to <code>&lt;nrf&gt;</code> defined as:</td>
</tr>
<tr>
<td></td>
<td>1 = FM INT 400Hz</td>
</tr>
<tr>
<td></td>
<td>2 = FM INT 1000Hz</td>
</tr>
<tr>
<td></td>
<td>3 = FM EXT</td>
</tr>
<tr>
<td></td>
<td>4 = PM INT 400Hz</td>
</tr>
<tr>
<td></td>
<td>5 = PM INT 1000Hz</td>
</tr>
<tr>
<td></td>
<td>6 = PM EXT</td>
</tr>
<tr>
<td></td>
<td>7 = AM INT 400Hz</td>
</tr>
<tr>
<td></td>
<td>8 = AM INT 1000Hz</td>
</tr>
<tr>
<td></td>
<td>9 = AM EXT</td>
</tr>
</tbody>
</table>
REF_OUT  Set the reference socket to output
REF_IN   Set the reference socket to input
REF_DIS  Disable the reference socket
BUZZ_ON  Enable the internal buzzer
BUZZ_OFF Disable the internal buzzer

**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.
RPP_RST Reset the reverse power protection trip latch. If the reverse power is still present the trip condition will be re-asserted immediately.
*SAV <nrf> Saves the complete instrument set–up in store number <nrf>. Valid store numbers are 1 – 9.
### Status Commands

**CLS**
Clear Status. Clears the Standard Event Status Register, Query Error Register and Execution Error Register. This indirectly clears the Status Byte Register.

**EER?**
Query and clear Execution Error Register. The response format is `<nr1><rmt>`.

**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>`.

**QER?**
Query and clear Query Error Register. The response format 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>`.

**SSR?**
Query and clear System Event Status Register. The response format is `<nr1><rmt>`.

**SSE <nrf>**
Set the System Event Status Enable Register to `<nrf>`.

**SSE?**
Returns the value of the System Event Status 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.

*LRN? Returns the complete set up of the instrument as a hexadecimal character data block approximately 108 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.

*TRG The generator has no trigger capability.

*TST? The generator has no self test capability and the response is always 0 <rmt>

 Calibration Specific Commands

See Service Manual for details of calibration specific commands.
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 if an OUT OF RANGE value is sent via a remote interface.

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.

<table>
<thead>
<tr>
<th>Error Message No.</th>
<th>Message</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>EEPROM READ ERROR</td>
<td>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 specification.</td>
</tr>
<tr>
<td>51</td>
<td>EEPROM WRITE ERROR</td>
<td>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.</td>
</tr>
<tr>
<td>52</td>
<td>RAM READ ERROR</td>
<td>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.</td>
</tr>
<tr>
<td>120</td>
<td>ERROR OUT OF RANGE</td>
<td>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.</td>
</tr>
<tr>
<td>121</td>
<td>NO VALID DATA IN STORE</td>
<td>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.</td>
</tr>
<tr>
<td>122</td>
<td>PK. DEV LIMITED BY CARRIER FREQUENCY</td>
<td>Displayed if both MOD and FM (or PM) are turned on with a peak deviation already set to greater than that permitted for the current carrier frequency. The entered deviation is remembered and is restored when the carrier frequency is changed or MOD ON/OFF and/or FM (or PM) are turned off.</td>
</tr>
<tr>
<td>123</td>
<td>+1dBm MAX WITH AM ON</td>
<td>Displayed if both RF OUT and AM are turned on with the output level already set to ➔+1dBm. The level is permanently changed to +1dBm.</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FREQUENCY</td>
<td>100.000 MHz</td>
</tr>
<tr>
<td>LEVEL</td>
<td>0.0 dBm</td>
</tr>
<tr>
<td>MODULATION</td>
<td>FM @ 1kHz internal OFF</td>
</tr>
<tr>
<td>PK. DEVIATION</td>
<td>50.0 kHz</td>
</tr>
<tr>
<td>FREQUENCY STEP</td>
<td>0.10000 MHz</td>
</tr>
<tr>
<td>LINEAR LEVEL STEP</td>
<td>10.0mV</td>
</tr>
<tr>
<td>dB LEVEL STEP</td>
<td>10.0dB</td>
</tr>
</tbody>
</table>