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10 kHz to 1 GHz AM/FM Signal Generators 2022A&C

- Wide frequency cover: 10 kHz to 1 GHz
- +13 dBm output (2022C)
- Small, light and rugged for portability
- Non-volatile memory with 100 settings
- Powerful second functions for rapid fault finding and calibration
- Comprehensive amplitude, frequency and phase modulation
- Simple operation
- Reverse power protection up to 50 W
- Choice of output calibration units
- Optional GPIB programmability

2022A and 2022C Signal Generators are compact, lightweight units offering frequency, phase and amplitude modulation over the frequency range 10 kHz to 1 GHz. Output levels up to +13 dBm are offered on the 2022C and +6 dBm on the 2022A. The units are designed for a wide range of applications in research development, production and maintenance. Microprocessor control provides simple and rapid operation by direct keyboard entry of settings. The non-volatile memory, which can store up to one hundred settings, further reduces measurement time. Full GPIB-programmability adds greater flexibility and faster throughput in systems applications.

SIMPLE OPERATION

A simple keyboard layout ensures easy operation. All parameters are set using the numeric keys, while up and down keys allow the values to be varied in steps of any size. A TOTAL SHIFT key displays the deviation from the original setting and a RETURN key returns the selected parameter to the original value. All front-panel

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7 & 8	Not used.
9	Read elapsed time.
10	Record external frequency standard choice.
11	Read instrument identity string.
12	Write via GPIB a user-defined string stored in non-volatile memory.
13	Read user-defined string via GPIB.
14	Display/change RF level units (i.e. voltage EMF or PD and dB reference).
15	Display/change RF level calibration offset.
16	Specify start-up with instrument settings from store 10.
17 & 18	Not used.

Functions 10 to 18 inclusive are protected functions.

190	Set identity string, displayed by SF11.
191 to 194	Calibration of FM tracking, RF level, voltage tuned filters and AM.
195 to 199	Other Second Functions reserved for calibration and servicing.

Functions 190 to 199 are doubly protected functions intended for use in manufacture and servicing only.

Displays

A single liquid crystal display provides simultaneous readout of Carrier Frequency, Modulation and RF Level.

Carrier frequency: 7 digit display with annunciators to show frequency units, external frequency standard, GPIB service requests, frequency limit exceeded, remote operation and instrument addressed.

Modulation display: 3 digit display with annunciators to show modulation units FM, ØM, AM, modulation off and external modulation selected.

RF level display: 4 digit display with annunciators to show RF level units, RF output off and reverse power trip operated.

GPIB INTERFACE

A GPIB interface is available as an accessory. All functions except the supply switch are remotely programmable.

Capabilities

Complies with the following subsets as defined in IEEE 488-1978 and IEC Publication 625-1.
SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, E1.

RADIO FREQUENCY INTERFERENCE

Conforms with the requirements of EEC directive 76/889 as to limits of r.f. interference.

SAFETY

Complies with IEC 348.

RATED RANGE OF USE (Over which full specification is met)

Temperature 0 to 55°C.

CONDITIONS OF STORAGE AND TRANSPORT

Temperature 40°C to +70°C.

Humidity Up to 90% relative humidity.

Altitude Up to [illegible] 27 kPa differential, i.e. 3·9lbf/in²).

POWER REQUIREMENTS

AC Supply Switchable voltage ranges 105 to 120 V, 210 to 240 V, all ± 10%.
45 to 440 Hz.
55 VA maximum

DIMENSIONS AND WEIGHT (not including handle forward projection)

Height	Width	Depth	Weight
152 mm	256 mm	367 mm	7·5 kg
6 in	10·25 in	14·5 in	16·5 lb

VERSIONS AND ACCESSORIES
When ordering please quote eight digit code numbers

Ordering numbers	Versions
52022-910E	10 kHz to 1 GHz Signal Generator 2022A (+6 dBm output).
52022-930X	10 kHz to 1 GHz Signal Generator 2022C (+13 dBm output)
	Supplied Accessories
	AC Supply Lead. 43129-003W
	Operating Manual
	2022A (H52022-910E Vol. 1) 46881-796V
	2022C (H5022-93X Vol. 1) 46881-846R.
	Optional Accessories
54124-023J	Front Panel Protective Cover.
46881-797S	Service Manual for 2022A (H52022-910E Vol. 2).
46881-847B	Service Manual for 2022C (H 52022-930X) Vol. 2.
54433-003N	GPIB Module.
43129-189U	GPIB Lead Assembly.
46881-365R	GPIB Manual. H54811-010P (contains details of general GPIB protocols).
46883-717K	Rack Mounting Kit (Single Unit).
46883-716B	Rack Mounting Kit (Double Unit).
43126-012S	RF Connector Cable, TM 4969/3, 50 Ω, 1·5 m, BNC.
54311-092P	Coaxial Adapter, N male to BNC female.
54311-095C	RF Connector Cable, 1 m, Type N connectors.
54411-051X	Impedance Adapter, 50 to 75 Ω, BNC Connectors.
46883-408K	IEEE/IEC Adapter Block for GPIB socket.

AM/FM Signal Generators 2022A and 2022C are ideal for a variety of applications in receiver testing.

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For peak output power levels up to +9 dBm for 2022C and +6 dBm for 2022A:–

Accuracy
Better than ± (4% of depth setting + 1%) for 1 kHz modulating frequency and depths of:
0 to 95% for carrier frequencies up to 62·5 MHz;
0 to 80% for carrier frequencies up to 400 MHz.

Frequency response
± 0·5 dB from 50 Hz to 15 kHz relative to 1 kHz at 80% depth using external mod. input and ALC on. DC coupled with ALC off.

Envelope distortion
Less than 3% total harmonic distortion at 1 kHz modulating frequency for depths up to 80% for carrier frequencies up to 400 MHz.
Less than 5% total harmonic distortion at 1 kHz modulation frequency for depths up to 95% for carrier frequencies up to 62.5 MHz.

External modulation input
With modulation ALC on the deviation is calibrated for input levels between 0·9 V and 1·1 V RMS A HI or LO message is indicated in the modulation display if the applied level is outside the range of the ALC. With modulation ALC off, the modulation depth is calibrated for an input level of 1 V PD.

Input impedance: 100 kΩ nominal, DC coupled.

MODULATION OSCILLATOR

Frequency
1 kHz.

Frequency accuracy
As reference frequency standard.

Distortion
Less than 1% total harmonic distortion.

FREQUENCY STANDARD

Internal or external frequency standard may be selected from the front panel. Annunciators show which is selected.

Frequency standard input
A rear-panel BNC socket provides an external standard input when external standard is selected.

INTERNAL FREQUENCY STANDARD

High stability oven controlled crystal oscillator.

Frequency
10 MHz.

Temperature stability
Better than ± 0·2 PPM over the temperature range 0 to 40°C.

Warm-up time
Within 0·5 PPM of final frequency 5 min. from switch on at 20°C ambient.

Ageing rate
Better than 0·1 PPM per month after 1 month's continuous use at constant ambient temperature.

EXTERNAL FREQUENCY STANDARD

External standard input
Accepts a 10 MHz signal of at least 1 V RMS into a 100 Ω nominal impedance. A 5 MHz or 1 MHz signal can be accepted by changing an internal link. Connection is via a rear panel BNC socket.

AUXILIARY INPUTS AND OUTPUTS

Modulation input/output
A front panel BNC socket provides an output from the modulation oscillator when internal modulation is selected and becomes the external modulation input when external modulation is selected.

The input signal may be levelled by selecting the MOD ALC ON/OFF key. Two LCD annunciators, HI and LO, provide an [illegible] in the ALC ON mode.

Internal modulation oscillator output
1 V ± 10% from a nominal 600 Ω source. The output frequency is 1 kHz with accuracy same as the internal frequency standard. Total harmonic distortion is less than 1%.

External modulation input
Input level nominally 1 V RMS into 100 kΩ. See FREQUENCY MODULATION, PHASE MODULATION and AMPLITUDE MODULATION.

Alternative RF output and modulation sockets
A blanked hole is provided so the RF output socket can be fitted to the rear panel. For 2022A an additional blanked hole is provided for rear panel mounting of the modulation input/output socket.

Auxiliary modulation input (2022C)
A rear panel BNC socket provides an auxiliary modulation input with a nominal sensitivity of 20% of the indicated modulation for a 1 V input.
Input impedance 600 ohms nominal.

KEYBOARD AND DISPLAYS

Main keyboard functions
All instrument settings are controlled by the front panel keyboard.
The main key functions are:

CARRIER FREQ	7 8 9 MHz/V
FM/ØM	4 5 6 kHz/mV
AM	1 2 3 Hz/µV
RF LEVEL	0 . - %/rad/dB

Settings are entered by selecting the required function, keying in the value and pressing the appropriate units key.

Other functions provided are:

△
Increment key. When pressed before a function key, an increment value is entered for that function.

↑ and ↓
Increments or decrements the selected function.

TOTAL △
Displays total increment shift from last keyed-in value.

RET'N
Returns setting to last previously keyed-in value for the selected function. (In remote operation requests return to local control).

INT EXT
If pressed after Carrier Freq., toggles between internal and external frequency standard. If pressed after AM, FM or ØM toggles between internal and external modulation.

CARR ON-OFF
Toggles between RF output on and off.

MOD ON-OFF
Toggles between modulation on and off.

MOD ALC
Toggles between modulation ALC on and off.

STORE and RECALL
Provide storage and recall of instrument settings in non-volatile memory. Up to 20 complete instrument settings and up to 80 carrier frequencies may be stored.

SECOND FUNCT.
Selects second function entry mode.

Secondary keyboard functions
The following secondary functions may be selected using the Second Function key followed by a number key.

0	Second function protection.
1	Display instrument status (GPIB address, RF output level units etc.)
2	Display/change GPIB address.
3	Direct addressing of internal bus system (servicing aid).
4	Display/change GPIB SRQ mask.
5	Read identity string (unprotected duplicate of SF11).
6	Test LCD readout and front-panel LEDs.

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RF OUTPUT

Level

−127 to +13 dBm (0·2 µV to 2 V EMF) for 2022C.

−127 to +6 dBm (0·2 µV to 892 mV EMF) for 2022A.
When AM is selected the maximum output power reduces linearly with AM depth to +7 dBm (2022C) or +0 dBm (2022A) at maximum AM depth.

Selection

By keyboard entry. Units may be µV, mV, V EMF or PD; dB relative to 1 µV, 1mV EMF or PD; dBm.
Conversion between dB and voltage units may be achieved by pressing the appropriate unit key (dB, or V, mV, µV).

Indication

4 digit LCD with units annunciators. See KEYBOARD AND DISPLAYS.

Displayed resolution

0·1 dB or better over the entire voltage range.

Output level accuracy

±1 dB for output levels above −10 dBm.
±2 dB for output levels below −10 dBm.

Output level flatness

Better than ±0·5 dB 10 kHz to 1 GHz for output levels above −10 dBm.

Output impedance

50Ω, type N female socket to MIL 390123D. VSWR is better than 1·5:1 for output levels below −10 dBm.

Reverse power protection

An electronic trip protects the generator output against reverse power of up to 50 W from a 50 ohm source or up to 25 W with a source VSWR up to 5:1 for frequencies from DC to 1 GHz. The trip may be reset from the front panel or via the GPIB. For safety the protection is also provided when the instrument is switched off.

SPURIOUS SIGNALS

Harmonically related signals

For output levels up to +7 dBm (0 dBm for 2022A), better than −25 dBc for carrier frequencies up to 62·5 MHz; typically −40 dBc.

Better than 25 dBc for carrier frequencies above 62·5 MHz; typically −36 dBc.

Sub-harmonics (at output levels below 0 dBm.)

None for carrier frequencies up to 500 MHz, better than 20 dBc for carrier frequencies above 500 MHz.

Non-harmonically related signals

For output levels up to +7 dBm (0dBm for 2022A) and at offsets from the carrier of 3 kHz or greater:
For carrier frequencies above 62·5 MHz better than −70 dBc.
For carrier frequencies below 62·5 MHz; better than −55 dBc in the band up to 150 MHz, and better than −40 dBc in the band above 150 MHz.

Residual FM (with FM OFF)

Less than 7 Hz RMS deviation in a 300 Hz to 3 kHz bandwidth from 250 to 499 MHz and improving by approximately 6 dB per octave with reducing carrier frequency down to 62·5 MHz. Better than 3.5 Hz RMS below 62·5 MHz.

RF leakage

Less than 0·5 µV p.d. generated in a 50 Ω load by a two-turn, 25 mm loop, 25 mm or more from the case of the generator, with the output level set to less than −10 dBm and the output terminated in a 50 Ω sealed load.

FREQUENCY MODULATION

Range

Peak deviation from 0 to 99·9 kHz for all carrier frequencies.

Displayed resolution

10 Hz for deviations up to 9·99 kHz.
100 Hz for deviations from 10 kHz to 99·9 kHz.

Selection

By front panel keyboard. Internal 1 kHz modulation or external input may be selected.

Display

3 digit LCD, see KEYBOARD AND DISPLAYS.

Deviation accuracy

±5% of deviation ±20 Hz at 1 kHz modulating frequency excluding residual FM.

Frequency response

±1 dB from 10 Hz to 50 kHz relative to 1 kHz, using external modulation input.

With ALC off the low frequency response is extended to 10 Hz with a peak deviation value limited to the lower of 99·9 kHz or [0·047 × Modulation Frequency in Hz × (Carrier Frequency in MHz + 160 (if Carrier Frequency is below 62·5 MHz))] kHz.

With ALC off, can also be used for 10 Hz square wave switching with a peak deviation value limited to the lower of 99·9 kHz or 0·6 times the value obtained by the formula above.

Distortion

Less than 2% total harmonic distortion at 1 kHz modulation frequency and maximum deviation for any carrier frequency above 250 kHz.
Less than 0·5% total harmonic distortion at 1 kHz modulating frequency for deviations up to 25 kHz for any carrier above 250 kHz with MOD ALC off.

External modulation

With modulation ALC on the deviation is calibrated for input levels between 0·9 V and 1·1 V RMS A HI or LO message is indicated in the modulation display if the applied level is outside the range of the ALC With modulation ALC off, the deviation is calibrated for an input level of 1 V PD.

Input impedance: 100 kΩ nominal.

PHASE MODULATION

Range

Peak deviation from 0 to 9·99 radians.

Displayed resolution

0·01 radians.

Selection

By front panel keyboard. Internal 1 kHz modulation or external input may be selected.

Deviation accuracy

±5% of deviation ±0·02 radians at 1 kHz modulating frequency excluding residual ØM.

Frequency response

±1 dB from 10 Hz to 10 kHz relative to 1 kHz, using external modulation input and ALC off.

±1 dB from 50 Hz to 10 kHz relative to 1 kHz using external modulation input and ALC on.

Distortion

Less than 5% total harmonic distortion at 1 kHz modulating frequency and maximum deviation for any carrier frequency above 250 kHz.

External modulation

With modulation ALC on the deviation is calibrated for input levels between 0·9 V and 1·1 V RMS A HI or LO message is indicated in the modulation display if the applied level is outside the range of the ALC With modulation ALC off, the deviation is calibrated for an input level of 1 V PD.

Input impedance: 100 kΩ nominal.

AMPLITUDE MODULATION

Range

0 to 99·5%.

Resolution

0·5%

Selection

By front panel keyboard. Internal 1 kHz modulation or external input may be selected

Display

3 digits. See KEYBOARD AND DISPLAYS.

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Stored status information
Status information stored includes: internal/external standard; GPIB address; type and serial number. Elapsed time indicators are also accessed via the internal memories. One stores the number of operational hours since the instrument was manufactured and cannot be altered. The other records the number of elapsed hours since the clock was last reset; re-settings being accomplished using a secure Second Function.

Stored user-defined information
In GPIB operation the non-volatile memory may be used to store a user-defined string. Up to 32 ASCII characters may be written to, or read from the unit, for example to record the instrument's inventory information, date of last calibration, normal instrument location etc.

PROGRAMMING
2022A and 2022C can be simply fitted at any time with the optional GPIB interface so that all functions can be controlled over the bus. The instruments function as talker as well as listener. In the listen mode the generator's functions are set by simple instructions, and in the talk mode strings of information containing details of the instrument's settings can be sent back over the bus, allowing the controller to learn settings for later use.

Ease of programming
Ease of programming is ensured by careful selection of mnemonics. For example to send a carrier frequency of 123·456 MHz, an FM deviation of 3·5 kHz and an output level of 1·74 µV, and to place these settings in store 10 of the memory, it is only necessary to send over the bus the instruction CF123.456MZ,FM3.5KZ,LV1.74UV,ST10. The use of commas as delimiters in the instruction string is not essential but often aids interpretation of program lines.

Controlled service requests
Service requests (SRQs) are sent for a variety of reasons including reverse power protection tripped and illegal characters received. SRQs may be inhibited if desired by setting flags in the generator using a Second Function.

SECOND FUNCTIONS
The front panel Second Function key gives access to a number of different features available with 2022A and 2022C. Some of these are related to maintenance, calibration and programmable operation via GPIB. To prevent accidental interference with the contents of internal memories, those Second Functions that enable the internal data to be altered are protected by a secure key sequence.

Protected calibration data
Two levels of protection are offered, appropriate to the Second Function being accessed. The most secure is reserved for Second Functions that alter the instrument's calibration data, change its identity string, protect its store settings or blank the displays when memories are recalled. Less severe is the first level of protection, which enables the user to access those Second Functions that do not affect the fundamental calibration, but which may be relevant to normal operation. Examples include the selection of: RF level calibration units, RF level offsets, external standard frequency and switch-on status.

Additional operating features
In addition, unprotected Second Functions provide a range of additional operating features, such as the ability to display status information, elapsed time and the type and serial number.

MAINTENANCE AND CALIBRATION
The Second Function mode provides powerful fault diagnostic facilities from the front panel or via the GPIB by allowing the operator to send data directly to individual latches in the instrument. The resulting changes in output conditions can be monitored and the area in which the fault lies can be localized quickly.

Automatic calibration
RF level, f.m. accuracy and frequency accuracy can be adjusted without removing the instrument's covers. Level and FM accuracy can be adjusted over the GPIB, leading to fully automated calibration routines.

Rapid repair
Careful mechanical design of the instrument ensures rapid access to all circuits for PCB or component replacement. The main RF assemblies are easily removed for inspection and repair. Printed boards interconnect by means of plugs and sockets, so simplifying first-line maintenance.

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GENERAL DESCRIPTION

2022A and 2022C are synthesized signal generators covering the frequency range 10 kHz to 1 GHz. The output may be amplitude, phase or frequency modulated using either the built-in AF source or an external signal. All control settings are entered from a front panel keyboard. A single liquid crystal display gives simultaneous readout of frequency, modulation and output level. Remote control, via the General Purpose Interface Bus is available as an option.

CARRIER FREQUENCY

Range	10 kHz to 1 GHz.
Selection	By keyboard entry.
Indication	7 digit LCD — see under KEYBOARD AND DISPLAYS.
Displayed Resolution	10 Hz up to 100 MHz, 100 Hz above 100 MHz.
Accuracy	Set to the frequency standard accuracy. See FREQUENCY STANDARD.

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functions are available from GPIB when the optional GPIB interface board is fitted. Frequency, phase and amplitude modulation are selected by operation of the appropriate key, and for rapid measurements of receiver signal-to-noise ratio the modulation can be switched on and off using the MOD ON-OFF key. Provision is made for operation with an external reference frequency of 1 MHz, 5 MHz or 10 MHz as required.

DISPLAY

Measurement settings are indicated on a large liquid crystal display, offering clarity and low power consumption. The display features 7-digit resolution for carrier frequency, 3 digits for modulation and 4 for RF level, with units annunciators for unambiguous reading. Status and diagnostic information are also shown. Carrier frequency, modulation and RF level are all shown together.

OUTPUT

RF output levels up to +13 dBm can be set on the 2022C (up to +6 dbm on 2022A) in all modulation modes by direct keyboard entry or via the GPIB with a resolution of at least 0·1 dB over the entire range. Total level accuracy is ±1 dB for output levels above −10 dBm and ±2 dB below −10 dBm. Levels are indicated on a four-digit liquid crystal display with units annunciators and levels can be incremented in steps of any size.

Calibration data held in memory

A choice of seven calibration units is available to the operator and provision is made for the simple conversion of units (e.g. dBm to µV). Calibration data for the output level is held in the memory and may be altered from the front panel or over the interface bus.

Offset facility

The output level can be offset by up to ±2 dB from the calibrated value to compensate for cable or switching losses external to the generator. The operator may also use this facility as a means of deliberately offsetting the output level to ensure that all generators in an area give identical measurements. While using the offsetting facility the main calibration of the generator is not lost and may be returned to at any time.

REVERSE POWER PROTECTION

An electronic trip protects the generator output against reverse power of up to 50 W, preventing damage to output circuits when RF or DC power is accidentally applied. This feature contributes to long unit life and low cost-of-ownership.

MODULATION

Comprehensive AM, FM and ØM facilities are provided for testing all types of receivers. A MOD ON-OFF key is fitted to allow signal-to-noise ratio checks to be made.

FM, AM and phase modulation

The wide range frequency modulation facility provides FM deviation up to a maximum of 99.9 kHz depending on modulation and carrier frequency, and excellent FM accuracy is assured by the storage of calibration values in the memory. Phase modulation is available with a deviation range of up to 9.99 radians and amplitude modulation is provided with steps of 0·5% up to 99·5% depth.

External modulation

External modulation is possible with a wide band input of 50 Hz to 50 kHz for FM, 50 Hz to 10 kHz for ØM and 20 Hz to 15 kHz (DC coupled) for AM. The characteristics of the FM input allow the digital signals commonly used in mobile radio to be handled. A modulation levelling function is included which can be disabled when not required. HI and LO indications show when the input level is outside the range of the ALC system.

Auxiliary modulation input

2022C is fitted with a rear panel auxiliary modulation input socket which allows an external modulation signal (e.g. a sub-audible signalling tone) to be mixed with the internal signal.

INCREMENTING

All parameters can be incremented or decremented in steps of any size, which may be simply entered via the keyboard or GPIB. If no step size is entered for a parameter the steps are pre-set to 1 kHz for carrier frequency, 1 kHz for FM deviation, 1 radian for ØM deviation, 1% for AM depth and 1 dB for output level.

Single key operation

A single tap on either the UP or DOWN key moves the parameter by one step. If the key is held down the parameter steps once, waits one second and then moves at three steps per second. For search purposes it is possible to reverse this stepping direction without the one second delay.

TOTAL SHIFT key

Operation of the TOTAL SHIFT key displays the variations in all parameters from their original settings. Use of the RETURN key sets the selected parameter back to its start value.

NON-VOLATILE MEMORY

The inclusion of a true non-volatile semiconductor memory for storage of up to twenty complete generator settings and a further eighty carrier frequencies ensures that settings are retained even when the generator is switched off, without relying on a battery. Any of the sets of data can be instantly recalled when required for later use and the UP/DOWN keys may be used to step through a sequence of tests. A further feature enables a single group of preset measurement values to be recalled automatically at switch-on.

Stored calibration data

In addition to storage and recall of measurement settings, non-volatile memory contains other useful data. Calibration data — on RF level, FM accuracy and RF calibration units — are retained in these stores and may be altered using protected Second Functions. Output level offset values are also retained in the instrument's memories and may be selected or deselected by Second Function operation.

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