

Blocking

Definition: The input level of an unmodulated interfering r.f. signal which causes a 12 dB SINAD ratio to be degraded to 6 dB or causes the receiver output to be reduced by 3 dB.

Method of Measurement: Tune generator 1 to the wanted channel frequency and modulate it with a 1 kHz tone to produce 30% a.m. depth for a.m. receivers or a deviation of 60% of the rated system deviation for f.m. receivers. With generator 2 unmodulated and set to a low level adjust the output of generator 1 to produce a 12 dB SINAD ratio at the

receiver output with an audio power of 50% of the rated maximum. Tune generator 2 to frequencies which are between 2 and 10 MHz above or below the wanted channel frequency and increase the level until the receiver SINAD ratio is reduced to 6 dB or the output falls by 3 dB. The input level at the receiver due to generator 2 (taking into account the attenuation caused by the coupling network) is the blocking level. Vary the frequency of generator 2 to establish the lowest blocking level, but ignore results which occur at frequencies where receiver spurious responses are known to exist.

	RESEARCH & DEVELOPMENT	PRODUCTION	MAINTENANCE	SERVICING	EDUCATION	FREQUENCY RANGE							Radio Communications	Broadcasting	EMC/RFI Testing	Radar	Avionics	Portable Application	Swept Measurements
						10kHz	80kHz	520MHz	1000MHz	1024MHz	1040MHz	8GHz	12.4GHz						
2017																			
2018A																			
2019A																			
2022																			
6812																			

Comparison chart for signal generators

OPTION

10 kHz to 1000 MHz AM/FM Signal Generator 2022



- ☐ **Wide frequency cover:**
10 kHz to 1000 MHz
- ☐ **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 push-button operation**
- ☐ **Reverse power protection up to 25 W**
- ☐ **Optional GPIB programmability**
- ☐ **Choice of output calibration units**

2022 is a compact and lightweight Signal Generator, offering frequency, phase and amplitude modulation over the frequency range 10 kHz to 1000 MHz. It is designed for applications in maintenance and servicing, and will also find uses in production and education. Microprocessor control provides simple and rapid operation by direct keyboard entry of settings and 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.

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 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 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 r.f. level, with units annunciators for unambiguous reading. Status and diagnostic information are also shown. Carrier frequency, modulation and r.f. level are all shown together.

Output

RF output levels up to +6 dBm (892 mV e.m.f.) can be set in c.w., f.m. and ϕ .m. modes (reducing linearly with a.m. depth to 0 dBm or 447 mV e.m.f. in a.m. mode) by direct keyboard entry or via the GPIB, with resolution of at least 0.1 dB over the entire range and a total accuracy of ± 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.

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 μ V). Calibration data for the output level is held in the memory and may be altered from the front panel or over the interface bus.

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.

Modulation

Comprehensive a.m., f.m. and ϕ .m. 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.

The wide range frequency modulation facility provides f.m. deviation up to 99.9 kHz and excellent f.m. 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 is possible with a wide band input of 50 Hz to 100 kHz for f.m., 50 Hz to 10 kHz for ϕ .m. and 20 Hz to 50 kHz (d.c. coupled) for a.m. The characteristics of the f.m. 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 a.l.c. system.

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 f.m. deviation, 1 radian for ϕ .m. deviation, 1% for a.m. depth and 1 dB for output level.

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.

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 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.

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

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.

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 2022, for example to record the instrument's inventory information, date of last calibration, normal instrument location etc.

Programming

2022 can be simply fitted with the optional GPIB interface so that all functions can be controlled over the bus. The instrument functions 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 is ensured by careful selection of mnemonics. For example to send a carrier frequency of 123.456 MHz, an f.m. deviation of 3.5 kHz and an output level of 1.74 μ V, 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.

Service requests (SRQ) are sent for a variety of reasons including reverse power protection tripped and illegal characters received. SRQs may be inhibited if desired by settings 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 2022. 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.

Two levels of protection are offered, appropriate to the Second Function being accessed. The most secure is reserved for Second Functions that alter the instruments' 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: r.f. level calibration units, r.f. level offsets, external standard frequency and switch-on status.

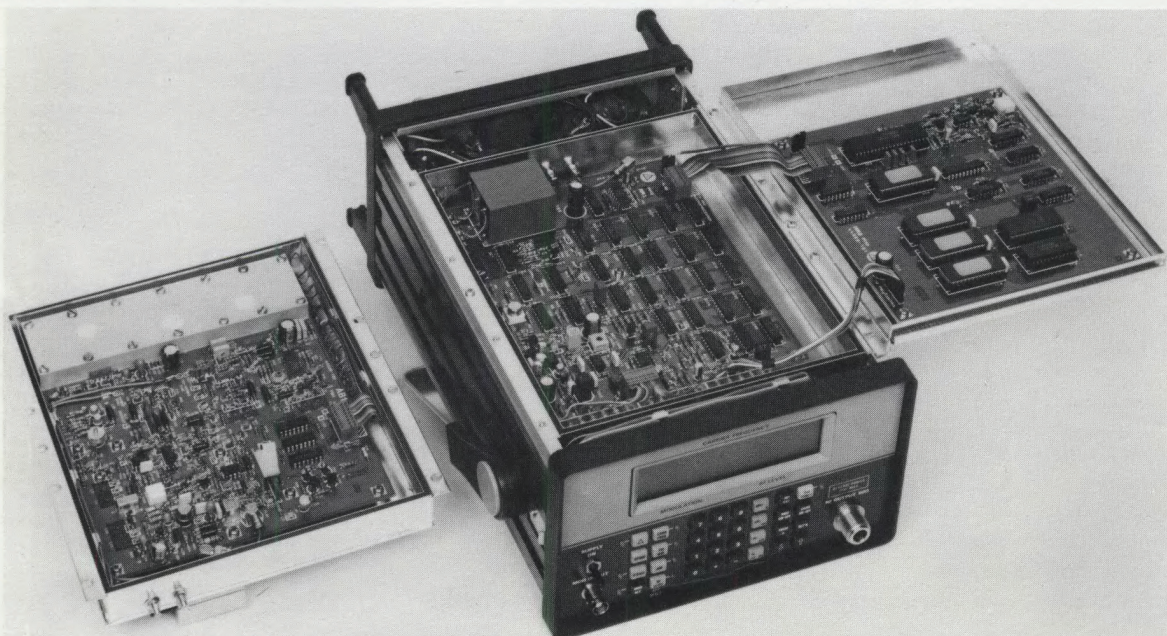
In addition, unprotected Second Functions provide a range of additional operating features, such as the ability to display status information, elapsed time and the type and serial number.

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.

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

Careful mechanical design of the instrument ensures rapid access to all circuits for p.c.b. or component replacement. The main r.f. assemblies are easily removed for inspection and repair, as shown in the photograph. Printed boards interconnect by means of plugs and sockets so simplifying first line maintenance.



Easy access to 2022's interior ensures low cost of maintenance and repair.

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GENERAL DESCRIPTION

2022 is a synthesized signal generator covering the frequency range 10 kHz to 1000 MHz. The output may be amplitude, phase or frequency modulated using either the built-in a.f. source or an external signal. All control settings are entered from a front panel keyboard. A single liquid crystal display gives simultaneous read-out 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 1000 MHz.
Selection	By keyboard entry.
Indication	7 digit l.c.d. - see under KEYBOARD AND DISPLAYS.
Displayed Resolution	10 Hz up to 100 MHz, 100 Hz above 100 MHz.
Accuracy	Equal to the frequency standard accuracy. See FREQUENCY STANDARD.

RF OUTPUT

Level	-127 to +6 dBm (0.2 μ V to 892 mV e.m.f.) in c.w. and f.m. modes. When a.m. is selected the maximum output power reduces linearly with a.m. depth to 0 dBm (447 mV e.m.f.) at maximum a.m. depth.
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Selection

By keyboard entry. Units may be μ V, mV, V e.m.f. or p.d.; dB relative to 1 μ V, 1mV e.m.f. or p.d.; dBm.

Indication

Conversion between dB and voltage units may be achieved by pressing the appropriate unit key (dB, or V, mV, μ V).

Displayed resolution

4 digit l.c.d. with units annunciators. See KEYBOARD AND DISPLAYS.

Output level accuracy

0.1 dB or better over the entire voltage range.

Output impedance

± 1 dB for output levels above -10 dBm
 ± 2 dB for output levels below -10 dBm.
50 Ω , type N female socket to MIL 90123D. 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 25 W from d.c. to 1 GHz. For safety the output socket is automatically disconnected from the attenuator when the power is switched off. The trip may be reset from the front panel or via the GPIB.

SPURIOUS SIGNALS

Harmonically related signals	Better than -25 dBc for output levels less than 0 dBm for any carrier frequency.
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 (at output levels below 0 dBm.)	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 f.m.	Less than 20 Hz equivalent peak deviation in a 300 Hz to 3 kHz bandwidth at 499 MHz and improving by approximately 6 dB per octave with reducing carrier frequency down to 62.5 MHz. Better than 10 Hz below 62.5 MHz.
RF leakage	Less than 0.5 μ V 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 l.c.d. See KEYBOARD AND DISPLAYS.
Deviation accuracy	$\pm 5\%$ of deviation at 1 kHz modulating frequency excluding residual f.m.
Frequency response	± 1 dB from 10 Hz to 25 kHz relative to 1 kHz, using external modulation input and a.l.c. off. ± 1 dB from 50 Hz to 25 kHz relative to 1 kHz using external modulation input and a.l.c. on. With a.l.c. off, can be used for 10 Hz square wave switching.
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 a.l.c. on the deviation is calibrated for input levels between 0.9 V and 1.1 V r.m.s. A HI or LO message is indicated in the modulation display if the applied level is outside the range of the a.l.c. With modulation a.l.c. off, the deviation is calibrated for an input level of 1 V p.d. Input impedance: 100 k Ω nominal.
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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	$\pm 5\%$ of deviation at 1 kHz modulating frequency excluding residual ϕ .m.
Frequency response	± 1 dB from 10 Hz to 10 kHz relative to 1 kHz, using external modulation input and a.l.c. off. ± 1 dB from 50 Hz to 10 kHz relative to 1 kHz using external modulation input and a.l.c. 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 a.l.c. on the deviation is calibrated for input levels between 0.9 V and 1.1 V r.m.s. A HI or LO message is indicated in the modulation display if the applied level is outside the range of the a.l.c. With modulation a.l.c. off, the deviation is calibrated for an input level of 1 V p.d.

Input impedance: 100 k Ω 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.
Accuracy	Better than $\pm 4\%$ 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	± 1 dB from 50 Hz to 15 kHz relative to 1 kHz at 80% depth using external mod. input and a.l.c. on. DC coupled with a.l.c. off.
Envelope distortion	Less than 5% total harmonic distortion at 1 kHz modulating frequency for depths of: 0 to 95% for carrier frequencies up to 62.5 MHz; 0 to 80% for carrier frequencies up to 400 MHz.

External modulation input

With modulation a.l.c. on the deviation is calibrated for input levels between 0.9 V and 1.1 V r.m.s. A HI or LO message is indicated in the modulation display if the applied level is outside the range of the a.l.c. With modulation a.l.c. off, the modulation depth is calibrated for an input level of 1 V p.d.
Input impedance: 100 k Ω nominal, d.c. coupled.

MODULATION OSCILLATOR

Frequency	1 kHz.
Frequency accuracy	As reference frequency standard.
Distortion	Less than 1% total harmonic distortion.

FREQUENCY STANDARD

Frequency standard input	Internal or external frequency standard may be selected from the front panel. Annunciators show which is selected. A rear-panel BNC socket provides an external standard input when external standard is selected.
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INTERNAL FREQUENCY STANDARD

Frequency	High stability oven-controlled crystal oscillator. 10 MHz.
Temperature stability	Better than ± 0.2 p.p.m. over the temperature range 0 to 40°C.
Warm-up time	Within 0.5 p.p.m. of final frequency 5 min. from switch-on at 20°C ambient.
Ageing rate	Better than 0.1 p.p.m. 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 r.m.s. 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

Internal modulation oscillator output

External modulation input

Alternative RF output and modulation sockets

KEYBOARD AND DISPLAYS

Main keyboard functions

the MOD ALC ON/OFF key. Two l.c.d. annunciators, HI and LO, provide an aid to maintain calibrated modulation in the ALC ON mode.

1 V \pm 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%.

Input level nominally 1 V r.m.s. into 100 k Ω . See FREQUENCY MODULATION, PHASE MODULATION and AMPLITUDE MODULATION.

Blanked holes are provided so the r.f. output socket and modulation input/output sockets can be fitted to the rear panel for systems use.

All instrument settings are controlled by the front panel keyboard.

The main key functions are:

CARRIER FREQ	7	8	9	MHz/V
FM/ \emptyset M	4	5	6	kHz/mV
AM	1	2	3	Hz/ μ V
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:

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

\uparrow and \downarrow Increments or decrements the selected function.
TOTAL Δ 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 \emptyset M 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 a.l.c. 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 (GPIO address, RF output level units etc.). |
| 2 | Display/change GPIO address. |
| 3 | Direct addressing of internal bus system (servicing aid). |
| 4 | Display/change GPIO SRQ mask. |
| 5 | Read identity string (unprotected duplicate of SF11). |
| 6 | Test l.c.d. readout and front-panel l.e.d.'s. |
| 7 & 8 | Not used. |
| 9 | Read elapsed time. |
| 10 | Record external frequency standard choice. |
| 11 | Read instrument identity string. |
| 12 | Write via GPIO a user-defined string stored in non-volatile memory. |
| 13 | Read user-defined string via GPIO. |
| 14 | Display/change RF level units (i.e. voltage e.m.f. or p.d. and dB reference). |

Displays

- 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.

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, GPIO service requests, frequency limit exceeded, remote operation and instrument addressed.

Modulation display: 3 digit display with annunciators to show modulation units FM, \emptyset M, 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.

GPIO INTERFACE

Capabilities

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

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



2022 is lightweight and compact, easily carried for portable applications.

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**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 2500 m (pressurised freight at 27 kPa
differential, i.e. 3.91bf/in²).

POWER REQUIREMENTS

AC supply Switchable voltage ranges 105 to 120 V,
210 to 240 V, all $\pm 10\%$.
45 to 440 Hz.
50 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
52022-900C	10 kHz to 1000 MHz Signal Generator 2022
	Supplied Accessories AC Supply Lead. 43129-003W Operating Manual (H52022-900C Vol. 1). 46881-514E
54124-023J 46881-515U 54433-003N 43129-189U 46881-365R 46883-717K 46883-716B 43126-012S 54411-051X 46883-408K	Optional Accessories Front Panel Protective Cover. Service Manual (H52022-900C) Vol. 2). GPIO Module. GPIO Lead Assembly. GPIO Manual. H54811-010P (contains details of general GPIO protocols) Rack Mounting Kit (Single Unit). Rack Mounting Kit (Double Unit). RF Connector Cable, TM 4969/3, 50 Ω , 1.5 m, BNC. Impedance Adaptor, 50 to 75 Ω . IEEE/IEC Adaptor Block for GPIO socket.



AM/FM Signal Generator 2022 is ideal for a variety of applications in receiver testing.

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AM/FM Signal Generators

2018A & 2019A



- ☐ **2018A: 80 kHz to 520 MHz**
2019A: 80 kHz to 1040 MHz
- ☐ **Frequency resolution 10 Hz up to 520 MHz,**
20 Hz above 520 MHz
- ☐ **High output level: up to 2 V e.m.f. (+13 dBm)**
- ☐ **Excellent output level accuracy**
- ☐ **Reverse power protection up to 50 W**
- ☐ **Auxiliary f.m. input socket for combining**
modulation signals
- ☐ **Choice of nine output calibration units**
- ☐ **Offset calibration**
- ☐ **Comprehensive amplitude, frequency and**
phase modulation
- ☐ **Optional GPIB programmability**
- ☐ **Non-volatile memory with 100 settings**
- ☐ **Powerful fault diagnostic aid system**
- ☐ **Variable a.f. oscillator output level**
- ☐ **Variants available for enhanced f.m.,**
avionics, 10 kHz carrier and pulse
applications.

Signal Generators 2018A and 2019A are synthesized generators similar except for their frequency range — 80 kHz to 520 MHz and 80 kHz to 1040 MHz respectively. Microprocessor control provides simple and rapid operation by direct keyboard entry of settings and the non-volatile memory, which can store up to one hundred settings, further reduces measurement time. Optional GPIB programmability extends the range of applications to include use in automatic test systems.

The excellent overall performance and wide range of facilities provided ensure that the generators have many uses in development, production and maintenance areas and for military applications. These features are further enhanced in four variant models.

Frequency selection

Selection of carrier frequency is accomplished by direct entry via the keyboard or over the General Purpose Interface Bus (GPIB), with indication by an 8 digit liquid crystal display and units annunciators. Frequency resolution is 10 Hz up to 520 MHz, and 20 Hz above 520 MHz. Carrier frequencies can be stored in the non-volatile memory with immediate recall when required. A CARRIER ON-OFF switch is provided to completely disable the output. Provision is made for operation with an external reference frequency of 1 MHz or 10 MHz as required.

Selection of frequencies above the upper limit of each generator is inhibited, but carrier frequencies below 80 kHz can be set with a warning appearing on the display. The

generators are usable down to 30 kHz with minimal degradation of performance. One of the variant options provides a lower carrier frequency limit of 10 kHz for tests on l.f. communications equipment.

An incrementing facility permits stepping of carrier frequency in precisely defined increments of any size with an indication of total shift by use of the TOTAL SHIFT key and with provision for instant return to the starting frequency.

Output

RF output levels up to 2 V e.m.f. (+13 dBm) can be set by direct keyboard entry or via the GPIB, with resolution of at least 0.1 dB over the entire range and a total accuracy of ± 1 dB from 80 kHz to 520 MHz and ± 2 dB above 520 MHz. Levels are indicated on a four-digit liquid crystal display with units annunciators. Output levels can be incremented in steps of any size and up to twenty level settings can be stored in the memory.

A choice of nine calibration units is available to the operator and provision is made for the simple conversion of units (e.g. dBm to μ V). Calibration data for the output level is held in the memory and may be altered from the front panel using a protected key sequence or over the interface bus.

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.

Modulation

Comprehensive a.m., f.m. and ϕ .m. 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, and a six-frequency a.f. oscillator is included to facilitate frequency response measurements. A front-panel socket provides a variable level output from the a.f. oscillator.

The wide range frequency modulation provides f.m. deviation up to 5.2 MHz for 2018A and up to 10.4 MHz for 2019A. Excellent f.m. accuracy is ensured by the storage of calibration values in the memory. Phase modulation is available with a deviation range of up to 520 radians for 2018A and up to 1040 radians for 2019A. Amplitude modulation is provided up to 99% depth. Modulation settings can be stored in the memory for recall when required. It is also possible to increment the deviation and depth settings.

External modulation is possible with a wide band input of 50 Hz to 100 kHz for f.m., 50 Hz to 10 kHz for ϕ .m. and 20 Hz to 50 kHz (d.c. coupled) for a.m. A modulation levelling function is included which can be disabled when not required. HI and LO lights are provided as an aid to maintain calibrated modulation. They are extinguished when the input level is in the range $1 \text{ V} \pm 5\%$.

An auxiliary f.m. input is provided to allow a low level modulation signal to be mixed with either internal or external modulation. This facility is provided to allow sub-audible tones to be applied with standard modulation when testing military or commercial radio receivers which require such tones to lift the squelch.

Enhancements offered by the variants provide pulse modulation, improved a.m. and extended f.m. bandwidth. Pulse modulation is intended for use in the testing of radar systems, and improved a.m. for testing avionics equipment. The extended f.m. bandwidth variant is ideal for stereo broadcast measurements and tests on mobile radio equipment fitted with digital signalling circuits.

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 f.m. deviation, 1 radian for ϕ .m. deviation, 1% for a.m. depth and 1 dB for output level.

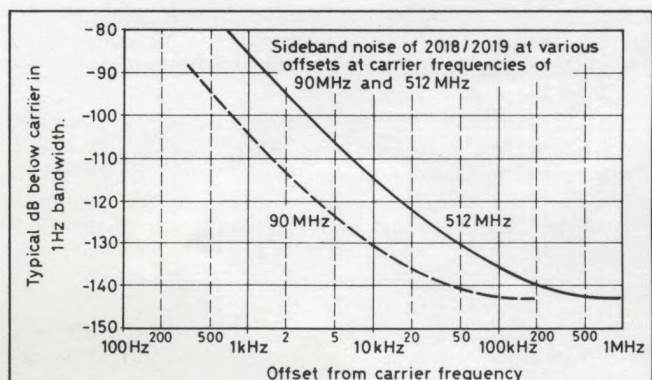
A single tap on either the UP or DOWN key moves the parameter by one step. If the key is held down the parameter steps once, waits one second and then moves at three steps per second. For search purposes it is possible to reverse this stepping direction without the one second delay.

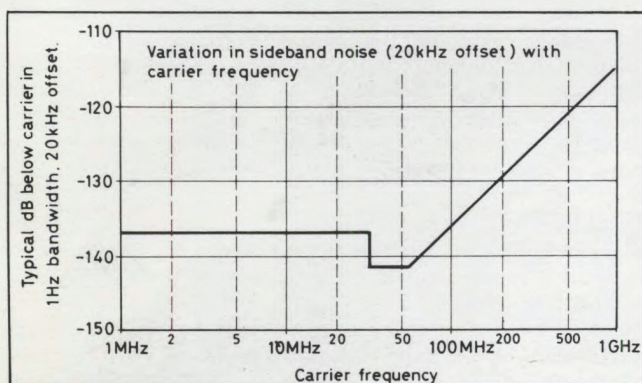
Operation of the TOTAL SHIFT key displays the variations in all parameters from their original settings. Use of the RETURN key sets the selected parameter back to its start value.

Spectral purity

Good in-band and sideband noise performance allows the generators to be used for all in-band tests and many out-of-band tests. Sideband noise figures better than -130 dBc/Hz at 20 kHz offset and at 90 MHz are obtained. Sideband noise improves at a rate of 6 dB per octave as carrier frequency is reduced. Typical sideband noise curves are shown below.

Harmonically related signals are better than -30 dBc for carrier frequencies up to 520 MHz and better than -20 dBc above 520 MHz. Non-harmonics are better than -70 dBc above 2.03126 MHz and -60 dBc below.





Non-volatile memory

The inclusion of a non-volatile semiconductor memory for storage of up to twenty complete generator settings and a further eight 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.

In addition to storage and recall of measurement settings, non-volatile memory contains other useful data. Calibration data — on r.f. level, f.m. accuracy and r.f. 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.

Status information stored includes type and serial number, internal/external standard and GPIB address. 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-setting being accomplished using a secure Second Function.

In GPIB operation the non-volatile memory may also be used to store a user-defined string. Up to 32 ASCII characters may be written to, or read from, the 2018A or 2019A, for example to record the instrument's inventory information, date of last calibration, normal instrument location etc.

Programming

2018A and 2019A can be simply fitted with the optional GPIB interface so that all functions can be controlled over the bus. The instruments function as talkers as well as listeners. 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 check that information has been transferred without error or to learn settings for later use.

Ease of programming is ensured by careful selection of mnemonics. For example to send a carrier frequency of 123.456 MHz a frequency deviation of 3.5 kHz and an output

level of $1.74 \mu\text{V}$, 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.

Service requests (SRQ) 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.

Programming speed is enhanced by the provision of a buffer memory which stores GPIB commands and allows the controller to continue with other tasks whilst the received data is processed by the generator.

To ensure compatibility with existing systems using 2018 or 2019, a Second Function command may be invoked that allows software written for the earlier models to be used with 2018A and 2019A.

Second Functions

The front panel Second Function key gives access to a number of different features available with 2018A and 2019A. 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.

Two levels of protection are offered, appropriate to the Second Function being accessed. The most secure is reserved for Second Functions that alter the instruments' 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: r.f. level calibration units, r.f. level offsets, external standard frequency and switch-on status.

In addition, unprotected Second Functions provide a range of additional operating features, such as the ability to display status information, elapsed time, type and serial number, as well as controlling the auxiliary output socket on the GPIB module.

Maintenance and calibration

The generators have been designed to have excellent reliability. The use of liquid crystal displays to reduce power consumption ensures cool running without the need for a cooling fan, and eliminates all the associated routine maintenance and cleaning of filters. The packing density of the instruments has been deliberately kept low to aid cooling and to improve access.

The Second Function mode provides powerful fault diagnostic aid 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.

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

Careful mechanical design of the instruments ensures rapid access to all circuits for p.c.b. or component replacement. The main r.f. assembly is hinged and the front panel can be lowered as shown in the photograph. Printed boards interconnect by means of plugs and sockets and all except the r.f. oscillator board can be changed without significant re-calibration, so simplifying first line maintenance.

A full servicing manual is available and an optional maintenance kit provides the necessary r.f. extension cables, l.c.d. insertion and extraction tools, etc.

Variants

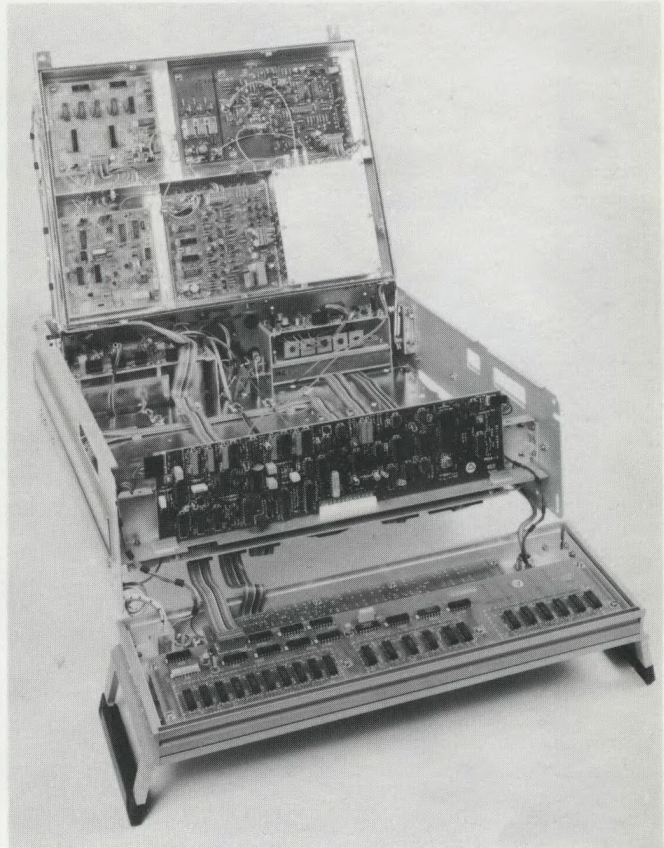
The 2018A/2019A range of signal generators is extended by the addition of four optional variants, which may be mixed to obtain a combination of performance features.

An extended f.m. bandwidth variant gives improved stereo separation for broadcast applications and adds digital signalling capabilities for tests on pagers and mobile radio receivers.

A second variant offers an enhanced a.m. performance, making it suitable for avionics applications. In particular, VOR/ILS signals can be handled with a specified d.d.m. performance of better than 0.045%.

Provision is made in another variant for operation down to 10 kHz, and this v.l.f. option is fully compatible with all other variants with the exception of the avionics variant.

Radar r.f. and i.f. stages can be tested with the aid of a variant that offers the extra facility of pulse modulation. The pulse mode is selected by pressing the AM PULSE and FM PULSE keys simultaneously. Pulse modulation can then be switched on and off using the MOD ON/OFF key.



15396/8

GENERAL DESCRIPTION

2018A and 2019A are synthesized signal generators covering the frequency range 80kHz to 520MHz and 80kHz to 1040 MHz respectively. The output may be amplitude phase or frequency modulated using either the built-in a.f. oscillator or an external source. All control settings are entered from a front panel keyboard. Three liquid crystal displays give simultaneous readout of frequency, modulation and output level. Remote control via the General Purpose Interface Bus is available as an option.

CARRIER FREQUENCY

Range	2018A: 80 kHz to 520 MHz, usable down to 30 kHz. 2019A: 80 kHz to 1040 MHz, usable down to 30 kHz.
Selection	By keyboard entry.
Indication	8 digit l.c.d.
Resolution	10 Hz up to 520 MHz, 20 Hz from 520 to 1040 MHz.
Accuracy	Equal to the frequency standard accuracy. See FREQUENCY STANDARD.

RF OUTPUT

Level	0.2 μ V to 2 V e.m.f. (–127 to +13 dBm) in c.w., f.m. and ϕ .m. modes. 0.2 μ V to 1 V e.m.f. (–127 to +7 dBm) in a.m. mode.
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Selection

By keyboard entry. Units may be μ V, mV, V e.m.f. or p.d.; dB relative to 1 μ V, 1 mV, 1 V e.m.f. or p.d.; dBm.

Conversion between dB and voltage units may be achieved by pressing the appropriate unit key (dB, or V, mV, μ V).

Indication

4 digit l.c.d. with units annunciators.

Resolution

0.1 dB or better over entire voltage range.

Output level

± 1 dB from 80 kHz to 520 MHz.

accuracy

± 2 dB above 520 MHz.

Output impedance

50 Ω , type N female socket to MIL 39012/3D. For output levels below 300 mV e.m.f. the VSWR is better than 1.2:1 for carrier frequencies up to 520 MHz and better than 1.5:1 for carrier frequencies above 520 MHz.

Reverse power protection

An electronic trip protects the generator output against reverse power of up to 50 W from d.c. to 1 GHz. The trip may be reset from the front panel or via the GPIB.

SPURIOUS SIGNALS

Harmonically related signals

For output levels less than 1 V e.m.f., better than –30 dBc for carrier frequencies up to 520 MHz and better than –20 dBc for carrier frequencies above 520 MHz.

Sub-harmonics

None for carrier frequencies up to 520 MHz. –20 dBc for carrier frequencies above 520 MHz.

Non-harmonically related signals

Better than -70 dBc for carrier frequencies from 2.03126 MHz to 1040 MHz.
Better than -60 dBc for carrier frequencies from 80 kHz to 2.03125 MHz.
(At offsets from the carrier of 3 kHz or more.)

Residual f.m.

Less than 6 Hz r.m.s. in CCITT telephone psophometric band at 520 MHz and improving by approximately 6 dB per octave with reducing carrier frequency down to 2.03126 MHz.

Single sideband phase noise

Better than -130 dBc/Hz at 90 MHz and 20 kHz offset from the carrier. Typical performance curves are shown in the text.

RF leakage

Less than 0.5 μ V 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 100 kHz for carrier frequencies up to 2.03125 MHz.
Peak deviation from 0 to 1% of carrier frequencies above 2.03125 MHz.

Selection

By front panel keyboard. Internal source (see AF OSCILLATOR) or external input may be selected.

Display

3 digit l.c.d.

Deviation accuracy

$\pm 5\%$ of deviation at 1 kHz modulating frequency excluding residual f.m.

Frequency response

± 1 dB from 50 Hz to 100 kHz relative to 1 kHz. Usable down to 10 Hz with reduced deviation.

Distortion

Less than 3% total harmonic distortion at 1 kHz modulating frequency and a deviation of up to 70% of maximum available at any carrier frequency. Less than 0.3% total harmonic distortion at 75 kHz deviation at carrier frequencies from 88 MHz to 108 MHz at 1 kHz modulating frequency using internal a.f. oscillator or external source with ALC OFF.

External modulation

With modulation a.l.c. on the deviation is calibrated for input levels between 0.8 V p.d. With modulation a.l.c. off, the deviation is calibrated for an input level of 1 V p.d. HI and LO l.e.d.'s are provided as an aid to maintaining calibrated modulation in the ALC OFF mode. When the HI and LO l.e.d.'s are extinguished, the input voltage will be in the range 1 V $\pm 5\%$.

Input impedance: 100 k Ω nominal.

PHASE MODULATION**Range**

Modulation index: 0 to 10 radians for carrier frequencies below 2.03125 MHz; 0 to a value in radians equal to the carrier frequency in MHz, for frequencies above 2.03125 MHz.

Selection

By front panel keyboard. Internal source (see AF OSCILLATOR) or external input may be selected.

Display

3 digit l.c.d.

Accuracy

$\pm 5\%$ excluding residual ϕ .m.

Frequency response

± 1 dB from 50 Hz to 10 kHz w.r.t. 1 kHz.

Distortion

Less than 3% total harmonic distortion at 1 kHz modulating frequency.

External modulation

With modulation a.l.c. on the deviation is calibrated for input levels between 0.8 V and 1.2 V p.d. With modulation a.l.c. off, the deviation is calibrated for an input level of 1 V p.d. HI and LO l.e.d.'s are provided as an aid

AMPLITUDE MODULATION**Range**

0 to 99% in 1% steps.

Selection

By front panel keyboard. Internal source (see AF OSCILLATOR) or external input may be selected.

Display

2 digit l.c.d.

Accuracy

Better than $\pm (4\%$ of depth setting + 1%) for modulation depths up to 95% at 1 kHz modulating frequency and carrier frequencies up to 400 MHz.

Frequency response

± 1 dB from 20 Hz to 50 kHz relative to 1 kHz at 80% depth d.c. coupled.

Envelope distortion

Less than 3% total harmonic distortion for modulation depths up to 80% at 1 kHz modulating frequency and carrier frequencies up to 400 MHz. Less than 2% total harmonic distortion for modulation depths up to 90% at 1 kHz modulating frequency for carrier frequencies up to 32 MHz.

External modulation

With the modulation a.l.c. on the modulation depth is calibrated for input levels between 0.8 V and 1.2 V p.d. With the modulation a.l.c. off, the modulation depth is calibrated for an input level of 1 V p.d. HI and LO l.e.d.'s are provided as an aid to maintaining calibrated modulation in the ALC OFF mode. When the HI and LO l.e.d.'s are extinguished, the input voltage will be in the range 1 V $\pm 5\%$.

Input impedance: 100 k Ω nominal, d.c. coupled.

AF OSCILLATOR**Frequencies**

300 Hz, 400 Hz, 500 Hz, 1 kHz, 3 kHz and 6 kHz selected sequentially by repetitive pressing of the AF OSC key.

Display

Six l.e.d.'s indicate selected frequency.

Frequency accuracy

$\pm 5\%$.

Output level

0.1 mV to 5 V into a load of 2 k Ω or greater, selected by keyboard entry. Output may be entered in mV, V or as dBm into 600 Ω . Capable of driving a 600 Ω load for levels below 2 V.
Source impedance less than 10 Ω .

Level accuracy

$\pm 5\%$ for output levels above 50 mV. $\pm 10\%$ for levels from 0.5 to 50 mV.

Distortion

Better than 0.1% total harmonic distortion for a 1 kHz output frequency at an audio level of 5 V r.m.s. into 100 k Ω .

FREQUENCY STANDARD**Frequency standard Input/Output**

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

A rear-panel BNC socket provides an output from the internal frequency standard at either 1 MHz or 10 MHz when internal standard is selected. This socket becomes the external standard input when external standard is selected.

INTERNAL FREQUENCY STANDARD**Frequency**

10 MHz.

Temperature stability

Better than ± 0.1 p.p.m. over the temperature range 0 to 40°C.

Warm-up time

Within 0.5 p.p.m. of final frequency 5 minutes from switch-on at 20°C ambient.

Internal standard output

Either 1 MHz or 10 MHz at nominally 3 V p-p square wave. Source impedance 100 Ω nominal.

EXTERNAL FREQUENCY STANDARD

External standard input

Accepts either a 1 MHz or 10 MHz signal of at least 1 V r.m.s. Frequency is selected by Second Function control.

Maximum input 2.5 V.

Input impedance: 100 Ω nominal.

AUXILIARY INPUTS AND OUTPUTS

Modulation input

A front panel BNC socket accepts an external modulation input. The input signal may be levelled by selecting the MOD ALC ON/OFF key. Two l.e.d. indicators, HI and LO, provide an aid to maintain calibrated modulation in the ALC OFF mode.

Internal a.f. oscillator output

The output can be set between 0.1 mV and 5 V into 2 k Ω or greater, selected by keyboard entry. Output may also be entered in dBm into 600 Ω by means of the keyboard selection. The output frequency is always that of the AF OSC and is short-circuit proof. At switch-on the AF level is set to 1 V. Capable of driving a 600 Ω load for levels below 2 V.

Output impedance: less than 10 Ω .

External modulation input

ALC ON; Input level nominally 1 V into 100 k Ω .

ALC OFF; 1 V is required for calibrated conditions. When the HI and LO l.e.ds are extinguished the input voltage will be in the range 1 V \pm 5%.

Alternative RF output and modulation sockets

Blanked holes are provided so the RF output socket and modulation input/output sockets can be fitted to the rear panel for systems use.

Auxiliary FM input:

Deviation: With the FM on (INT or EXT) the application of 1 V to the AUX FM INPUT will result in a f.m. deviation of 10% of that indicated on the modulation display. With ϕ m. selected (INT or EXT) the application of 1 V will result in an f.m. deviation in kHz equal to the phase deviation in radians shown in the modulation display.

Accuracy: \pm 15%.

Impedance: 600 Ω nominal.

This facility is intended to allow the insertion of sub-audible tones used in receiver testing.

KEYBOARD AND DISPLAYS

Main keyboard functions

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

CARRIER				
FREQ	FM	7 8 9	MHz/V	
AM	\emptyset M	4 5 6	kHz/mV	
RF LEVEL	AF LEVEL	1 2 3	Hz/ μ V	
STORE	RECALL	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:

Δ Increment key. When pressed before a function key, increment values may be displayed and, if required, may be changed.

\uparrow and \downarrow

Increment or decrement the selected function (including memories).

TOTAL Δ

Display total shift from last keyed-in value.

RETURN

Return 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 \emptyset M, toggles between internal and external modulation.

MOD

ON-OFF

Toggle AM, FM or \emptyset M between ON and OFF.

AF

ON-OFF

Toggle between a.f. oscillator ON and OFF.

CARRIER

ON-OFF

Toggle between r.f. output ON and OFF.

AF

OSC

Sequentially select one of six internal a.f. oscillator frequencies.

MOD

ALC

Toggle between modulation a.l.c. 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.

Select Second Function entry mode.

Secondary keyboard functions

The following secondary functions may be selected using the Second Function key followed by one or more number keys.

Unprotected functions

- 0 Second Function protection
- 1 Display instrument status (GP-IB address, calibration offsets, 1 or 10 MHz external standard, level of protection, RF output level units etc.)
- 2 Display/change GPIB address
- 3 Direct addressing of internal latches (servicing aid)
- 4 Display/change GPIB SRQ mask
- 9 Elapsed time display (since last reset)
- 11 Read identity string (type and serial number)
- 12 Write a user-defined string (GPIB only)
- 13 Read a user-defined string (GPIB only)
- 18 Set data on GPIB auxiliary output pins

Protected functions

- 5 Display/change RF level units
- 6 Display/change RF level offset
- 14 Select 1 or 10 MHz external frequency standard
- 15 Select old/new GPIB command set
- 16 Select start-up with settings recalled from Store 10

Doubly protected functions

- 7 RF calibration
- 8 FM calibration
- 9 Reset elapsed time display
- 10 Display total instrument operating time
- 17 Reserved for calibration
- 190 Write identity string setting
- 191 Protect store settings
- 192 Blank display of recalled stores

Displays

Three liquid crystal displays provide simultaneous readout of Carrier Frequency, Modulation and RF Level.

Carrier frequency display: 8 digit display with annunciators to show frequency units, external frequency standard, frequency limit exceeded and remote operation.

Modulation display: 3 digit display with annunciators to show modulation units, FM, \emptyset M, AM, modulation off, external modulation selected and modulation limit exceeded.

Level display: 4 digit display with annunciators

GPIB INTERFACE

Capabilities

to show level units, output off, reverse power trip operated and level limit exceeded.

A GPIB interface is available as an option. All functions except the supply switch are remotely programmable. In addition to allowing full GPIB control of the instrument, the GPIB module has an auxiliary output socket which can be used to control relays etc.

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 2500m (pressurised freight at 27 kPa differential, i.e. 3.9 lbf/in²).

POWER REQUIREMENTS

AC supply

Switchable voltage ranges 105 to 120 V, 210 to 240 V, all $\pm 10\%$.
45 to 440 Hz.
85 VA maximum.

DIMENSIONS AND WEIGHT

(over projections but excluding optional front panel handles)

Height	Width	Depth	Weight
152 mm	425 mm	525 mm	16 kg
6 in	16.7 in	20.7 in	35.2 lb

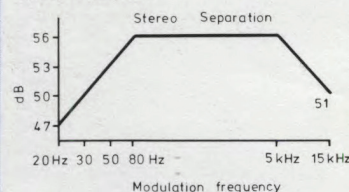
EXTENDED FM BANDWIDTH VARIANTS

FREQUENCY MODULATION

Stereo separation

Specification is the same as for the standard models with the following exceptions.

For carrier frequencies between 88 MHz and 108 MHz. Better than 50 dB at 1 kHz. Typical separation:-



Frequency response

± 1 dB from 50 Hz to 100 kHz relative to 1 kHz. Usable down to 1 Hz with reduced deviation. The instrument is suitable for testing receivers requiring signalling tones with a frequency content down to 1 Hz.

Carrier frequency settling time (FM ON)

The fitting of the extended FM bandwidth option results in the settling time of the instrument in the FM ON mode being approximately 5 s to within 100 Hz of the final frequency.

AVIONICS VARIANTS

CARRIER FREQUENCY

Range

Specification is the same as for the standard models with the following exceptions.

2018A: 1.5 MHz to 520 MHz.
2019A: 1.5 MHz to 1040 MHz.

RF OUTPUT

Level accuracy

± 2 dB from 1.5 MHz to 5 MHz.
 ± 1 dB from 5 MHz to 520 MHz.
 ± 2 dB from 520 MHz to 1040 MHz (2019A only).

AMPLITUDE MODULATION

Envelope distortion

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

DDM performance

Better than 0.045% a.m. difference in depth of modulation for ILS tones at 90 Hz and 150 Hz each of 40% modulation depth.

PULSE MODULATOR VARIANTS

RF OUTPUT

Level accuracy

Specification is the same as for the standard models with the following exceptions.

With pulse modulation not selected:
 ± 1 dB from 80 kHz to 520 MHz,
 ± 3 dB from 520 MHz to 1040 MHz (2019A only).
With pulse modulation selected and +5 V applied to pulse modulation input (i.e. carrier on):
 ± 1.5 dB from 80 kHz to 520 MHz,
 ± 4.5 dB from 520 MHz to 1040 MHz (2019A only).
N.B. With pulse modulation selected the maximum output level is reduced to +3 dBm.

PULSE MODULATION

Carrier pulse response

Rise time less than 100 ns.
Fall time less than 100 ns.

Carrier on/off ratio

Better than 65 dB at 70 MHz carrier frequency reducing linearly to better than 50 dB at 520 MHz carrier frequency, and then to better than 35 dB at 800 MHz carrier frequency.

Propagation delay pulse input to carrier pulse

Typically 280 ns.

Input

Rear panel BNC connector.
Input impedance: 50 Ω nominal.
Nominal signal levels: 0 V for carrier off, +5 V for carrier on.

Selection and display

Pulse modulation is selected by pressing the AM PULSE and ϕ M PULSE keys simultaneously. It is then switched on and off using the MOD ON/OFF key.

EXTENDED LF CARRIER RANGE VARIANTS

CARRIER FREQUENCY

Range

Specification is the same as for the standard models, with the following exceptions:

2018A: 10 kHz to 520 MHz.
2019A: 10 kHz to 1040 MHz.

RF OUTPUT

Level accuracy

± 1 dB from 10 kHz to 520 MHz.
 ± 2 dB from 520 MHz to 1040 MHz (2019A only).

VERSIONS AND ACCESSORIES

VERSIONS

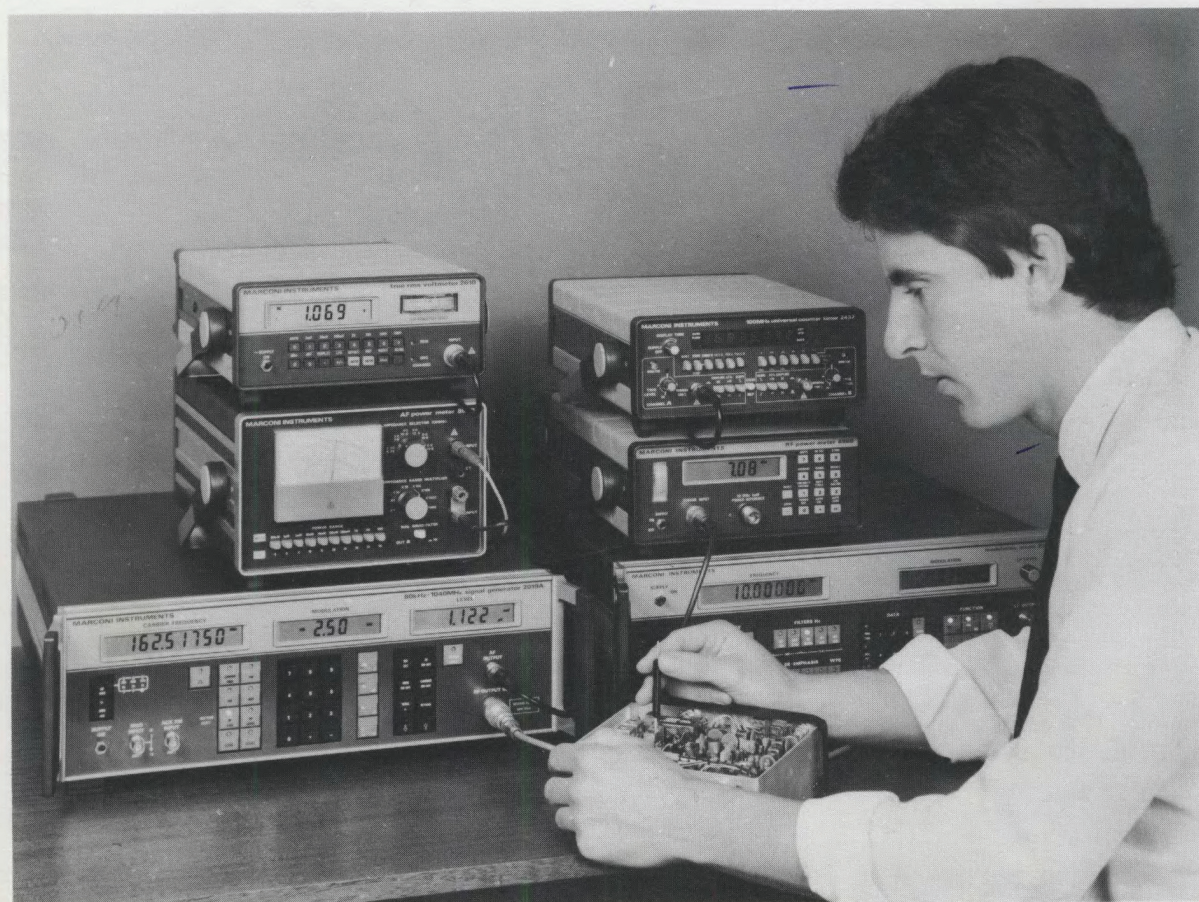
	Single Option			
Standard Version	52018-910P 52019-910E			
Avionics	52018-402B 52019-402J	Avionics		
10 kHz carrier	52018-404A 52019-404G	Combination not available	10 kHz carrier	
Pulse Modulation	52018-408U 52019-408D	52018-410E 52019-410W	52018-412Y 52019-412T	Pulse Modulation
FM Extension	52018-401R 52019-401L	52018-403K 52019-403F	52018-405Z 52019-405V	52018-409Y 52019-409T
FM Extension with Pulse Modulation		52018-411U 52019-411D	52018-413N 52019-413P	

VERSIONS AND ACCESSORIES

ACCESSORIES

When ordering please quote eight digit code numbers.

Ordering numbers	Supplied Accessories
	AC supply lead 43129-076Y Operating manual 46881-511A (H52018-910P Vol. 1) for 2018A and 2019A.
54433-001U 43129-189U 46881-365R 46883-408K 54711-033E 46883-511R 46883-506M 43126-012S 54411-051X 46881-512Z	Optional Accessories GPIB Module. GPIB Lead Assembly. GPIB Manual H554811-010P (contains details of general GPIB protocols). IEEE/IEC Adapter Block for GPIB socket. Maintenance Kit. Front Handle Kit. Rack Mounting Kit. RF Connecting Cable (TM4969/3) 50 Ω 1.5m, BNC. Impedance Adapter 50/75 Ω . Service Manual H52018-910P Vol. 2 (for 2018A and 2019A).



15396/7

10 kHz to 1024 MHz AM/FM Signal Generator 2017



15041/1

- ☐ Wide frequency range: 10 kHz to 1024 MHz
- ☐ High output level: up to 4 V e.m.f. (+19 dBm)
- ☐ Simple operation by keyboard entry of settings
- ☐ GPIB programmable
- ☐ Frequency modulation up to 2.56 MHz deviation
- ☐ Amplitude modulation up to 99% depth
- ☐ Low noise
- ☐ Excellent output level accuracy
- ☐ Built-in frequency sweep facility
- ☐ Microprocessor control with memory facilities

Signal Generator 2017 is a stable, low-noise generator offering high outputs over the frequency range 10 kHz to 1024 MHz. Microprocessor control makes the instrument easy to use by direct keyboard entry or by the use of rotary controls. Programmability via the General Purpose Interface Bus extends the range of applications of the 2017 to include automatic testing either as part of a simple bench-top system or in a full a.t.e. assembly.

Tuning

The 2017's wide frequency range allows measurements to be made over the full spectrum from 10 kHz to 1024 MHz and tuning is accomplished using manual

controls (range selection, coarse and fine tuning) or by direct entry via the keyboard. In the manual mode the instrument can be freely tuned and locked whenever the operator wishes. An incrementing facility allows the carrier frequency to be stepped up or down in steps of any size and a key can be pressed to indicate the total shift – a useful benefit for bandwidth measurements.

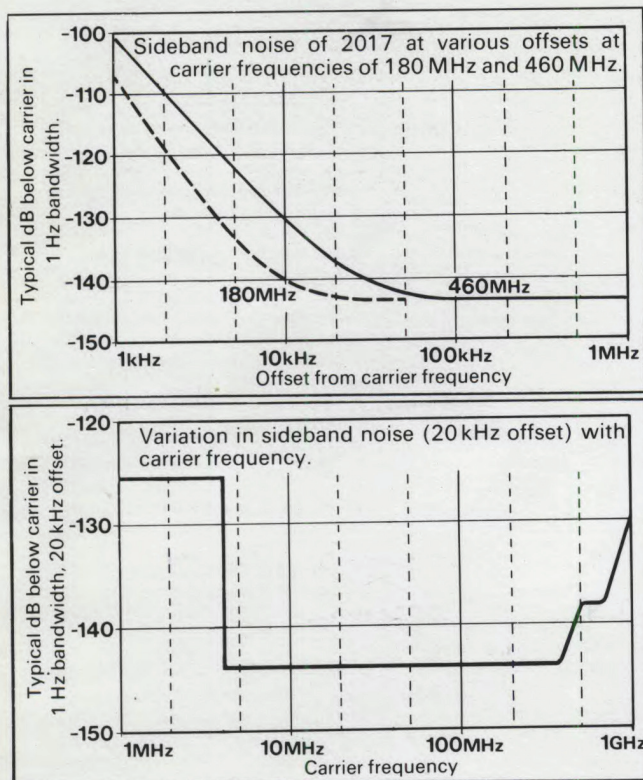
Measurements of receiver spurious responses are made easier by the provision of a slow sweep mode operating between any two frequencies on a carrier frequency range. The full spectral purity of the output signal is retained in the sweep mode.

Spectral purity

A low noise cavity-tuned oscillator forms the heart of the 2017 and provides a sideband noise figure of better than -135 dBc/Hz at 20 kHz offset at 470 MHz. At lower frequencies the noise is even lower as 2017 uses a series of digital dividers and filters to obtain output frequencies below 256 MHz.

The oscillator does not generate any non-harmonically related spurious signals and consequently the output has unrivalled purity over its frequency range.

In-band noise components (FM on CW and AM on CW) are also low enough to permit accurate measurements of signal to noise ratio on all types of receiver.



Output

Levels up to 4 V e.m.f. (+19 dBm) are available under full keyboard control or by means of rotary coarse and fine attenuator controls. The fine attenuator is continuously variable and has a generous amount of overlap with the steps of the switched coarse attenuator to make squelch (or mute) tests simple to perform. A choice of five r.f. calibration units is available to the operator on a front panel switch.

Reverse power protection is fitted as standard to prevent damage to the output circuits due to the accidental application of power up to 50 W when testing transceivers. This protection in no way degrades the

excellent output level accuracy or v.s.w.r. of the generator. Tripping of the protection completely disables the instrument and this condition is indicated by the continual flashing of the front panel RF OFF annunciator. When operating under remote control an indication is sent over the bus. After removal of the overload the instrument can be reset either manually, by depressing the front panel RF ON/OFF key, or via the bus. When the generator is switched off the output socket is automatically disconnected from the output attenuator as a further safety precaution.

Modulation

Comprehensive a.m., f.m. and pulse modulation facilities are provided for testing all types of receivers and radar modules. A wide range modulation oscillator allows frequency response tests to be made without the need for any external a.f. source.

DC coupled a.m. circuits allow 2017 to be used in the testing of aircraft landing systems and the wideband input for f.m. handles stereo-encoded signals.

External modulation to the full rated accuracy is made possible by the provision of a levelling circuit which automatically maintains a constant peak voltage for use by the modulation circuits. Inputs in the range 0.5 to 1.5 V r.m.s. can easily be accommodated by this facility, but where it is desired to control the amount of modulation by means of the external signal, the levelling amplifier can be disabled.

Microprocessor control

The use of a microprocessor in 2017 makes the generator simple to operate and gives the user the choice of keyboard entry or rotary control. Digital displays and annunciators clearly indicate the settings of the instrument at all times.

Conversion of r.f. calibration units is simply performed by the microprocessor along with such routine operations as r.f. range selection, limits detection, f.m. calibration, etc.

A memory facility allows storage of up to ten complete generator settings (carrier frequency, f.m. deviation, a.m. modulation depth, r.f. level, frequency increment value or sweep end frequency). Any of the ten sets of data can be simply recalled when required for later use.

Programming

2017 is fully compatible with GPIB programming and is configured as a talker and listener. All signal generator functions are set in the listen mode by simple instructions and, under program control, the rotary controls can be made available for operator adjustment. Frequency and r.f. level information can then be retrieved in the talk mode.

Ease of programming is ensured by careful selection of mnemonics. For example to send a carrier frequency of 523.4 MHz with an output level of 1.25 μ V it is only

necessary to send the instruction CF 523.4 MZ, LV 1.25 UV over the bus. The bus address can be easily changed by means of a set of rear panel switches. Front panel indication of the address selected appears in the frequency display area for a short time whenever the instrument is switched on.

Counter

Access is provided to the generator's frequency counting function for measurement of frequencies, for example from the internal modulation oscillator or from an external device. The measured frequency can be talked back over the bus.

CARRIER FREQUENCY	
Range	10 kHz to 1024 MHz in 9 ranges. 1. 10 kHz to 4 MHz 2. 4 MHz to 8 MHz 3. 8 MHz to 16 MHz 4. 16 MHz to 32 MHz 5. 32 MHz to 64 MHz 6. 64 MHz to 128 MHz 7. 128 MHz to 256 MHz 8. 256 MHz to 512 MHz 9. 512 MHz to 1024 MHz
Selection	Manual: Eleven-turn main tuning control with separate three-turn fine-tune control. Keyboard: Provides for entry of up to 8 significant digits, decimal point and frequency units. Counter transfer: A manually tuned frequency may be locked by pressing the LOCK key.
Indication	7½ digit LED, seven segment indicators showing carrier frequency. RF range shown by 9 LEDs.
Resolution	10 Hz for carrier frequencies up to 128 MHz. 100 Hz for carrier frequencies above 128 MHz.
Accuracy	Unlocked: Refer to frequency counter accuracy. Locked: Refer to internal reference standard.
Stability	Locked mode. Refer to reference standard specification. Less than 7s is required for the generator to regain frequency lock after a frequency change is made.
Frequency sweep	Single shot sweep for use with X-Y plotter. Maximum sweep width is one carrier frequency range. Sweep rate: 30 to 150s for a full range sweep. Horizontal output: 1 to 9 V over one frequency range.
RF OUTPUT	
Level	0.13 µV to 2 V e.m.f. (-131 to +13 dBm) in a.m. mode. 0.13 µV to 4 V e.m.f. (-131 to +19 dBm) in c.w., f.m. and pulse modes.
Selection	Manual: Two concentric knob controls; switched coarse attenuator with 6 dB steps and continuously variable fine attenuator with 8 dB range. Keyboard: Allows entry of up to 4 significant digits, decimal point, sign and units.
Indication	3½ digit LED, seven segment indicators with illuminated legend showing e.m.f., p.d., dBµV e.m.f., dBµV p.d., and dBm. Units are selected by front panel switch.
Total level accuracy	±1 dB up to 512 MHz. ±2 dB up to 1024 MHz.
Source impedance	50 Ω. VSWR at r.f. levels below 0.5 V e.m.f. Better than 1:15:1 up to 256 MHz. Better than 1:25:1 up to 512 MHz. Better than 1:35:1 up to 1024 MHz.

RF leakage	Less than 1 µV generated in a 50 Ω load by a 2 turn, 25 mm dia. loop, 100 mm or more from the generator.
Reverse power protection	Protects the generator output system against accidental reverse power from a transmitter of up to 50 W capacity from 10 kHz to 1024 MHz, or applied d.c. of up to ±40 V.
AMPLITUDE MODULATION	
Carrier frequency range	10 kHz to 400 MHz, usable up to 1024 MHz.
Depth	Up to 99% in 1% steps. 2 digit LED, seven segment indicators. Entered via keyboard or remote programming.
Accuracy (At 1 kHz modulation rate) Envelope distortion (using internal 1 kHz modulation oscillator)	Better than ±3% depth up to 80%. Better than 2% total harmonic distortion up to 30% depth. Better than 3-5% total harmonic distortion up to 80% depth.
External modulation	Frequency range: 20 Hz to 50 kHz, d.c. coupled. Frequency response: ±0.3 dB from 20 Hz to 50 kHz (±0.5 dB in levelled mode). Input level: 0.5 to 1.5 V r.m.s. into 600 Ω to set reference level, indicated by an illuminated legend in the levelled mode only. 1 V r.m.s. into 600 Ω to set reference level in unlevelled mode.
FREQUENCY MODULATION	
Deviation	Entered via keyboard or remote programming and displayed by 3 digit LED, seven segment indicators. RF Range Maximum Deviation 1 40 kHz 2 40 kHz 3 80 kHz 4 160 kHz 5 320 kHz 6 640 kHz 7 1.28 MHz 8 2.56 MHz 9 200 kHz
Accuracy Distortion	±4% of deviation selected ±50 Hz. Using the internal 1 kHz fixed modulation oscillator, less than 2% total harmonic distortion at maximum deviation on each r.f. range.
External modulation	Frequency range: 20 Hz to 125 kHz, d.c. coupled, at maximum deviation and up to 260 kHz at half maximum deviation. Frequency response: ±0.3 dB from 20 Hz to 125 kHz (±0.5 dB in levelled mode). Input level: As for AM.

INTERNAL MODULATION OSCILLATOR

Frequency	20 Hz to 20 kHz continuously variable in 3 decade ranges. Also 2 fixed frequencies, switch selected, of 400 Hz and 1 kHz.
Accuracy	±5% for fixed frequencies.

PULSE MODULATION

Carrier frequency range	4 to 1024 MHz.
Pulse carrier rise time	Less than 25 ns for carrier frequencies above 25 MHz.
Pulse duration	100 ns to infinity.
Carrier suppression	Better than 70 dB up to 80 MHz; 46 dB up to 512 MHz.
Additional carrier level error	±2 dB.
Input characteristic	Positive-going modulation up to +1 V input. Saturation level: +1.1 V. Maximum input: +5 V. Input impedance: 50 Ω. Effective bandwidth d.c. to 15 MHz reduced below 25 MHz carrier.

FREQUENCY COUNTER (External mode)

Frequency range	10 Hz to 520 MHz.
Resolution	1 Hz, from 10 Hz to 10 MHz. 10 Hz, from 1 to 100 MHz. 100 Hz, from 10 to 520 MHz.
Sensitivity	100 mV p.d. into 50 Ω from 1 to 520 MHz. 200 mV p.d. into 1 MΩ from 10 Hz to 10 MHz.
Accuracy	±1 digit + reference standard accuracy.

INTERNAL REFERENCE STANDARD

Temperature stability	Better than ±2 in 10 ⁷ over the temperature range 0 to 40°C.
Warm-up time	Within 0.5 p.p.m. of final frequency within 5 min from switch-on at 20°C ambient.

SPURIOUS SIGNALS

Carrier harmonics	Better than -27 dBc, typically better than -40 dBc.
Carrier sub-harmonics	For carrier frequencies up to 512 MHz no carrier sub-harmonics are generated. -60 dBc above 512 MHz.
Non-harmonic components	For carrier frequencies between 4 and 1024 MHz no non-harmonically related signals are generated. -50 dBc below 4 MHz.
FM on CW (CCITT telephone psophometric weighted)	Less than 3 Hz equivalent deviation up to 512 MHz and less than 6 Hz up to 1024 MHz. Reduces by approximately 6 dB/octave as the carrier frequency is reduced (down to 4 MHz).
AM on CW (-3 dB bandwidth 20 Hz to 20 kHz)	Less than -70 dBc. Equivalent to less than 0.06% modulation depth.
Single sideband phase noise (at 20 kHz offset)	Better than -135 dBc/Hz at 470 MHz. For performance at other carrier frequencies see sideband noise curves on page 2.

AUXILIARY FACILITIES**Remote operation**

All major front panel functions may be remotely controlled via the GPIB. Complies with the following subsets as defined in IEEE 488-1978.
SH1, AH1, T5, TE0, L4, LE0
SR1, RL1, PP0, DC1, DT0, C0, E1.
(Marconi Instruments General Purpose Interface Bus is in accordance with IEEE Standard 488-1978 and IEC Publication 625-1, first edition. GPIB instruments are supplied with connectors to IEEE standards. An IEEE/IEC Adapter Block is available as an optional accessory for use with equipment using IEC connectors.)

Modulation oscillator output

Front panel socket provides 1 V r.m.s. into 600 Ω.

Frequency standard output

Switch selected output providing 1 MHz TTL compatible signal.

External frequency standard input

Switch selected input accepting 4 V p-p at 1 MHz.
Input impedance: approximately 1 kΩ.

RADIO FREQUENCY INTERFERENCE

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

SAFETY

Complies with IEC 348.

LIMIT RANGE OF OPERATION**Temperature**

0 to 55°C.

CONDITIONS OF STORAGE AND TRANSPORT**Temperature
Humidity
Altitude**

-40°C to +70°C.
Up to 90% relative humidity.
Up to 2500 m (pressurised freight at 27 kPa differential, i.e. 3.9 lbf/in²).

POWER REQUIREMENTS**AC supply**

105 to 120 V ±10% and 210 to 240 V ±10%. 45 to 65 Hz. 120 VA maximum.

DIMENSIONS AND WEIGHT

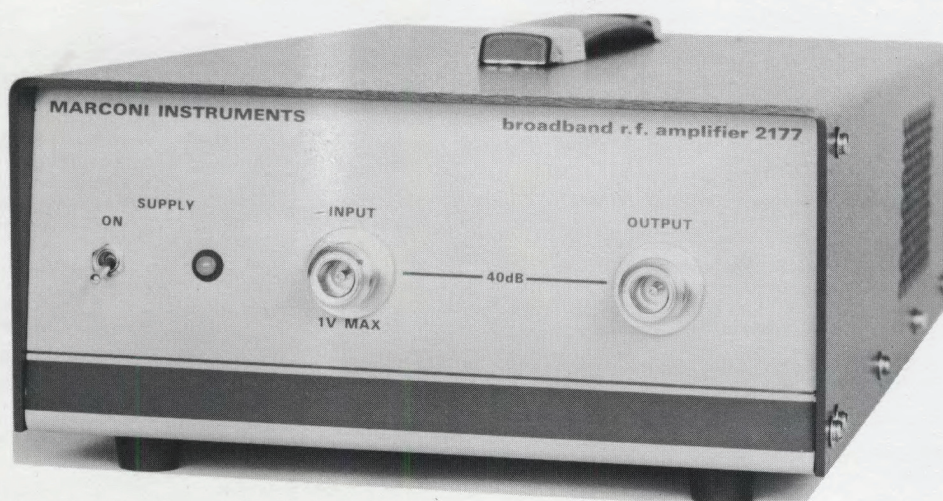
Height	Width	Depth	Weight
190 mm	432 mm	483 mm	29 kg
7½ in.	17 in.	19 in.	63 lb

VERSIONS AND ACCESSORIES

When ordering please quote eight digit code numbers

Ordering numbers	Versions
52017-900K	10 kHz to 1024 MHz Signal Generator 2017.
	Supplied Accessories AC Supply Lead 43129-071D. Operating Manual 46881-388D (H 52017-900K Vol. 1.)
46883-482E 54711-032H	Optional Accessories Rack Mounting Kit. Maintenance Kit (including l.f. and r.f. extender cables). Service Manual H 52017-900K (Vol. 2). GPIB Manual H 54811-010P. GPIB Lead Assembly. IEEE/IEC Adapter Block for GPIB Socket. RF Connecting Cable TM 4969/3 50 Ω, 1.5 m (5 ft) BNC.
46881-389T 46881-365R 43129-189U 46883-408K 43126-012S	

Broadband RF Amplifier 2177



15241/1

- ☐ Wide frequency range — 800 kHz to 1 GHz
- ☐ High gain — 40 dB typical
- ☐ High linear power output — 3 W p.e.p. to 400 MHz
- ☐ High saturated power output — 10 W p.e.p. to 100 MHz
- ☐ Unconditionally stable
- ☐ Phase and gain matched to allow parallel operation

Broadband RF Amplifier 2177 is a low-noise solid-state wideband power amplifier operating in Class A conditions whose capabilities include the accurate high-power reproduction of complex modulated signals including AM, FM, SSB, CATV and pulse waveforms. It is unconditionally stable, allowing maximum flexibility in applications where varying load and frequency conditions exist, and is equally suitable for both linear and non-linear applications.

The 2177 provides high gain, 40 dB typical, over the wide frequency range of 800 kHz to 960 MHz, with useful gain being provided up to 1 GHz. It is therefore

capable of delivering up to 3 watts into a 50Ω load with low harmonic and intermodulation distortion from an input voltage of 122 mV. The amplifier will give a minimum linear power of 2 W p.e.p. up to 960 MHz, and 5 W p.e.p. saturated power up to 500 MHz, with higher powers at reduced bandwidth. Its bandwidth and power ratings are both conservatively stated.

The 2177 is protected against input overload of up to 16 dB and its stability is such that its forward power will remain constant regardless of the extent of the load mismatch, i.e. from short circuit to open circuit.

FREQUENCY RESPONSE	0.8 to 960 MHz.
GAIN	40 dB nominal.
Variation	±2 dB up to 1W (+30 dBm) output. ±2 dB up to maximum rated linear power from 0.8 to 400 MHz. ±3 dB up to maximum rated linear power from 0.8 to 960 MHz.
POWER OUTPUT	
Maximum 'linear' output (peak envelope power)	3 W (+35 dBm) from 0.8 to 400 MHz. 2 W (+33 dBm) from 400 to 960 MHz.
Typical saturated output (peak envelope power)	10 W (+40 dBm) from 1 to 100 MHz. 4 W (+36 dBm) from 100 to 500 MHz. 3 W (+35 dBm) from 500 to 960 MHz. 1 W (+30 dBm) from 960 to 1000 MHz.
SIGNAL PURITY	
Harmonic distortion (at rated 'linear' output)	All single harmonics – 20 dBc at max. power output. Lower distortion at reduced power (typically better than –30 dBc at +30 dBm output).
Typical 3rd order inter-modulation intercept point	+46 dBm.
Noise figure	10 dB nominal.
INPUT/OUTPUT PORT	
Connectors	50 Ω, N type female.
VSWR	Input: less than 2:1 nominal. Output: less than 3:1 nominal.
STABILITY	Unconditionally stable.
PROTECTION	Unit will withstand a +16 dB overdrive i.e. a 1 volt r.m.s. (+13 dBm) input for all output load conditions including short and open circuits.
RADIO FREQUENCY INTERFERENCE	Complies with EEC Directive 76/889.
SAFETY	Complies with IEC 348.

RATED RANGE OF USE			
Temperature	+10° to +35°C.		
LIMIT RANGE OF OPERATION			
Temperature	0° to +45°C.		
CONDITIONS OF STORAGE AND TRANSPORT			
Temperature	–40° to +70°C.		
Humidity	Up to 90% r.h.		
Altitude	Up to 2500 m (pressurised freight at 27 kPa differential i.e. 3.9lbf/in ²).		
POWER REQUIREMENTS			
AC supply	230/115 V ±10%. 50 to 60 Hz at 120 VA.		
DIMENSIONS AND WEIGHT			
Height	Width	Depth	Weight
107 mm	203 mm	406 mm	4.5 kg
4.2 in	8.0 in	16.0 in	10 lbs

VERSIONS AND ACCESSORIES

When ordering please quote eight digit code numbers.

Ordering numbers	Versions
52177-900S	Broadband RF Amplifier 2177.
	Supplied Accessories Instruction Manual 46881-457W.
54127-303M 43126-026A 54422-011A	Optional Accessories Rack Mounting Kit. RF Connecting Cable, 50Ω, 457 mm, Type N. Termination, 12W, 50Ω.