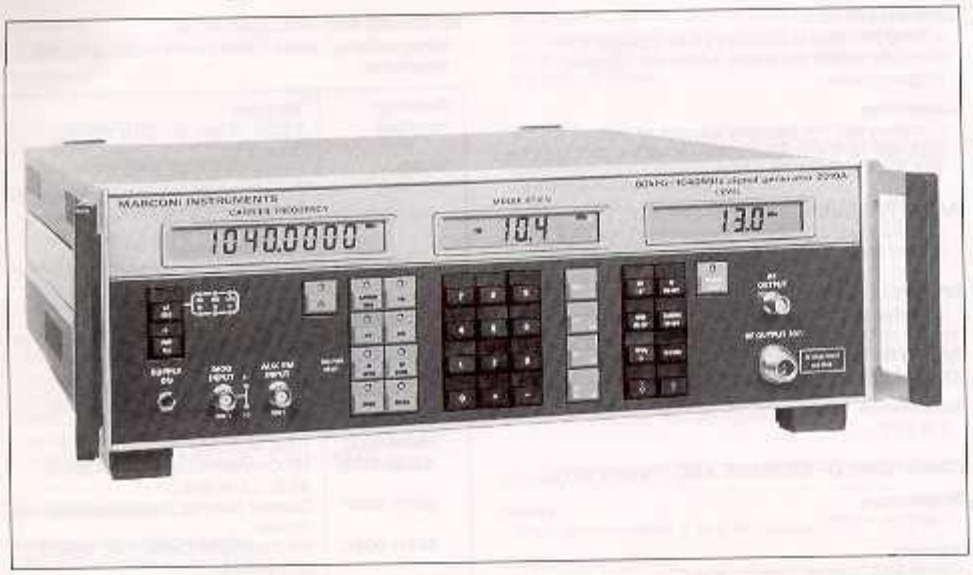
AM/FM Signal Generators

2018A & 2019A



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- 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 EMF (+13 dBm)
- Excellent output level accuracy
- Reverse power protection up to 50 W
- Auxiliary FM 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 AF oscillator output level
- Variants available for enhanced FM, avionics, 10 kHz carrier and pulse applications

Signal Generators 2018A and 2019A are similar synthesized generators except for the 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 variant models and special versions.

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.

Low frequency selection

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

Carrier frequency stepping

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 EMF (+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 annuciators. Output levels can be incremented in steps of any size and up to twenty level settings can be stored in the memory.

Output calibration

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 μV). 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.

Output level offset

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

Frequency and phase modulation

The wide range frequency modulation provides FM deviation up to 5.2 MHz for 2018A and up to 10.4 MHz for 2019A. Excellent FM 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

also possible to increment the deviation and depth settings.

External modulation

External modulation is possible with a wide band input of 50 Hz to 100 kHz for FM, 50 Hz to 10 kHz for ØM and 20 Hz to 50 kHz (DC coupled) for AM. 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 V ±5%.

Auxiliary FM input

An auxiliary FM 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 subaudible tones to be applied with standard modulation when testing military or commercial radio receivers which require such tones to lift the squelch.

Variants extend applications

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

Wideband modulation

A wideband version of the 2019A is also available and is intended for use with high bit rate digital radio systems. This version accepts modulation rates up to 7 MHz on a special rear panel connector socket.

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 preset 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.

One touch incrementing

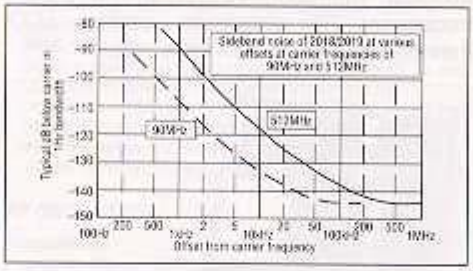
A single tap on either the ↑ or ↓ key moves the parameter by one step. If the key is held down the parameter steps once, waits one second and then moves at three steps per second. For search purposes it is possible to reverse this stepping direction without the one second delay. Operation of the TOTAL SHIFT key displays the variations in all parameters from their original settings. Use

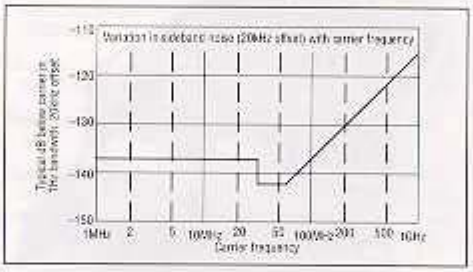
SPECTRAL PURITY

Good in-band and sideband noise performances allows the generators to be used for all in-band tests and many out-of-band tests.

Low sideband noise

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.





Low harmonics

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 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 ↑↓ 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

Stored status information

Status information stored includes type an serial number, internal/external standar and GPIB address. Elapsed time indicator are also accessed via the interna memories. One stores the number o operational hours since the instrument wa manufactured and cannot be altered. Th other records the number of elapsed hour since the clock was last reset; resettin being accomplished using a Secon Function.

Store a user-defined string

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

PROGRAMMING

2018A and 2019A can be simply fitted with the optional GPIB interface so that al functions can be controlled over the bus The instruments function as talkers as wel 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 tha information has been transferred withou error or 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 a frequency 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 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

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 generators using a Second Function.

Speed of programming

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

2018A & 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.

Second function protection

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 re-called. 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, 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.

Cool operation ensures 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.

Diagnostic aids

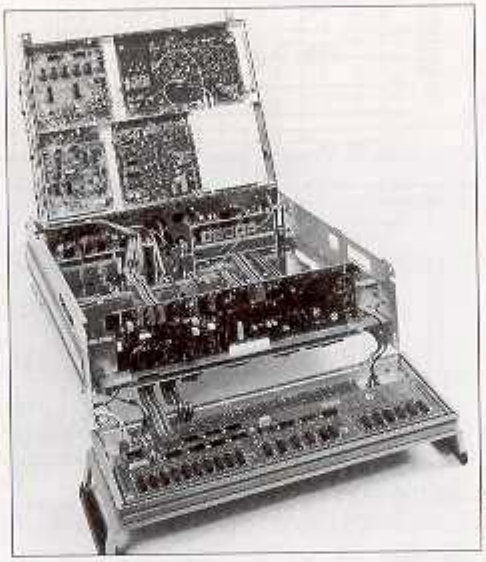
The Second Function mode provides powerful fault diagnostic aid facilities from the front panel or via the GPIB by allowing the operator to send data directly to individual latches in the instrument. The resulting changes in output conditions can be monitored and the area in which the fault lies can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

Automated calibration

RF level, FM accuracy and frequency accuracy can be adjusted without removing the instrument's covers. Level and FM accuracy can be adjusted over the GPIB.

Ease of component replacement

Careful mechanical design of the instruments ensures rapid access to all circuits for PCB or component replacement. The main RF 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 RF oscillator board can be changed without significant recalibration, so simplifying first-line maintenance. A full servicing manual is available and an optional maintenance kit provides the necessary RF extension cables, LCD insertion and extraction tools, etc.



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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.

Extended FM bandwidth

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

Enhanced AM performance

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

Low frequency operation

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

Pulse modulation

Radar RF and IF stages can be tested with 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.

SPECIFICATION

GENERAL DESCRIPTION

2018A and 2019A are synthesized signal generators covering the frequency range 80 kHz to 520 MHz and 80 kHz to 1040 MHz respectively. The output may be amplitude, phase or frequency modulated using either the built-in AF 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 LCD.

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 µV to 2 V EMF (−127 dBm to +13 dBm) in CW FM and ØM modes. 0.2 µV to 1 V EMF (−127 to +7 dBm) in AM mode.

Selection
By keyboard entry. Units may be µV, mV, V EMF or PD; dB relative to 1 µV, 1 mV, 1 V 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.

Resolution
0.1 dB or better over entire voltage range.

Output level accuracy
±1 dB from 80 kHz to 520 MHz, ±2 dB above 520 MHz.

Output impedance
50 Ω, type N female socket to MIL 39012/3D. For output levels below 300 mV EMF 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 DC to 1 GHz from a source VSWR of up to 5:1. 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 EMF, 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 FM
Less than 6 Hz RMS in CCITT telephone psophometric

2018A & 2019A

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 µV PD 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 frequency for 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 LCD.

Deviation accuracy
±5% of deviation at 1 kHz modulating frequency excluding residual FM.

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 AF oscillator or external source with ALC OFF.

External modulation
With modulation ALC on the deviation is calibrated for input levels between 0.8 V and 1.2 V PD. With modulation ALC off, the deviation is calibrated for an input level of 1 V RMS. HI and LO LEDs are provided as an aid to maintaining calibrated modulation in the ALC OFF mode. When the HI and LO LEDs are extinguished, the input voltage will be in the range 1 V ±5%. Input impedance: 100 kΩ 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 LCD.

Accuracy
±5% excluding residual ØM.

Frequency response
±1 dB from 50 Hz to 10 kHz relative to 1 kHz.

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

External modulation
With modulation ALC on the deviation is calibrated for input levels between 0.8 V and 1.2 V RMS. With modulation ALC off, the deviation is calibrated for an input level of 1 V RMS. HI and LO LEDs are provided as an aid to maintaining calibrated modulation in the ALC OFF mode. When the HI and LO LEDs are extinguished, the input voltage will be in the range 1 V RMS ±5%. Input impedance: 100 kΩ nominal.

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.

Accuracy
Better than ±(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 DC 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 ALC on the modulation depth is calibrated for input levels between 0.8 V and 1.2 V RMS. With the modulation ALC off, the modulation depth is calibrated for an input level of 1 V RMS. HI and LO LEDs are provided as an aid to maintaining calibrated modulation in the ALC OFF mode. When the HI and LO LEDs are extinguished, the input voltage will be in the range 1 V RMS ±5%. Input impedance: 100 kΩ nominal, DC 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 LEDs indicate selected frequency.

Frequency accuracy
±5%.

Output level
0.1 mV to 5 V into a load of 2 kΩ 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 2V. Source impedance less than 10 Ω.

Level accuracy
±5% for output levels above 50 mV. ±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 RMS into 100 kΩ.

FREQUENCY STANDARD

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

Frequency standard Input/Output
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 PPM over the temperature range 0 to 40°C.

Warm-up time
Within 0.5 PPM of final frequency 5 minutes 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.

Internal standard output
Either 1 MHz or 10 MHz at nominally 3 Vp-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

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 LED indicators, HI and LO, provide an aid to maintain calibrated modulation in the ALC OFF mode.

Internal AF oscillator output
The output can be set between 0.1 mV and 5 V into 2 kΩ 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 RMS. Capable of driving a 600 Ω load for levels below 2 V RMS.

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 (GPIB 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, ØM, AM, modulation off, external modulation selected and modulation limit exceeded. Level display: 4 digit display with annunciators to show level units, output off, reverse power trip operated and level limit exceeded.

GPIB INTERFACE

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.

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 RF interference.

SAFETY

Complies with IEC 348.

RATED RANGE OF USE