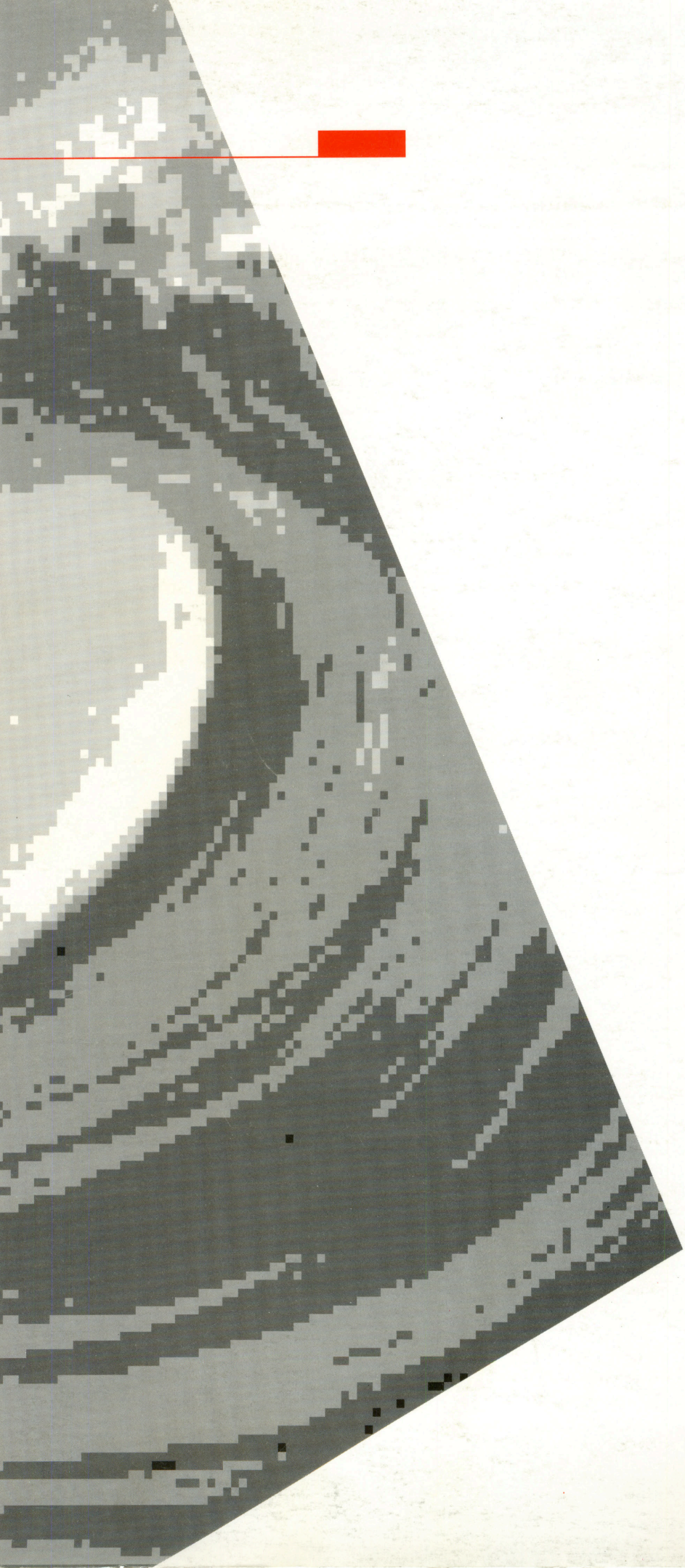

RE 122
Signal Generator
Operating Manual

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1. INTRODUCTION

1.1 Introduction

The RE 122 Signal Generator offers a unique combination of speed and modulation capabilities making it an obvious choice as a standard high quality signal generator.

With the RE 122 new technologies with regard to frequency synthesis, modulation, RF shielding and cabinet design are introduced. In the design of the generator specific attention has been given to the requirements for testing RF chips and commercial radios.

The key features are:

Frequency range	100 kHz to 250 MHz with 1 Hz resolution
Frequency switching time	<2 ms
Output level	-123.9 to 23 dBm with 0.1 dB resolution
Glitch free setting	0 to -16 dB starting from any level
Level switching time	
Mechanical attenuator	<2.5 ms
Electronic attenuator	<30 μs
Powerful modulators	AM, DC AM, AM Stereo, FM, DC FM, PM, DC PM
Simultaneous modulation	AM/FM, AM/PM with modulation source and level freely selected
Analog RF sweep	Width and time can be set independently. A sweep ramp output is available at the rear panel. Both sawtooth and triangular sweeps are possible.

The switching speed of 2 ms for frequency changes and 30 μs for level changes makes the RE 122 ideal for automated testing. In addition, the high speed IEEE488 interface, which is a standard feature, offers storage of up to 500 complete instrument setups allowing you to program even the most demanding applications for optimum performance.

The RF output attenuator, which traditionally is a weak spot in automatic RF test systems employed by high volume manufacturers, has been given special

consideration. A new attenuator has been designed using a switch element, whose reliability has been verified through a very comprehensive test programme.

Built-in diagnostic software and a strong modularization of the RE 122 Signal Generator is included to facilitate troubleshooting and thus minimizing downtime.

Through a number of different options the RE 122 can be fitted to meet most applications. In the standard configuration the generator is delivered as a black-box unit intended for production applications. This means that the RE 122 has no keyboard and display for manual operation. For laboratory or test engineering applications a front panel can be added through various options:

* A factory installed front panel for the standard instrument, i.e. the generator is still to be used for rack mounting in system applications.

* A desktop model option where the generator is delivered in a desktop cabinet with full front panel control as a standard feature.

* A separate control panel that can be connected to the standard unit by means of a connector on the front of the generator. This means that manual operation of the instrument is possible even when it is still rack mounted.

Furthermore, an optional AM stereo, Motorola C-QUAM modulator and an oven-controlled reference oscillator is offered allowing you to configure the RE 122 to your needs.

1.2 Operating Manual

The present Operating Manual contains all information needed to operate the instrument, including all options.

The following sections are included:

Section 1	General introduction.
Section 2	Installation information, for the RE 122 itself, as well as information regarding installation of those options which may be user installed after the time of purchase.
Section 3	Description of front and rear panels including operating instructions.
Section 4	Programming information for remote operation.

Section 5	Equipment and Accessories. A list of the accessories supplied with the instrument, available options and optional equipment and accessories.
Section 6	Specifications
Section 7	Miscellaneous

1.3 Servicing Manual

The Servicing Manual contains the following sections:

Section 1	Introduction. A general introduction to the manual.
Section 2	Principle of Operation. Description of the principles of operations, emphasizing information that eases the understanding of the main concept of the RE 122.
Section 3	Dismantling. General description of how to get access to the individual printed circuit boards of the RE 122.
Section 4	Adjustments and Maintenance. Description of how to perform adjustments and maintenance on the RE 122.
Sections 5 to 23	Each of the sections 5 to 23 deals with one specific PC board in the RE 122. First the section describes the individual circuits on the board. Then the section describes any adjustments required. Finally follow schematic diagram, component locations and the parts list for the board in question.
Section 24	Equipment and Accessories. Lists of standard equipment and accessories, available options and optional equipment and accessories.
Section 25	Specifications including a list of typical measurement speeds at different instrument settings.
Section 26	Index.

Section 27	Section 27 presents miscellaneous information such as a list of abbreviations, a drawing of the mechanical assembly of the RE 122, and a response sheet.

The Servicing Manual is not a part of the standard accessories. It must be ordered separately if required.

2. INSTALLATION

This section contains general instructions for the installation of the RE 122 Signal Generator. This section must be read to ensure correct installation.

2.1 Unpacking

When unpacking the RE 122, the instrument, the accessories and the packing material should be inspected for any physical damage. Please refer to section 6, Specifications for a description of equipment and accessories. Should any item be damaged, please notify the carrier and your local RE TECHNOLOGY AS representative or the factory.

In case of complaint you must retain the packing material for inspection by the carrier.

After you have verified that no damage has occurred, the instrument is ready for installation. However, before you apply line power to the instrument, we recommend that the following sections 2.2 Power Application and 3, Front and Rear Panels must be studied in detail.

2.2 Power Application

The RE 122 operates on either 110 V or 220 V AC supplies. The required line voltage is selected by means of a code plug built into the mains adapter at the rear of the instrument. Make sure that the installed fuse has the correct value:

AC Voltage	Line Fuse
90 V to 130 V AC	3.15 A, slow blow
180 V to 260 V AC	1.6 A, slow blow

Table 2.1 - Line Fuse Ratings

CAUTION Always make sure that the line voltage selector is set to the correct position and that a fuse having the correct rating is installed in the fuse holder before connecting the RE 122 to any AC power source.

The following procedure should be used when applying power for the first time:

1. Check that the power switch is set to off.

2. Remove the code plug in the mains adapter and check that the correct fuse has been installed.

3. Install the code plug so that the correct text, 110 V/220 V, coincides with the white marking below the code plug.

4. Connect the power cord supplied with the instrument between the power connector and the AC power receptacle.

5. Set the power switch to on.

NOTE According to international safety regulations, the RE 122 is grounded via the third wire in the power cord. In case the RE 122 must be operated from AC outlets without a ground connector, the instrument must be grounded by means of the banana plug close to the mains adapter.

2.3 Battery Backup

Settings and setups in the RE 122 are retained during periods of power-down by means of a Lithium battery on the CPU Board (902-020). In case of data loss during power-down, this battery should be checked and replaced if necessary. Please refer to the Servicing Manual for information.

2.4 Selftest

Following power-up the RE 122 performs a complete selftest of all digital circuitries. This test comprises:

* EPROMs on CPU Board (902-020)
* Integrity of stored data
* Modulation Uncal, Reference Unlock and Frequency Unlock functions
* Display test if front panel available

The selftest can also be performed on command from both the front panel and the IEEE488 interface. Please refer to the operation and programming sections.

3. FRONT AND REAR PANELS

This section contains a short description of the front and rear panels of the RE 122. All controls and connectors are described.

You should make yourself familiar with the front and rear panel functions before applying mains power to the instrument.

3.1 Front Panel Standard Instrument

The front panel layout for the standard RE 122 Signal Generator is shown in figure 3.1. In the standard configuration the instrument is intended for automated system applications. Therefore it only has a blank front panel, i.e. no controls and displays are available. Furthermore, being intended for systems applications rack mounts are built into the cabinet of the standard RE 122.

The functions of the blank front panel are:

Power LED indicator that lights when instrument powered on.

Control Panel 9 pin SUB-D connector that is used to interface a separate control panel to the instrument for remote operation. The control panel is available as an option.

Manual control can also be obtained through an optional front panel for the standard instrument. This front panel as well as the control panel offer the same controls and displays as the RE 122 desktop model.

3.2 Front Panel Desktop Model

The front panel layout for the RE 122 desktop model is shown in figure 3.2. The desktop configuration must be ordered as an option and is intended for laboratory applications.

The functions of the front panel are described in the following.

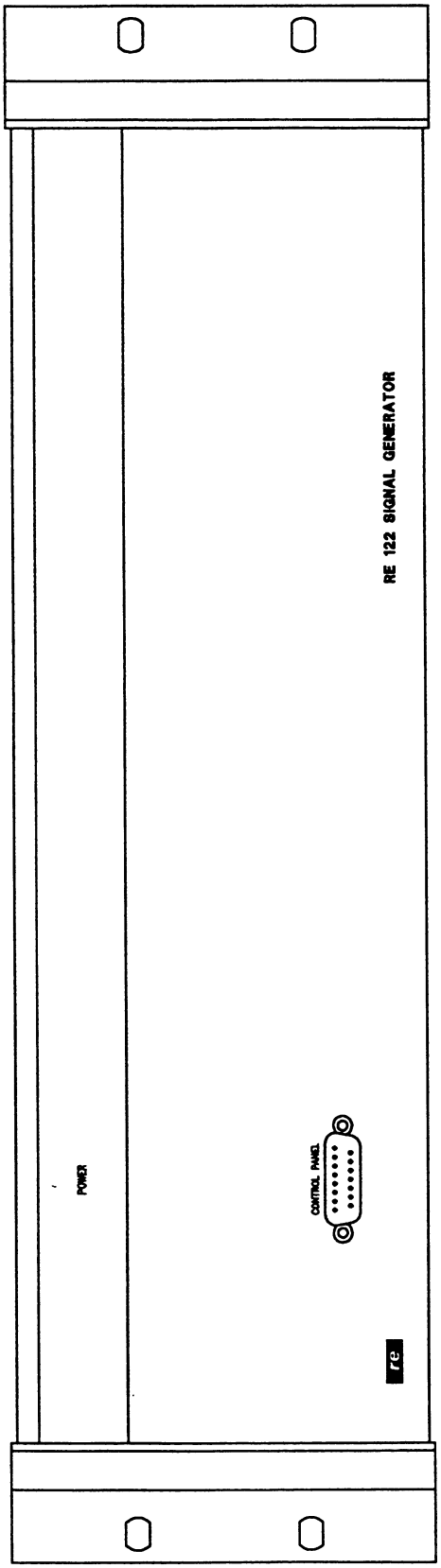


Fig. 3.1 - RE 122 Signal Generator, Front Panel Standard Instrument

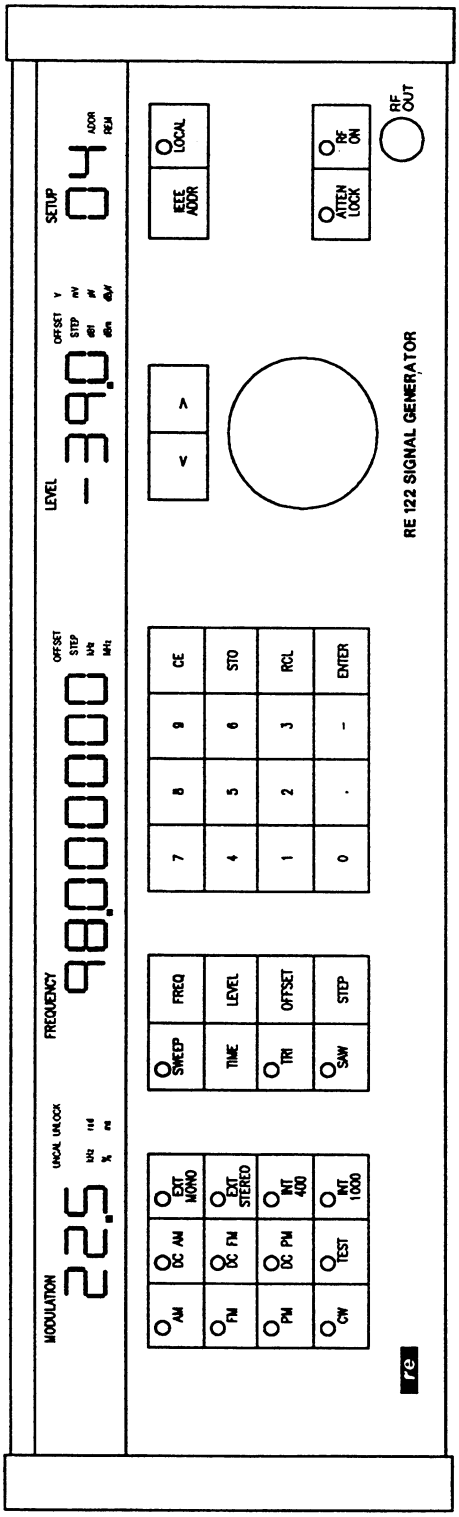


Fig. 3.2 - RE 122 Signal Generator, Front Panel Desktop Model

Displays

MODULATION 4 digits. This field displays AM depth, FM deviation, PM deviation, sweep width or sweep time, depending on the chosen modulation mode.

Next to this field are indicator bars for the various units: *%* for AM deviation, *kHz* for FM deviation and sweep width, *rad* for PM deviation, *ms* for sweep period time.

Placed here are also the indicators for external mono input *UNCAL* condition and for the reference oscillator and carrier frequency *UNLOCK* condition.

FREQUENCY 9 digits. This field displays carrier frequency, carrier frequency offset or carrier frequency step size, depending on the setting of the offset and step modes.

Next to this field are indicator bars for the frequency units *kHz* and *MHz*, plus indicator bars for the frequency *OFFSET* and *STEP* modes.

LEVEL 3 1/2 digits. This field displays output level, level offset or level step size, depending on the setting of the offset and step modes.

Next to this field are indicator bars for the level units *dBf*, *dBm*, *V*, *mV*, *µV*, and *dBµV*, plus indicator bars for the level *OFFSET* and *STEP* modes.

SETUP 2 digits. This field displays either setup number or IEEE488 bus address, depending on the state of the controls.

Next to this field are indicator bars for the IEEE488 bus address *ADDR*, plus an indicator *REM* showing the IEEE488 bus remote/local state of the unit.

In the display fields, the cursor position is indicated by the blinking of a digit or an indicator bar. The cursor is moved by the arrow keys < and >. Certain function keys will also move the cursor.

Modulation Mode Controls

AM This key switches on the AM modulation. The cursor is moved into the *MODULATION* display field, which will show the current AM depth, as indicated by the lit % unit bar.

Operating the codewheel or the numeric keys now will modify the AM depth.

If the *AM* key is pressed a second time, the AM modulation is turned off.

FM This key switches on the FM modulation. The cursor is moved into the *MODULATION* display field, which will show the current FM deviation, as indicated by the lit *kHz* unit bar. Operating the codewheel or the numeric keys now will modify the FM deviation.

Note that switching on FM will automatically switch off any PM or sweep modulation.

If the *FM* key is pressed a second time, the FM modulation is turned off.

PM This key switches on the PM modulation. The cursor is moved into the *MODULATION* display field, which will show the current PM deviation, as indicated by the lit *rad* unit bar. Operating the codewheel or the numeric keys now will modify the PM deviation.

Note that switching on PM will automatically switch off any FM or sweep modulation.

If the *PM* key is pressed a second time, the PM modulation is turned off.

CW This key switches off all modulation, making the unit generate pure carrier wave output. When no modulation is present, the LED in the *CW* key will be lit, and the *MODULATION* display will be blank.

DC AM This key toggles the DC AM mode.

DC FM This key toggles the DC FM mode. Switching on the DC FM mode will also switch off any DC PM mode.

DC PM This key toggles the DC PM mode. Switching on the DC PM mode will also switch off any DC FM mode.

TEST This key puts the RE 122 into test mode. The test mode is described in detail later in this section. This is a toggle key, so pressing the key a second time will restore normal operation.

Modulation Source Controls

The keys in this group select which modulation source is to be used with the present modulation mode (AM/FM/PM). All keys in the modulation source group have LED indicators, showing the currently selected source.

EXT MONO — This key selects the rear panel connectors *AM MONO*, *FM MONO* or *PM MONO*, depending on the chosen modulation mode.
Note that in PM mode, this is the only modulation source available.

EXT STEREO — This key selects the rear panel connectors *FM STEREO* or *AM STEREO L-R/L+R*, depending on the chosen modulation mode.

INT 400 — This key selects the internal 400 Hz oscillator for the modulation source.

INT 1000 — This key selects the internal 1000 Hz oscillator for the modulation source.

Sweep Controls

SWEEP — This key switches on the sweep function. The LED indicator in the key is lit, and the cursor is moved into the *MODULATION* display field, which will show the current sweep width, as indicated by the lit *kHz* unit bar. Operating the codewheel or the numeric keys now will modify the sweep width. Switching on sweep will automatically switch off any FM or PM modulation. To switch off the sweep mode, press the *CW* key.

TIME — This key will cause the cursor to be moved to the *MODULATION* field, which will display the sweep time, as indicated by the lit *ms* unit bar. Operating the codewheel or the numeric keys now will modify the sweep time. If the sweep function was not previously on, it will be switched on by the pressing of this key.

TRI — This key will cause the sweep waveform to be triangular. If the sweep function was not previously selected, pressing this key will have no effect.

SAW — This key will cause the sweep waveform to be sawtooth. If the sweep function was not previously selected, pressing this key will have no effect.

Frequency and Level Controls

FREQ — This key will cause the cursor to be moved into the *FREQUENCY* display field. Operating the codewheel or the numeric keys now will modify the carrier frequency.

LEVEL — This key will cause the cursor to be moved into the *LEVEL* display field. Operating the codewheel or the numeric keys now will modify the output signal level.

OFFSET — This key will put the frequency or level display into offset mode. This and the step mode is described in detail later in this section.

STEP — This key will put the frequency or level display into step mode, which is described in detail later in this section.

The offset and step functions are only selectable while the cursor is in the *FREQUENCY* or *LEVEL* display fields. If the cursor is not in one of these fields, pressing the *OFFSET* or *STEP* keys will have no effect.

Numeric Keypad

These keys are used for entring numeric parameters including decimal point (.) and sign (-). Special keys control the numeric entry and the storage and recall of setups.

CE — Clear entry. Clear the last pressed digit. If pressed twice in succession, it clears the entire entry.

STO — Store setup. Stores the current instrument setting in non-volatile memory for later retrieval. When the key is pressed, the cursor is moved to the *SETUP* display field. A two-digit setup number can now be typed, followed by *ENTER*, to store the setting in memory.

RCL — Recall setup. Recalls a previously stored instrument setting from non-volatile memory. When the key is pressed, the cursor is moved to the *SETUP* field. A two-digit setup number can now be typed, followed by *ENTER*, to recall the setting from memory.

Cursor controls

< and > — Moves the cursor left or right. If pressed for more that approx. half a second, the keys will auto-repeat.

Rotary Control Modifies parameters and units. By positioning the cursor on a digit in a display field, turning the knob will modify that digit. Positioning the cursor on the frequency or level units, turning the knob will change that unit.

Interface Controls

IEEE ADDR This key will cause the cursor to be moved to the *SETUP* display field, which will show the current IEEE488 bus address, as indicated by the lit *ADDR* bar. Operating the codewheel or the numeric keys will modify the address.

LOCAL This key will force the IEEE488 interface of the RE 122 into Local mode, overriding external bus control. While the RE 122 is in this 'Forced to Local' mode, the LED in the *LOCAL* key will be lit. The switch is a toggle; pressing it a second time will return the interface to its normal operating mode. See also the discussion of the Remote/Local function in paragraph 4.1, IEEE488 Bus Implementation.

Output Controls

ATTN LOCK This key locks the electromechanical attenuator at its present attenuation. While this mode is active, as indicated by the LED in the key being lit, only the electronic attenuator is active, providing up to 16.0 dB glitch-free attenuation. Pressing the key again frees the electromechanical attenuator, thus resuming normal attenuator operation.

RF OFF This key toggles the RF Output on/off.

RF Signal Output Connector

RF OUT BNC female connector for RF output. On the front panel only on the desktop model. On the other models, this output is placed on the rear panel.

Offset and Step Modes

In addition to the normal operating mode, the Frequency and Level controls can operate in two other modes: Offset mode and Step mode.

In Offset mode, an offset to the frequency or level is defined, whereafter the output of the unit will correspond to the sum of the 'normal' and 'offset' values.

In step mode, the normal operation of the rotary control is suspended; turning the control knob will modify the value by a fixed step size. Thus, the position of the cursor position no longer determines which digits to change, but only which signal parameter.

Frequency offset mode

With the cursor in the *FREQUENCY* field, pressing the *OFFSET* key will put the frequency field into offset mode, indicated by the lit *OFFSET* bar next to the field.

In this mode, the *FREQUENCY* field will display the carrier frequency offset, and operating the codewheel or the numeric keys will modify the current frequency offset.

Pressing the *FREQ* key will return the *FREQUENCY* field to the normal carrier frequency display mode, but the selected frequency offset will still be active. In order to cancel frequency offset, set the offset to zero.

The frequency offset function may thus be used in two ways: either by varying the frequency offset around a fixed 'center' frequency, or by varying the carrier frequency while maintaining a fixed offset.

The fixed center frequency method is convenient when examining e.g. a filter response, and the fixed offset method can be useful for example when examining a frequency converter.

Level offset mode

With the cursor in the *LEVEL* field, pressing the *OFFSET* key will put the level field into offset mode, indicated by the lit *OFFSET* bar next to the level field. In this mode, the level offset is displayed in the level field, and operating the rotary knob or the numeric keypad will change the current level offset.

Pressing the *LEVEL* key will return the level display to the carrier level mode, but the selected level offset will still be active. To cancel the level offset, set the offset to zero.

The level offset can be set set in dB unit only, regardless of the current level unit chosen.

The level offset is convenient for compensating for losses in the signal path, where the offset can be adjusted so that the display shows the level at the input of the device under test.

Frequency step mode

With the cursor in the *FREQUENCY* field, pressing the *STEP* key will put the frequency field into step mode, indicated by the lit STEP bar next to the field.

In this mode, the *FREQUENCY* field will display the carrier frequency step size, and operating the codewheel or the numeric keys will modify the current frequency step.

Pressing the *FREQ* key will return the *FREQUENCY* field to the normal carrier frequency display mode, but the selected frequency step will still be active. In order to cancel frequency step, set the step size to zero.

Level step mode

With the cursor in the *LEVEL* field, pressing the *STEP* key will put the level field into step mode, indicated by the lit *STEP* bar next to the level field. In this mode, the level step size is displayed in the level field, and operating the rotary knob or the numeric keypad will change the current level step.

Pressing the *LEVEL* key will return the level display to the carrier level mode, but the selected level step will still be active. To cancel the level step, set the step size to zero.

The level offset can be set set in dB unit only, regardless of the current level unit chosen.

The level offset is convenient for compensating for losses in the signal path, where the offset can be adjusted so that the display shows the level at the input of the device under test.

Test mode

In the test mode, it is possible to view certain system parameters, and to execute internal selftest routines in the RE 122. Pressing the *TEST* key a second time restores the unit to normal operation.

The test functions are arranged in a menu system that is navigated by the codewheel and the < and > keys. The selftest functions are executed by pressing the *ENTER* key.

The menu system contains the following items and subitems:

- Configuration
  - Firmware version
  - Installed options
- On-time counter display

Attenuator switch counter display
One subitem for each of the 7 attenuator stages
Selftest routine selection
RAM function test of the two RAM chips
CRCC check of the two EPROM chips
CRCC check of the stored setups
CRCC check of the internal system variables

The main item selections are displayed in the *MODULATION* field. When the text in this field is blinking, turning the codewheel will scroll through all the main items.

When the > key is pressed, the blinking will move to the subitem display in the *FREQUENCY* field. Now, turning the codewheel will scroll through the available subitems.

Pressing the < key will move the codewheel control back into the main item field.

Note that the on-time counter display item does not have any additional subitems. When this function is shown in the main item field, pressing > will have no effect. This is also the case with the configuration display item, when no options are installed.

In the following, the available choices in the menu are detailed:

Configuration

The configuration item contains the firmware version display, which shows the unit name, 'RE 122', together with the firmware revision number.

If any of the AM Stereo or the Oven Oscillator options are installed, these are indicated by the display of the option's code number:

906-154 for the AM Stereo C-QUAM modulator
906-226 for the Oven-controlled reference oscillator

On-time counter display

Shows the number of hours that the unit has been powered on.

Attenuator switch counter display

Shows the number of switchings that each of the seven stages of the mechanical attenuator has made.

Selftest routine selection

The available selftest routines can be scrolled through by turning the codewheel, and executed by pressing the *ENTER* key. While a test executes, a blinking 'run' is displayed, and when the test is finished, the outcome is displayed as 'PAS' (pass) or 'FAI' (fail).

QD12 and QD13 RAM function tests

Performs functionality tests on either of the two RAM chips on the CPU board. If any of these tests should fail, the unit should be returned to RE for servicing.

QD14 and QD15 PROM CRCC tests

Verifies the embedded checksums of either of the two EPROM chips containing the unit firmware. If any of these tests should fail, the unit should be returned to RE for servicing.

Stored setups CRCC test

Verifies the checksums of the setups stored in non-volatile memory. If the test fails, the corrupted setups are voided. If this test fails repeatedly, the unit should be returned to RE for servicing.

Internal variables CRCC test

Verifies the checksum of the internal system variables. If the test fails, the system variables will be restored to factory defaults. If this test fails repeatedly, the unit should be returned to RE for servicing.

3.3 Rear Panel

The rear panel of the RE 122 is shown in figure 3.3. The function of the various connector are:

RF Signal Output

RF OUT BNC female connector for RF output. Only available on the rear for the standard instrument, i.e. a rack model for systems applications.

Modulation Input/Outputs

AM MONO External AM input that can be either AC or DC coupled. The AM depth can be controlled by means of a modulation attenuator. 1 Vp is required for calibrated AM depth. Variations on the input level of more than ±5 % are indicated with an *UNCAL* indicator in the *MODULATION* display field of the desktop model. The uncal function can also be interrogated over IEEE488 bus.

AM STEREO L+R External AM stereo input for generating a Motorola C-QUAM stereo signal. On this input the L+R signal from an appropriate stereo generator e.g. the RE 503 is applied. The input is a fixed gain input calibrated to 1 Vp for 100 % AM.

AM STEREO L-R External AM stereo input for the L-R signal. The input is a fixed gain input calibrated to 1 Vp for $\pi/4$ rad PM deviation.

FM MONO External FM input. The FM deviation can be controlled by means of a modulation attenuator. 1 Vp is required for calibrated FM deviation. Variations on the input level of more than ±5 % are indicated with an *UNCAL* annunciator in the *MODULATION* display field of the desktop model. The uncal function can also be interrogated over IEEE488 bus.

FM STEREO External FM stereo input designed specifically input of a high quality composite FM stereo signal. The input is a fixed gain input calibrated to 1 Vp for 100 kHz FM deviation in the RF range 2 to 250 MHz and 20 kHz FM deviation in the RF range 0.1 to 2 MHz.

PM MONO External PM input. The PM deviation can be controlled by means of a modulation attenuator. 1 Vp is required for calibrated PM deviation. Variations on the input level of more than ±5 % are indicated with an *UNCAL* annunciator in the *MODULATION* display field of the desktop model. The uncal function can also be interrogated over IEEE488 bus.

DC FM/PM An input that provides frequency and phase control of the reference oscillator. This allows the RE 122 to be used as e.g. a VCO in a phase locked loop built around an RF chip in a test system.

AF OUT Output from internal 400 Hz and 1 kHz oscillators. The output frequency will depend on the selected modulation source for a given modulation mode. In case no modulation is selected 1 kHz will be output. Output level is 1 Vp.

SWEEP OUT Sweep signal output for control of an X-Y oscilloscope. The sweep signal has a marker that will show the center frequency as a bright spot on an oscilloscope. Output level is ±5 V.

Reference Oscillator Input/Output

EXT REF Input for locking the RE 122 to an external frequency reference for applications requiring a better frequency stability than offered by the build-in reference oscillator. The input accepts 1, 2, 5 and 10 MHz. The RE 122 will automatically detect an applied signal and lock to it. Input level range is 150 mVrms to 1.75 Vrms.

REF OUT 10 MHz reference output for locking other instruments to the RE 122. Output level is > 0.15 mVrms into 50 Ω.

Trigger Output

TRIG OUT Trigger output that can be activated over the IEEE488 interface. A 250 μs trigger pulse is provided for synchronization of other instruments e.g. digitizers to the signal change of the RE 122. The output is driven by a 50 Ω TTL line driver.

Remote Interface

IEEE488 Interface Standard connector for an IEEE488 controller. The interface has the capabilities: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP1, DC1, DT0, C0, E2

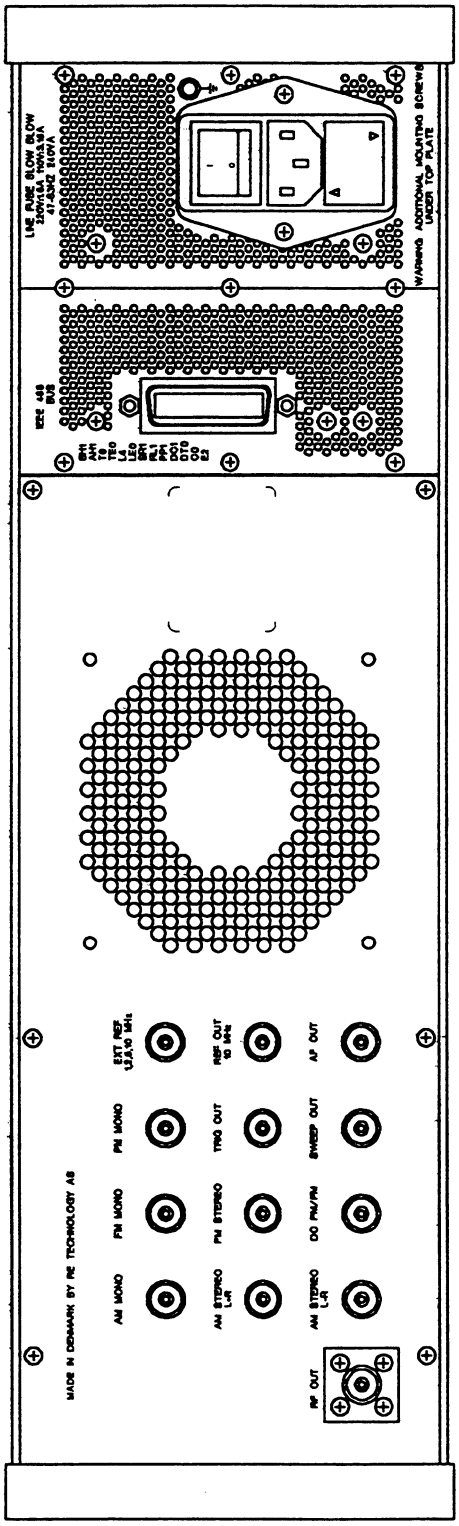


Fig. 3.3 - RE 122 Signal Generator, Rear Panel

Power Inlet

The RE 122 operates on either 110 V or 220 V AC supplies. The required line voltage is selected by means of a code plug built into the mains adapter.

In order to change the line voltage, pull out the code plug and reinstall it, so that the correct text, 110 V/220 V, coincides with the white arrow below the coding plug. Make sure that the installed fuse has the correct value before installing the code plug:

Nominal AC Voltage	Line Fuse
110 V AC	3.15 A, slow blow
220 V AC	1.6 A, slow blow

Table 3.1 - Line Fuse Ratings

CAUTION Always make sure that the line voltage selector is set to the correct position and that a fuse having the correct rating is installed in the fuse holder before connecting the RE 122 to any AC power source.

4. PROGRAMMING

This section contains information on how to control the RE 122 Signal Generator from the IEEE488 interface using a computer. In order to use the information presented you should be familiar with the IEEE488 interface standard and the programming of the instrument controller you intend to use.

4.1 IEEE488 Bus Implementation

Interface Capabilities

The following subset of the IEEE488 standard is implemented in the interface:

Function	Description	Implementation
SH1	Source Handshake	Complete capability
AH1	Acceptor Handshake	Complete capability
T6	Talker	Talk only omitted
TE0	Extended Talker	No capability
L4	Listener	Listen only omitted
LE0	Extended Listener	No capability
SR1	Service Request	Complete capability
RL1	Remote Local	Complete capability
PP1	Parallel Poll	Remote configuration
DC1	Device Clear	Complete capability
DT0	Device Trigger	No capability
C0	Controller	No capability
E2	Output Circuit	Three State Output. The interface changes to E1, open collector, in case a parallel poll is issued.

Table 4.1 - IEEE488 Interface Capabilities

Remote/Local Function

The RE 122 Signal Generator has full remote/local capability, i.e. interface function RL1. This means that the generator will be in one of the following four states:

1. LOCS, Local State

   The local state is entered from power-up. It can be entered from remote state by means of either a GTL interface message, or activation of the *LOCAL* key on the front panel. In addition, a false level on the REN line will perform the same function. Note that when the LED indicator in the *LOCAL* key is lit, the generator cannot leave the local state on command from the controller, it is forced to local.

2. LWLS, Local With Local Lock-out State

   The local with local lock-out state is entered either from LOCS by means of an LLO interface message, or from remote with local lock-out state by means of a GTL interface message. Note that this state cannot be entered by using the front panel *LOCAL* key.

3. REMS, Remote State

   The remote state is entered only from LOCS and by means of the interface being listen addressed. The latter can only occur if the local LED indicator is off, i.e. the generator is not in forced local mode.

4. RWLS, Remote With Local Lock-out State

   The remote with local lock-out state is entered either from REMS by means of an LLO interface message, or from LWLS by means of the interface being listen addressed.

The REMOTE/LOCAL state diagram in figure 4.1 on the next page shows the four states.

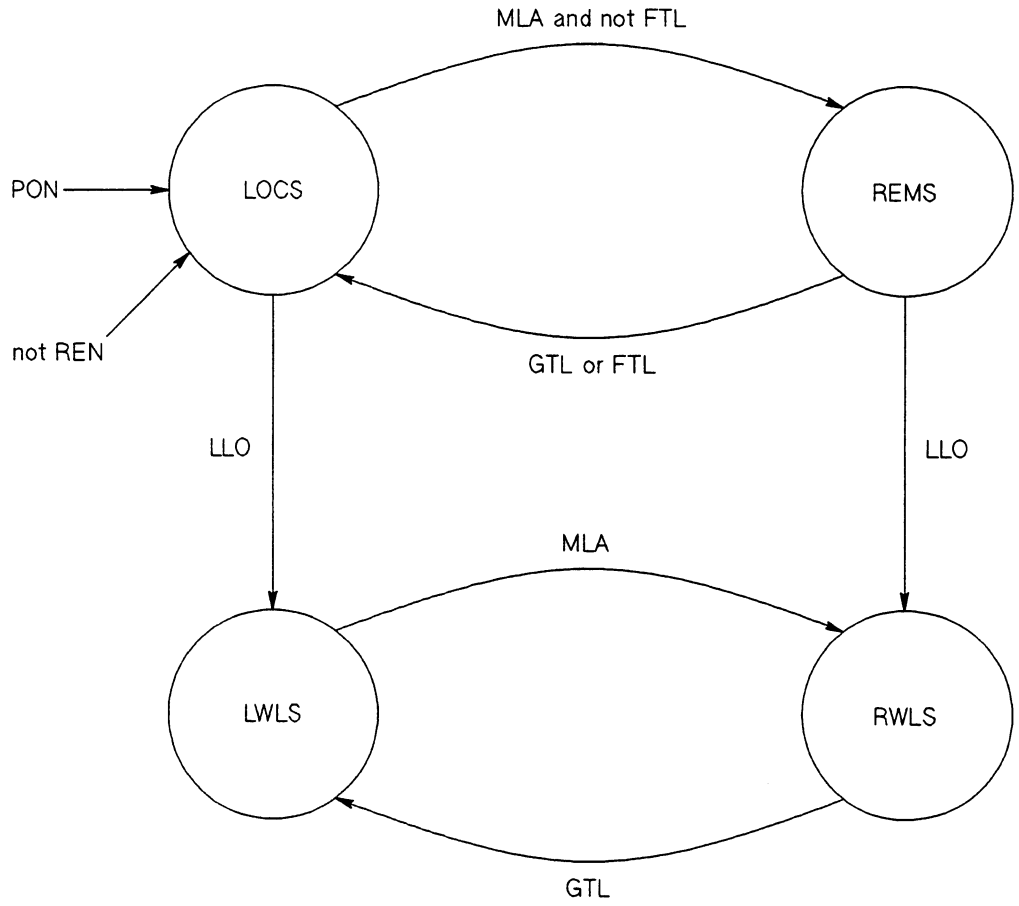


Fig. 4.1 - Remote/Local Instrument States

Notation used in state diagram.

not : Logical NOT function
and : Logical AND function
or : Logical OR function
PON : Initial Power-ON of the instrument
REN : IEEE bus Remote ENable line
MLA : Being addressed as a Listener
FTL : State of LED in *LOCAL* key. Lit when in forced to local state
GTL : Go To Local interface message received
LLO : Local Lock-Out interface message received
LOCS : LOCal State
REMS : REMote State
LWLS : Local With local Lock-out state
RWLS : Remote With local Lock-out state

Service Request Function

The interface capability of issuing service requests is utilized to flag errors, warnings, and ready codes. Upon a service request the controller may obtain the status byte by means of a serial poll sequence. The status byte indicates the cause of the service request, e.g. whether it was caused by an error or a result being ready.

By means of the SRQDIS command the controller may disable service requests initiated by errors/warnings or ready codes, or both, but still be able to obtain the same status bytes by using the serial poll sequence.

4.2 Setting the IEEE488 Address

Before you can operate the generator remotely, you need to know its IEEE488 address. When the generator leaves the factory the default address setting is 04. The default address is defined by means of a DIP switch on the CPU Board.

The IEEE488 address may be changed in two ways. Either remotely from a computer using the IR command or manually using the front or control panel.

In the standard configuration the RE 122 has a blank front panel, i.e. you can either set the address from a control panel or remotely from a computer. To set the address from a computer you must use the IR command, e.g. sending the command **IR,22** will change the address from the default 04 to 22. For further detail on the IR command please refer to the command description.

If you have a generator with a desktop option or a standard generator with a control panel you can inspect the address setting using the *IEEE ADDR* key.

The IEEE488 address is displayed in the *SETUP* display field, please refer to section 3.2. As this display field is used for both address and the generator setup number an *ADDR* annunciator is lit when the address is being displayed. In case you have the setup number displayed press the *IEEE ADDR* key followed by *ENTER* to change the display mode.

Once the IEEE488 address has been changed it will be kept in battery backed memory, i.e. the address will not be affected by power on-off switching. However, the DIP switch is read on every power on, and in case of a change in setting the generator will default the address to the setting of the DIP switch. Should the battery on the CPU Board fail, the generator will also use the DIP switch for address setting.

You can change the default address setting by changing the DIP switch setting. To gain access to the CPU Board, which is the board with the IEEE488 connector, you must remove the 6 hexagon screws on the rear panel of the CPU Board. The CPU Board can then be drawn out from the digital section of the generator by inserting a

screw driver or a similar tool in the slot between the rear panel of the CPU Board and the chassis. You will easily find the address switch S1 located at the top of the board.

The default address is defined by the switches 1 to 5, 1 being LSB and 5 being MSB. A switch in open position has a binary weight of 1. An example is shown in figure 4.2, where the address is set to 4.

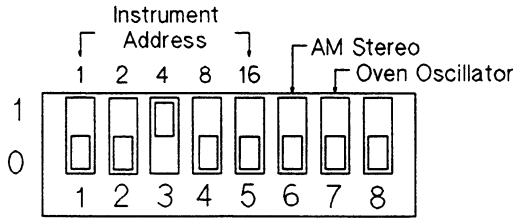


Fig. 4.2 - Default Address Setting

Please note that you do not have to change the default address setting in order to change the instrument address. The default address should only be changed if absolutely necessary, e.g. for service or maintenance reasons.

Remember, however, that since the DIP switch is not always used for setting the address, you cannot just read the DIP switch setting to determine the address of the generator. For example if you have programmed another address by means of the **IR** command the DIP switch does not show the current address. Therefore if you want to make absolutely sure that the address equals the DIP switch you must change the switch setting, power on-off and then set the switch to the address you want.

4.3 Command Language

The programming of the generator is described by means of syntax diagrams and command descriptions. The command language is explained in four steps:

1. Syntax notation, i.e. how to read the syntax diagrams and command descriptions.

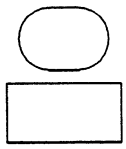
2. Syntax diagram for a command sequence i.e. how you can put commands together to program the generator to a specific setup.

3. Syntax diagram for a single command i.e. what is the common structure of a command.

4. Command descriptions, i.e. an alphabetical list of all the control commands available.

Syntax Notation

In the following syntax diagrams a special pictorial notation is used:



All items enclosed in a circle or an oval are ASCII or special characters that must be entered exactly as shown.
All items enclosed in a rectangular box indicate a parameter that must be specified.

Other elements of the notation used throughout this section in order to described the command language are shown in table 4.2.

Element	Description
SP	Blank character, space, ASCII character decimal 32
CR	Carriage return, ASCII character decimal 13
LF	Linefeed, ASCII character 10
^END	EOI asserted concurrent with the last byte in the transmission
LITERALS	All literals e.g. command mnemonics or parameter units are shown in Courier typeface. You must enter the indicated text exactly as shown. Some changes, however, are allowed, as described below. The command language in not case sensitive. This means that e.g. **FQ** and **fq** are interpreted as the same command. Mnemonics, units or alphabetical parameters are interpreted by the generator using only the first and the last letter of the text. This means that additional letters may be inserted in a command to clarify a command string, e.g. **FQ** and **FREQ** are interpreted as the same command, **kHz** and **KZ** are interpreted as the same unit.
Parameter	A parameter that must be specified is shown in Italic typeface, e.g. **FQ,***Frequency*. A parameter may have a unit attached to it. Information about the actual parameter and the unit can be found in the command description. A value for a parameter can expressed in integer, decimal or exponential (E) form.

Table 4.2 - Notation Elements

Command Sequence

Commands can be sent in a sequence. A sequence of commands consists of all the commands to be sent to the generator in one data transmission.

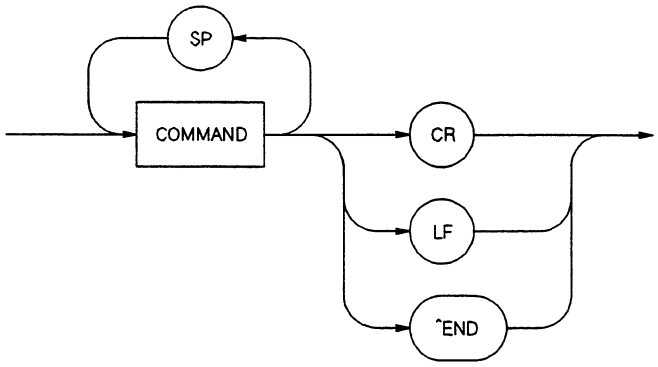


Fig. 4.3 - Command Sequence

As shown in the above figure two commands in a sequence must be separated by one space, SP. The command sequence is terminated by means of:

LF	Linefeed
CR	Carriage return
^END	EOI asserted concurrent with the last byte in the transmission.

Command Syntax

Commands are mnemonics followed by parameters. Most of the commands have default values for the parameters. These are employed if no parameters or only some of the parameters are specified.

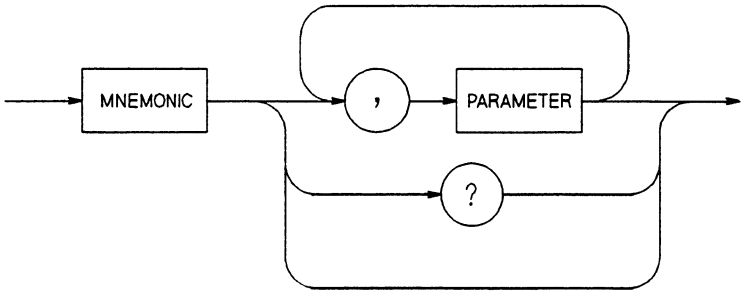


Fig. 4.4 - Single Command

From the figure it can be seen that a comma is used to separate parameters. Blank characters, i.e. spaces may be freely inserted to make the command more readable.

A specific generator setting may be interrogated by means of a command query. A command query is simply the command name followed by a question mark. The generator will respond with the name of the command followed be the actual setting of all parameters for this command. For example the **FQ?** query will return **FQ,98.100000MHZ** in case the carrier frequency is set to 98.1 MHz.

4.4 Command Descriptions

The command descriptions comprise a functional description, a reference part and examples of how the particular command is used.

The functional descriptions describe the action caused by the commands and how to use them in conjunction with the variety of functions available in the RE 122. References to related commands, if any, are also included.

The reference part contains details on abbreviations allowed for the command, the required syntax and the parameter specifications including units and the applicable parameter range. It also includes information on how command errors will affect the service request code. This might be used for troubleshooting purposes.

Each command description is concluded by commented examples on how to use this particular command.

AM, Amplitude Modulation

Description

The AM command is used to set AM modulation mode, source and depth.

Syntax

AM, *Source, Depth*

AM?

Parameters

Parameter	Range	Default Value
Source	**OFF** **MN** **ST**, **L** or **400Hz**, **H** or **1000Hz**	Previous source
Depth	**0** to **99.5**	Previous depth
Depth Unit	**%**	**%**

AM,MN,30 will set modulation to AM, external mono and 30 % AM depth.

AM,L, will set modulation to AM, internal 400 Hz source and the previous AM depth.

AM,ST will set modulation to AM and external stereo. The modulation depth cannot be specified for this command, as it is set by the stereo generator.

AM? will cause the generator to transmit its current AM setting.

AT, Inspect Attenuator Switchings

Description

The AT command is used to inspect the number of switchings that each of the mechanical attenuator stages has performed in its lifetime.

Syntax

AM

AM?

Parameters

Parameter	Range	Default Value
None		

AM or **AM?** will cause the generator to transmit 7 numbers, each indicating the number of switchings, each corresponding stage in the mechanical attenuator has performed. The switch countings are sorted ascending, according to the attenuation of the stage, i.e. 1-2-4-8-16-32-64 dB.

CR, Cursor Position

Description

The CR command allows remote control of the cursor position. With this command the cursor can be placed on a parameter that requires manual operation using the rotary knob prior to setting the RE 122 into local mode.

Syntax

CR, *Position*

CR?

Parameters

Parameter	Range	Default Value
Position	**1** to **21**	**1**

The command **CR,21** sets the cursor to the rightmost position.

CR? will cause the generator to transmit the current cursor position.

CW, Carrier Wave Only

Description

The CW command switches off all modulation and provides carrier only output.

Syntax

CW

CW?

Parameters

Parameter	Range	Default Value
None		

CW? will cause the generator to transmit the current modulation setting, i.e. if the generator is not in CW mode it will transmit a list of the active modulation modes.

DA, DC Amplitude Modulation

Description

The DA command is used to DC couple the AM Mono external modulation input.

Syntax

DA, *Mode*

Parameters

Parameter	Range	Default Value
Mode	**ON** or **1**, **OFF** or **0**	**ON**

DA,1 will set DC coupling on the AM Mono input.

DA? will cause the generator to transmit its current DC AM setting.

DF, DC Frequency Modulation

Description

The DF command is used to switch on DC frequency modulation. When enabled the reference oscillator can be controlled by means of the DC FM/PM input.

Syntax

DF, *Mode*

DF?

Parameters

Parameter	Range	Default Value
Mode	**ON** or **1**, **OFF** or **0**	**ON**

DF,1 will set DC FM modulation on.

DF? will cause the generator to transmit its current DC FM setting.

DP, DC Phase Modulation

Description

The DP command is used to switch on DC phase modulation. When enabled the phase of reference oscillator compared to the RF output can be controlled by means of the DC FM/PM input.

Syntax

DP, *Mode*

DP?

Parameters

Parameter	Range	Default Value
Mode	**ON** or **1**, **OFF** or **0**	**ON**

DP,ON will set DC PM modulation on.

DP? will cause the generator to transmit its current DC PM setting.

EX, Execute Setup

Description

The EX command is used to execute/recall an instrument setting previously defined by means of the SF command.

By means of the setup facility, it is possible to speed up a specific test considerably, as it requires less time to execute a setup than to transfer the equivalent information about the generator setting on the IEEE488 bus.

Syntax

EX, *Setup_Number*

EX?

Parameters

Parameter	Range	Default Value
Setup_Number	**0** to **499**	None

EX, 15 will execute setup number 15.

EX? will cause to generator to transmit its current setting, i.e. the status of all generator parameters.

FM, Frequency Modulation

Description

The FM command is used to set FM modulation mode, source and deviation.

Syntax

FM, *Source, Deviation*

FM?

Parameters

Parameter	Range	Default Value
Source	**OFF** **MN**, **ST**, **L** or **400Hz**, **H** or **1000Hz**	Previous source
Deviation	**0** to **250.0** kHz	Previous deviation
Deviation Unit	**Hz**, **kHz**	**kHz**

Please note that the maximum FM deviation is dependent on the carrier frequency and that higher resolution applies a low deviation. Consult the specifications for details.

FM, PM and Sweep are mutually exclusive generator functions.

FM,MN,75000HZ will set modulation to FM, external mono and 75 kHz peak deviation.

FM,,10.1KZ will set modulation to FM, previous modulation source and 10.1 kHz peak deviation. Please note that 0.1 kHz deviation resolution is provided below 25 kHz.

FM,ST will set modulation to FM and external stereo. The FM deviation cannot be specified for this command as it is set by the stereo generator.

FM? will cause the generator to transmit its current FM modulation setting.

FO, Frequency Offset

Description

The FO command is used to introduce a frequency offset to the current carrier frequency. Any offset can be defined, as long as the resulting carrier frequency is within the 0.1 to 250 MHz range, and there are no conflicts with the present modulation.

Syntax

FO, *Offset_Freq*

FO?

Parameters

Parameter	Range	Default Value
Offset_Freq	**-99.9** to 99.9 MHz	None
Offset_Freq Unit	**Hz**, **kHz**, **MHz**	**MHz**

The command `FO,-0.1` will offset the carrier frequency by -100 kHz, i.e. if the carrier frequency was set to 98 MHz, it will now be at 97.9 MHz.

The FO command will also change the front panel frequency display from carrier to offset display mode.

FO? will cause the generator to transmit its current frequency offset setting.

FQ, Carrier Frequency

Description

The FQ command is used to set the frequency of the RF signal.

Syntax

FQ, *Frequency*

FQ?

Parameters

Parameter	Range	Default Value
Frequency	**0.1** to **250** MHz	**100**
Frequency Unit	**Hz**, **kHz**, **MHz**	**MHz**

FQ,98.121 will set the carrier frequency to 98.121 MHz.

FQ,530KZ will set the carrier frequency to 530 kHz.

FQ? will cause the generator to transmit its current carrier frequency.

FS, Frequency Step

Description

The FS command defines the control panel codewheel frequency step size.

Syntax

FS, *Step_Freq*

FS?

Parameters

Parameter	Range	Default Value
Step_Freq	**0** to **250** MHz	None
Step_Freq Unit	**Hz**, **kHz**, **MHz**	**MHz**

FS? will cause the generator to transmit its current frequency step setting.

FU, Frequency Unit

Description

The FU command is used to change the unit for the carrier frequency display. With this command the RE 122 can be programmed to a specific setup before allowing manual operation of the generator.

Syntax

FU, *Unit*

FU?

Parameters

Parameter	Range	Default Value
Unit	**kHz, MHz**	**MHz**

The command **FU, KZ** will change the unit for the carrier frequency display to kHz. The change of unit will be performed independently of the current use of the display i.e. carrier or delta frequency.

FU? will cause the generator to transmit its current frequency unit setting.

ID, Instrument Identity

Description

By means of the ID command, it is possible to give the generator an identity number and to inspect the software revision.

Syntax

ID, *Identity_Number.*

ID?

Parameters

Parameter	Range	Default Value
Identity_Number	**0** to **255**	None

ID,122 will set the ID number to 122.

When sending an **ID?** command, the generator will transmit a character string with the following format:

ID,*nnn*
RE122 SIGNAL GENERATOR
SOFTWARE VERSION *x.y yymmdd*
AM STEREO OPTION
OVEN OSCILLATOR OPTION

where *nnn* is to be substituted by the actual ID number. *x.y yymmdd* is to be substituted by the actual software revision and date code.

The option strings are only transmitted when the corresponding option is installed.

IR, IEEE Address

Description

By means of the IR command, it is possible to change the generators IEEE address. The address is stored in battery backed memory, i.e. it will not be affected by power on-off switching. However, should the battery on the CPU Board fail the generator will again default the address to the setting of the DIP switch. Please refer to section 4.2 for further details on the DIP switch.

Syntax

IR, *Address*

IR?

Parameters

Parameter	Range	Default Value
Address	**0** to **30**	DIP switch setting

IR,22 will change the IEEE address to 22.

IR will change the IEEE address to the current DIP switch setting.

IR? will cause the generator to transmit the current DIP switch setting.

IT, Inspect Setups

Description

The setup inspection command, IT, enables you to examine the contents of the defined setups. This feature is especially valuable during the writing and debugging of controller programmes.

The IT command generates an inspect ready service request code, and when talk addressed the RE 122 will output the contents of the specified setup. If no setup specifications are used, all defined setups will be presented to the controller.

Syntax

IT, *Setup_Number*

IT?

Parameters

Parameter	Range	Default Value
Setup_Number	**0** to **499**	None

IT,2 will cause the generator to transmit the contents of setup number 2.

IT? will cause the generator to transmit the contents of all setups.

The setup contents are returned as shown below:

SF,*n Command Command* etc.

Corresponding to the **SF** format, *n* being the number of the setup being inspected.

LA, Lock Mechanical Attenuator

Description

The LA command is used to lock the mechanical attenuator for glitch-free level changes over a 16 dB range.

Syntax

LA, *Mode*

LA?

Parameters

Parameter	Range	Default Value
Mode	**ON** or **1**, **OFF** or **0**	**ON**

LA,ON will lock the mechanical attenuator, i.e. the following changes of output level using the command LL will be made with the electronic attenuator only. This means that changes in output level will be glitch-free and that switching is performed much faster than with the mechanical attenuator.

LA? will cause the generator to transmit the current attenuator mode selection.

LL, Output Level

Description

The LL command is used to set the RF output level. The level may be defined in various units:

* dBf, dB relative to one femto Watt
* dBm, dB relative to one milli Watt
* dBu, dB relative to one micro Volt EMF
* V, Volts
* mV, milli Volts
* uV, micro Volts

Syntax

LL, *Level*

LL?

Parameters

Parameter	Range	Default Value
Level	**-123.9** to **23.0** dBm **-10.9** to **136.0** dBu **-3.9** to **143.0** dBf **0.29** to **19.99** μV **0.01** to **19.99** mV **0.01** to **6.32** V	**0** dBm
Level Unit	**dBm**, **dBf**, **dBu**, **V**, **mV**, **uV**	**dBm**

The generator employs an electronic attenuator that allows you to program level with a resolution of 0.001 dB. Please note, however, that depending on your level setting the generator may not be able to give you exactly 0.001 dB. This is due to the fact that a linear DAC is used to implement a logarithmic attenuator. A setting as close to the desired level is made. You can use the **LL?** to interrogate the generator on the exact level setting.

Please note that the front panel can only display a resolution of 0.1 dB.

The command **LL,-19.5DBM** sets the output level to -19.5 dB relative to one milli Watt.

LL? will cause the generator to transmit its current output level setting.

LO, Level Offset

Description

The LO command is used to specify a level offset to the RF output level. This can be used to compensate the absolute level setting for losses in the signal path, e.g. antenna pads. Any offset can be defined, as long as the resulting output level is within the possible output level range, and there are no conflicts with the present modulation.

Syntax

LO, *Offset*

LO?

Parameters

Parameter	Range	Default Value
Offset	**-123.9** to **23.0**	None
Offset Unit	**dB**	**dB**

LO,6DB will set a level offset of 6 dB, i.e. the generator EMF level will be increased by 6 dB to compensate for loss in the signal path.

LO? will cause the generator to transmit its current level offset setting.

LS, Level Step

Description

The LS command allows the control panel codewheel level step size to be set from the IEEE488 bus, in preparation for manual control.

The chosen step size can only be set in units of dB, regardless of the chosen level unit. Even if a linear (voltage) level unit is chosen, the step size will still be logarithmic (in dB).

Syntax

LS, *Step*

LS?

Parameters

Parameter	Range	Default Value
Step	**0** to **80** dB	None
Offset Unit	**dB**	**dB**

LS? will cause the generator to transmit its current level step setting.

LU, Level Unit

Description

The LU command is used to change the unit for the output level display. With this command the RE 122 can be programmed to a specific setup before allowing manual operation of the generator.

Syntax

LU, *Unit*

LU?

Parameter

Parameter	Range	Default Value
Unit	**dBm**, **dBf**, **dBu**, **V**, **mV**, **uV**	**dBm**

The command **LU, DU** will change the unit for the output level display to dBμV. The level offset setting if any is not affected by the command.

LU,MV will set the output level unit to milli volts. Should the current level be too large or too small for a proper display of the level it will be indicated with over- and underflow, respectively.

LU? will cause the generator to transmit its current level unit selection.

PM, Phase Modulation

Description

The PM command is used to set PM modulation mode and deviation. The PM MONO input is the only available modulation source.

Syntax

PM, *Deviation*

PM?

Parameters

Parameter	Range	Default Value
Deviation	**0** to **25** rad	Previous deviation
Deviation Unit	**rad**	**rad**

Please note that the maximum PM deviation is dependent on the carrier frequency and that higher resolution applies a low deviation. Consult the specifications for details.

FM, PM and Sweep are mutually exclusive generator functions.

PM,0.79RD will set modulation to PM with 0.79 rad peak deviation. Please note that 0.01 rad deviation resolution is provided below 2.5 rad.

PM, will set modulation to PM using the previously defined peak deviation.

PM? will cause the generator to transmit its current PM modulation setting.

RF, RF Output On/Off

Description

The RF command is used to switch the RF output on/off.

Syntax

RF, *Mode*

RF?

Parameters

Parameter	Range	Default Value
Mode	**ON** or **1**, **OFF** or **0**	None

RF,1 will switch the RF signal on, i.e. set the output level to the previous setting.

RF? will cause the generator to transmit its current RF output setting.

RT, Reset

Description

The RT command is used to reset the unti to the factory defaults.

Syntax

RT, *Mode*

Parameters

Parameter	Range	Default Value
Mode	**0** Current setting **1** All setups **2** Attenuator counter **3** On-time counter	**0**

The attenuator counter and on-time counter resets RT,2 and RT,3 should only be issued in connection with maintenance.

SF, Setup Definition

Description

The SF command allows complete or partial generator settings to be stored as individual setups by using the various function control commands. The setups, generator settings, may then at a later point of time be recalled by means of the EX command. Generator settings not included in a setup definition will not be changed when the setup is recalled.

Note that when a setup is stored from the keyboard, an entire front panel setup is stored.

Syntax

SF, *Setup_Number Commands*

Parameters

Parameter	Range	Default Value
Setup_Number	**0** to **499**	None
Commands	All	None

The command list for the SF command may be any combination of valid commands.

The command **SF,3 FQ,80MHZ LL,0DBM** stores information as setup number 3, which when recalled by an **EX,3** command will cause the frequency to be 80 MHz and the level to be 0 dBm.

The commands **SF,15 EX** will store the current front panel setting as setup number 15.

SF,4 EX,5 will copy setup number 5 to setup number 4.

SP, Sweep Width and Time

Description

The SP command is used to specify the sweep width, time and waveform.

Syntax

SP, *Width*, *Time*, *Waveform*

SP?

Parameters

Parameter	Range	Default Value
Width	**1** to **1000** kHz	Previous width
Width Unit	**Hz**, **kHz**	**kHz**
Time	**10** to **200** ms	Previous time
Time Unit	**s**, **ms**	**ms**
Waveform	**TRI**, **SAW**	Previous waveform

Please note that the maximum sweep width is dependent on the carrier frequency and that higher resolutions apply for sweep width and time at low settings. Consult the specifications for further details.

FM, PM and Sweep are mutually exclusive generator functions.

SP,100,10,SAW will set up a sawtooth sweep, 100 kHz wide and with 10 ms sweep time.

SP? will cause the generator to transmit its current sweep setting.

TT, Selftest

Description

The TT command is used to execute selftest routines.

Syntax

TT, *Mode*

Parameters

Parameter	Range	Default Value
Mode	**0** All tests **1** RAM chip QD12 **2** RAM chip QD13 **3** EPROM chip QD14 **4** EPROM chip QD15 5 Stored setups crcc test 6 Global variables crcc test	**0**

TT will cause the generator to perform a full selftest, and transmit the following:

```
Testing RE122
1 RAM QD12 function PASS
2 RAM QD13 function PASS
3 ROM QD14 crcc     PASS
4 ROM QD15 crcc     PASS
5 Setups crcc       PASS
6 Globals crcc      PASS
```

4.5 Service Request Codes

The following is a list of the possible service request codes followed by a detailed description. The type of column indicates whether the code is an error, a warning, a ready code or a status code.

Class	Hex	Decimal	Description
Error	50	80	Syntax error
	51	81	Illegal parameter count
	52	82	Parameter limits exceeded or unit error
	53	83	Missing option
	54	84	Setup not defined
	56	86	Hardware error detected
Warning	65	101	Parameter truncated
	6B	107	Command ignored
	6C	108	Modulation source Uncalibrated
	6D	109	Modulation source Calibrated
	6E	110	Reference oscillator Unlocked
	6F	111	Reference oscillator Locked
	70	112	Carrier frequency Unlocked
	71	113	Carrier frequency Locked
Result	D4	212	Inspect of setup ready
	D9	217	Query result ready
Status	00	0	Busy
	40	64	Forced to local mode
	41	65	Forced to local released
	80	128	Idle state

Table 4.3 - Service Request Codes

A more detailed explanation for on the service request codes is given in the following.

Forced to Local **Hex 40; Decimal 64**

Forced to Local is issued when the *LOCAL* key is pressed during remote operation. This means that the generator will change to local state. The LED in the LOCAL key will be lit indicating that the generator is in forced to local mode, please refer to section 4.1 for details on the remote/local operation.

Forced to Local Release **Hex 41; Decimal 65**

Pressing the LOCAL key when in forced to local mode will turn off the LED in the key. This indicates that the instrument controller may again operate the generator. Hint - the generator can be taken out of the forced to local mode by entering the local with lockout state, i.e. issue a local lockout command before sending commands to the generator. For further details on remote/local operation please refer to section 4.1.

Syntax Error **Hex 50, Decimal 80**

A Syntax Error is flagged whenever a command mnemonic is not recognized or if an illegal character is encountered in the input command sequence.

Illegal Parameter Count **Hex 51; Decimal 81**

An Illegal Parameter Count error occurs whenever needed parameter values are not specified or when too many parameters are specified.

Parameter Limits Exceeded **Hex 52; Decimal 82**

Parameter Limits Exceeded is issued if a parameter value is out of range, for example if you specify a carrier frequency above 250 MHz.

Missing Option **Hex 53; Decimal 83**

Missing Option occurs when a command calls for a function requiring an option which is not available in the instrument, e.g. changing modulation to AM stereo with no AM stereo option installed.

Setup Not Defined **Hex 54; Decimal 84**

If INSPECT or EX is attempted on a setup not previously defined by an SDEF command, the Setup Not Defined error is issued.

Hardware Error Detected **Hex 56; Decimal 86**

Hardware Error Detected is issued during selftest and run time test whenever a failure is found. To get a report on what error was detected use the Test command.

Parameter Truncated **Hex 65; Decimal 101**

Parameter Truncated occurs, for example, if the carrier frequency is specified with 0.1 Hz resolution.

Command Ignored **Hex 6B; Decimal 107**

The Command Ignored warning is issued when an attempt is made to define a setup containing one of the commands: SDEF, INSPECT or E.

Mod Source Uncal **Hex 6C; Decimal 108**

Mod. Source Uncal is issued when the input of the currently enabled external MONO input is uncalibrated, i.e. the input level exceeds 1 Vp $\pm$ 5 %.

Mod Source Cal **Hex 6D; Decimal 109**

Mod. Source Cal issued after an uncal when the input signal becomes calibrated again.

Reference Oscillator Unlock **Hex 6E; Decimal 110**

When presenting an external reference signal to the generator it will automatically detect the presence of the new reference signal. This will cause the generator to issue the Reference Unlock warning, indicating that the RF signal is not locked to the new reference signal.

Reference Oscillator Lock **Hex 6F; Decimal 111**

The Reference Lock message is issued when the generator has locked to the current reference frequency.

Carrier Frequency Unlock **Hex 70; Decimal 112**

The FM modulation phase locked loop is a very low bandwidth loop. This means that this loop will need some time after power up in order to lock. Changing the reference oscillator, e.g. by presenting an external reference frequency to the generator may also cause the FM loop to fall out of lock. In case this happen the Carrier Unlock

warning is issued.

Carrier Frequency Lock **Hex 71; Decimal 113**

Carrier Frequency Lock indicates the FM modulation loop has locked again, i.e. the displayed frequency is again within the specified accuracy.

Inspect of Setup Ready **Hex D4; Decimal 212**

The setup requested is ready to be sent.

Query Result Ready **Hex D9; Decimal 217**

The result of a parameter query is ready to be sent.

5. EQUIPMENT AND ACCESSORIES

This sections contains a list of the accessories supplied with the RE 122 Signal Generator and lists of available options and optional equipment and accessories.

5.1 Standard Equipment and Accessories

The following equipment and accessories should be found when unpacking the RE 122 Signal Generator:

Code	Type	Description
391-047	RE 122	Signal Generator
450-125	3.15 A	Fuse, slow blow
450-901	1.6 A	Fuse, slow blow
615-303	220 V	Line cord, 2.5 m
615-403	110 V	Line cord, 2.5 m
983-403		Operating Manual
983-708		Installation Instructions

Table 5.1 - Standard Equipment and Accessories

5.2 Available Options

The following options are available for the RE 122 Signal Generator:

Code	Description
906-150	Desktop model with front panel, front RF output
906-151	Front panel, factory installed
906-152	Control panel, remote with cable
906-153	AM stereo, Motorola C-QUAM modulator
906-226	Oven controlled reference oscillator

Table 5.2 - Available Options

Please note that all options except the Control Panel are factory installed options. The Control Panel can **only** be used on the standard instrument, i.e. an RE 122 with a blank front panel.

5.3 Optional Equipment and Accessories

Optional equipment and accessories to be used with the RE 122 Signal Generator:

Code	Description
618-085	Coaxial Extender Cable with SMB/SMB connectors
618-086	Coaxial Test Cable with SMB/BNC connectors
901-805	96-pole DIN Extender Board to be used with: CPU Board, 902-020 SMPS Unit, 901-850
901-885	48-pole DIN Extender Board to be used with all other plug-in boards
906-070	19" rack mounting kit
983-404	Servicing Manual

Table 5.3 - Optional Equipment and Accessories

The rack mounting kit can only be used with the desktop model. The standard version of the RE 122 Signal Generator is a 19" rack model with a blank front panel. 19" rack mounts are an integral part of the cabinet.

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6. SPECIFICATIONS

This section contains a full specification for the instrument. The listed data are guaranteed specifications.

6.1 Performance Specifications

Frequency

Range	100 kHz to 250 MHz
Resolution	1 Hz
Switching time	< 2 ms to within 100 Hz of final frequency excluding command processing latency

Reference Oscillator

Internal Reference

Standard	10 MHz crystal oscillator
Temperature stability	±10 ppm, 5° to 50° C
Accuracy	±1 ppm, 25°C
Option	10 MHz oven-controlled crystal oscillator
Temperature stability	±0.1 ppm, 5° to 50° C
Accuracy	±0.1 ppm, 25° C
Aging	±1 x 10^{-7}/year
	±1 x 10^{-9}/day

External Reference Input

Frequency	1, 2, 5 or 10 MHz
Locking range	±100 ppm
Waveform	Sine or square wave
Input level	150 mVrms to 1.75 Vrms
Input impedance	1 kΩ
Type of connector	BNC

Reference Output

Frequency	10 MHz
Waveform	Sine wave
Output level	> 320 mVrms EMF
Output impedance	50 Ω
Type of connector	BNC

Spectral Purity

Harmonics	
100 kHz to 70 MHz	< -40 dBc
70 to 250 MHz	< -35 dBc
Non-harmonic spurious[1)]	
100 kHz to 2 MHz	< -75 dBc
2 to 120 MHz	< -65 dBc
120 to 250 MHz	< -60 dBc
Residual AM	< 0.01% rms, 20 Hz to 10 kHz bandwidth
Residual FM	
100 kHz to 2 MHz	< 1 HZ rms, 20 Hz to 15 kHz bandwidth
2 to 120 MHz	< 5 HZ rms, 20 Hz to 15 kHz bandwidth
100 kHz to 250 MHz	< 5 HZ rms, 300 Hz to 3 kHz bandwidth
	< 10 HZ rms, 20 Hz to 15 kHz bandwidth
SSB phase noise	
100 kHz to 2 MHz	< -120 dBc/Hz, 1 kHz offset
	< -125 dBc/Hz, 10 kHz offset
2 to 120 MHz	< -100 dBc/Hz, 1 kHz offset
	< -115 dBc/Hz, 10 kHz offset
	< -125 dBc/Hz, 100 kHz offset
120 to 250 MHz	< -95 dBc/Hz, 1 kHz offset
	< -110 dBc/Hz, 10 kHz offset
	< -115 dBc/Hz, 100 kHz offset

1) More than 100 kHz from carrier

Output

Level range	
AM depth ≤30%	-123.9 to 23 dBm, 0.29 μV to 6.3 Vrms EMF
AM depth > 30%	-123.9 to 19 dBm, 0.29 μV to 4 Vrms EMF
Level with RF off	< -130 dBm
Glitch free setting	0 to -16 dB starting from any level
Resolution	
Front panel control	0.1 dB
Remote control	0.001 dB
Flatness	±0.5 dB
Absolute accuracy	±1.5 dB, level ≥ -43 dBm ±2.5 dB, level < -43 dBm
Output impedance	50 Ω
VSWR	< 1.2, level 13 dBm < 1.6, level 13 dBm
Intermod., 3rd order[2)]	< -70 dBc, level > 13 dBm < -60 dBc, level ≥ 13 dBm
Switching time	
Mechanical attenuator	< 2.5 ms to within 0.1 dB of final output level excluding command processing latency
Electronic attenuator	< 30 μs to within 0.1 dB of final output level excluding command processing latency
Attenuator rated life	100 million switchings
Leakage	< 1 μV in a two-turn loop 25 mm in diameter, held 25 mm away from any instrument surface and loaded by 50 Ω, for output levels ≤0 dBm and RF output loaded by 50 Ω
Display modes	dBm, dBμV, dBf, μV, mV, V, Offset
Type of connector	BNC

Amplitude Modulation

AM depth	0 to 99.5%, level ≤19 dBm 0 to 30%, level > 19 dBm
Resolution	0.5%
Accuracy	
100 kHz to 2 MHz	±2% of setting
2 to 250 MHz	±5% of setting
Bandwidth	20 Hz (DC) to 25 kHz, ±0.1 dB

2) For two signals 5 kHz apart using a resistive combiner

	1 Hz (DC) to 200 kHz, ±3 dB
Distortion	
100 kHz to 2 MHz	< 0.1% THD, 30% AM, 1 kHz
	< 0.15% THD, 50% AM, 1 kHz
	< 0.2% THD, 80% AM, 1 kHz
2 to 250 MHz	< 0.15% THD, 30% AM, 1 kHz
	< 0.2% THD, 50% AM, 1 kHz
	< 0.4% THD, 80% AM, 1 kHz
S/N ratio	> 80 dB, 100% AM, 20 Hz to 10 kHz bandwidth
Incidental FM	
100 kHz to 2 MHz	< 3 Hz peak, 30% AM, 1 kHz
2 to 250 MHz	< 50 Hz peak, 30% AM, 1 kHz
Incidental PM	
100 kHz to 2 MHz	< 3×10^{-3} rad peak, 30% AM, 1 kHz
2 to 250 MHz	< 5×10^{-2} rad peak, 30% AM, 1 kHz

AM Stereo Option

Stereo system	Motorola C-QUAM
Frequency range	400 kHz to 1.8 MHz
AM depth	0 to 99.5%, level ≤19 dBm
	0 to 30%, level > 19 dBm
PM deviation	0 to $\pi/4$ rad
Accuracy	±2% with calibrated input
Bandwidth	20 Hz to 10 kHz, ±0.1 dB
Distortion	
Main channel modulation	< 0.2% THD, L+R = 30%, L-R = 0%, 1 kHz
Subchannel modulation	< 0.2% THD, L+R = 0%, L-R = 30%, 1 kHz
L and R only modulation	< 0.2% THD, L = 30%, R = 0% or L = 0%, R = 30%, 1 kHz
	< 0.3% THD, L = 50%, R = 0% or L = 0%, R = 50%, 1 kHz
	< 0.5% THD, L = 70%, R = 0% or L = 0%, R = 70%, 1 kHz
Stereo separation	> 45 dB, L = 30%, R = 0% or L = 0%, R = 30%, 1 kHz
	> 40 dB, L = 30%, R = 0% or L = 0%, R = 30%, 20 Hz to 10 kHz
S/N ratio	> 70 dB, 100% AM, $\pi/4$ rad PM, 200 Hz to 10 kHz bandwidth
	> 60 dB, 100% AM, $\pi/4$ rad PM, 20 Hz to 10 kHz bandwidth

Residual AM	< 0.01% rms, 20 Hz to 10 kHz bandwidth
Residual PM	< 0.15 x 10^{-3} rad peak, 200 Hz to 10 kHz bandwidth
	< 0.5 x 10^{-3} rad peak, 20 Hz to 10 kHz bandwidth

Frequency Modulation

FM deviation	
100 kHz to 2 MHz	0 to 50 kHz
2 to 250 MHz	0 to 250 kHz
Resolution	
0 to 25 kHz	0.1 kHz
25 to 125 kHz	0.5 kHz
125 to 250 kHz	1.0 kHz
Accuracy	
2 to 120 MHz	±2% of setting
100 kHz to 250 MHz	±5% of setting
Bandwidth	
FM Mono	20 Hz to 20 kHz, ±0.1 dB
FM Stereo	20 Hz to 100 kHz, ±0.3 dB
Distortion	
100 kHz to 2 MHz	< 0.03% THD, 10 kHz deviation, 1 kHz
2 to 250 MHz	< 0.01% THD, 75 kHz deviation, 1 kHz
Stereo separation	
10 to 12 MHz, 70 to 110 MHz	> 60 dB, 1 kHz
	> 50 dB, 300 Hz to 5 kHz
	> 40 dB, 40 Hz to 15 kHz
S/N ratio	
2 to 120 MHz	> 80 dB, 75 kHz deviation, 20 Hz to 15 kHz bandwidth
	> 90 dB, 75 kHz deviation, 50 µs de-emphasis
	> 94 dB, 75 kHz deviation, 75 µs deemphasis
100 kHz to 250 MHz	> 74 dB, 75 kHz deviation, 20 Hz to 15 kHz bandwidth
Incidental AM	< 0.1%, 100 kHz deviation, 1 kHz

DC FM

FM Deviation	±400 ppm of carrier frequency 40h @ 100M
Bandwidth	DC to 500 Hz, -3 dB

Phase Modulation

PM deviation	
100 kHz to 2 MHz	0 to 5 rad
2 to 250 MHz	0 to 25 rad
Resolution	
0 to 2.5 rad	0.01 rad
2.5 to 25 rad	0.1 rad
Accuracy	
2 to 120 MHz	±2% of setting
100 kHz to 250 MHz	±5% of setting
Distortion	
100 kHz to 2 MHz	< 0.03% THD, 2 rad deviation, 1 kHz
2 to 250 MHz	< 0.01% THD, 10 rad deviation, 1 kHz
Bandwidth	10 Hz to 10 kHz, ±0.2 dB
Residual PM	< 0.15 x 10^{-3} rad peak, 200 Hz to 10 kHz bandwidth
	< 0.5 x 10^{-3} rad peak, 20 Hz to 10 kHz bandwidth
Incidental AM	< 0.1%, 20 rad deviation, 1 kHz

DC PM

PM Deviation	±10π rad, 10 MHz
Bandwidth	DC to 25 Hz, -3 dB

Sweep Characteristics

Sweep modes	Sawtooth and triangular

Sweep Width

Range	
100 kHz to 2 MHz	±1 to ±50 kHz
2 to 45 MHz	±10 to ±250 kHz
45 to 70 MHz	±10 to ±500 kHz
70 to 250 MHz	±10 to ±1000 kHz
Resolution	1 kHz, ±1 to ±250 kHz sweep
	5 kHz, ±250 to ±1000 kHz sweep
Accuracy	±5% of setting

Sweep Time

Range	10 to 200 ms
Resolution	1 ms
Accuracy	±5% of setting

Sweep Output

Output level	±5 V
Output impedance	< 10 Ω
Load	> 500 Ω, < 200 pF
Marker	Bright spot on oscilloscope trace at center frequency
Type of connector	BNC

Modulation Characteristics

Modulation modes	AM, DCAM, AM stereo, FM, DCFM, PM, DCPM
Simultaneous modulation	AM/FM, AM/PM

Internal Modulation

Frequency	400 Hz and 1 kHz
Accuracy	As reference oscillator
Distortion	< 0.003% THD
Modulation output	400 Hz or 1 kHz, AF OUT
Output level	1 Vp
Output impedance	< 10 Ω
Load	> 500 Ω, < 500 pF
Type of connector	BNC

External Modulation Inputs

AM Mono	
AC coupled	1 Vp for displayed AM depth
DC coupled	0 Vdc for displayed output level and AM depth
AM Stereo L+R	1 Vp for 100% AM depth
AM Stereo L-R+Pilot	1 Vp for $\pi/4$ rad PM deviation
FM Mono	1 Vp for displayed FM deviation
FM Stereo	
100 kHz to 2 MHz	1 Vp for 20 kHz FM deviation
2 to 250 MHz	1 Vp for 100 kHz FM deviation
PM Mono	1 Vp for displayed PM deviation
Calibration	With front panel an UNCAL annunciator indicates departure from 1 Vp ± 5% on mono inputs
Input impedance	100 kΩ
Type of connector	BNC

DC FM/PM Input

Characteristic	Carrier frequency varies linearly with input voltage
Sensitivity	
DC FM	40 ppm/V ±20%
DC PM	π rad/V ±20%, 10 MHz
Maximum input	±12 V
Input impedance	100 kΩ
Type of connector	BNC

Trigger Output

Signal	250 μs positive going TTL pulse
Output impedance	50 Ω
Type of connector	BNC

Remote Programming and Operation

IEEE488 Bus

Functions controlled	All except power on/off and the rotary knob
Interface functions	SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP1, DC1, DT0, C0, E2
Instruments set-ups	500 complete set-ups can be stored and recalled from non-volatile memory
Command processing latency	Typical < 500 μs for complete instrument setting by recall of previously defined setup

General

Temperature

Operating temperature	5° to 50° C (41° to 122° F)
Storage temperature	-40° to 70° C (-40° to 158° F)
Relative humidity	20 to 80% non-condensing

Line	
Voltage	90 V to 130 V AC, 180 V to 260 V AC
Frequency	47.5 to 63 Hz
Power consumption	240 VA
Dimensions and Weight	
Height	133 mm (5.2")
Width	440 mm (17.3")
Depth	501 mm (19.7")
Net weight	15 kg (33 lbs.)
Shipping weight	20 kg (44 lbs.)

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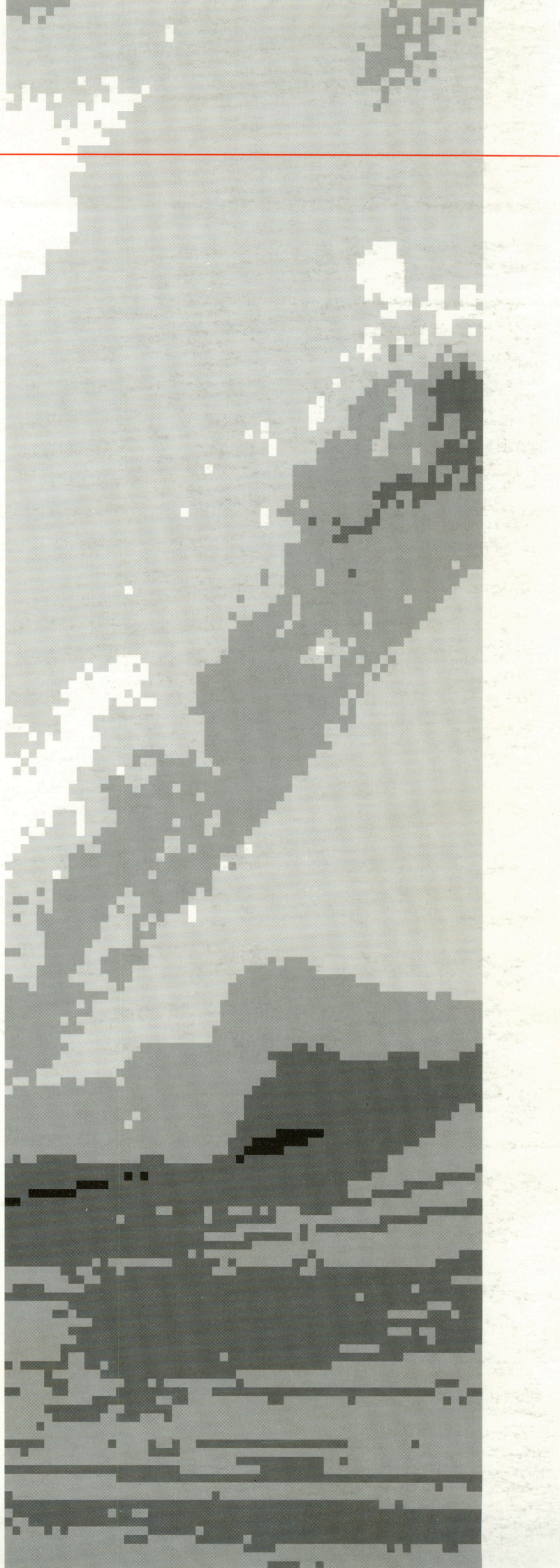
7. INDEX



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