# Chapter 1
# GENERAL INFORMATION

## FEATURES

The 2022D is a light-weight synthesized signal generator having a frequency range of 10 kHz to 1 GHz and providing comprehensive amplitude, frequency and phase modulation facilities with an RF output level range of -127 dBm to +13 dBm. It is designed to cove a wide range of RF applications in development, production and maintenance. Output frequency is phase locked to an internal or external frequency standard and frequencies up to 100 MHz can be set to a resolution of 10 Hz, and above that to a resolution of 100 Hz.

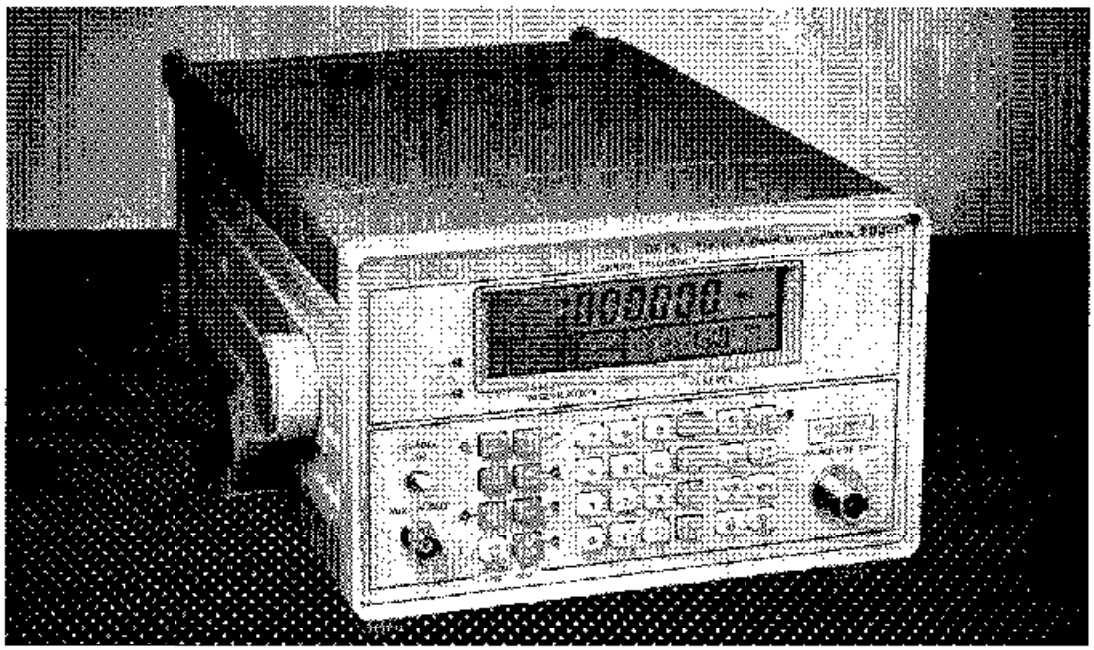

*Fig. 1-1 10 kHz to 1 GHz Signal Generator 2022D*

Front panel operation is carried out by direct entry of required settings via the keyboard. Microprocessor control ensures flexibility, simplicity of use and allows programming by the General Purpose Interface Bus (GPIB)* This facility is offered as an option enabling the instrument to be used both as a manually operated bench mounted instrument or as part of a fully automated test system.

## Output

Calibrated output levels from −127 dBm to +13 dBm are provided. A choice of ten output level unit combinations can be obtained on the front panel. The RF output level can be set to a resolution of 0.1 dB over the entire output voltage range. Protection against the accidental application of up to 50 W of reserve power is provided by a fast responding relay trip. Full protection is also provided when the instrument is switched off.

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**GPIB: IFR General Purpose Interface Bus in accordance with IEEE Standard 488 – 1978 and IEC Publication 625–1.*

An RF level offset capability allows the output level to be varied relative to the indicated value to compensate for external cable losses or to ensure that all instruments in a particular area give identical results.

## Modulation

Amplitude, frequency and phase modulation can be provided by internal or external sources. AM depth can be set in 0.5% steps up to 99.5%, FM deviation up to 999 kHz and phase modulation up to 9.99 radians. An auxiliary modulation input allows dual modulation to be applied for receiver testing. An internal modulation oscillator provides switch selected frequencies of 400 Hz, 1 kHz and 3 kHz.

## Front panel

All data and units selected are visible on a single liquid crystal display. Data is entered on a keyboard that has been designed to be simple and logical to use. Carrier frequency, modulation and RF level functions may be incremented or decremented using the ↑ (UP) and ↓ (DOWN) keys. Non-volatile store and recall facilities are also provided using an electrically alterable read only memory that does not require a battery back-up system. A front panel cover for protecting the instrument in transit is available as an accessory.

## Second function mode of operation

This enables a number of auxiliary functions such as setting the GPIB address, selection of alternative RF level calibration units, access to various calibration routines and an aid to diagnostic fault finding via the internal instrument bus.

# PERFORMANCE DATA

### Carrier frequency

| | |
|---|---|
| Range: | 10 kHz to 1 GHz. |
| Displayed resolution: | 10 Hz up to 100 MHz,<br>100 Hz above 100 MHz. |
| Selection: | By keyboard entry. |
| Accuracy: | Equal to the frequency standard accuracy - see under 'Frequency standard'. |
| Indication: | 7 digit LCD with units annunciation. |

### RF output

| | |
|---|---|
| Level: | -127 to +13 dBm. (0.2 µV to 2 V EMF). When AM is selected the maximum output power reduces linearly with AM depth to +7 dBm at maximum AM depth. |

| | |
|---|---|
| Selection: | By keyboard entry. Units may be μV, mV EMF or PD; dB relative to 1 μV, 1 mV, 1 V EMF or PD; dBm.<br>Conversion between dB and voltage units may be achieved by pressing the appropriate units key (dB or V, mV, μV). |
| Output impedance: | 50 Ω, Type N female socket to MIL 39012/3D. |
| VSWR: | Better than 1.5:1 for outptut levels below −7 dBm. |
| Reverse power protection: | An electronic trip protects the generator output against reverse power of up to 50 W from a 50 Ω source and 25 W with a source VSWR up to 5:1 for frequencies from DC to 1 GHz. The trip may be reset from the front panel or via the GPIB. For safety the protection is also provided when the instrument is switched off. |
| Output level flatness: | Better than ±0.5 dB from 10 kHz to 1 GHz for RF levels above −7 dBm. |
| Output level accuracy: | ±1 dB for output levels above −10 dBm.<br>±2 dB for output levels below −10 dBm. |
| Displayed resolution: | 0.1 dB or better over the entire voltage range. |
| Indication: | 4 digit LCD with units annunciators. |

### Spurious signals

| | |
|---|---|
| Harmonically related signals for output levels up to +7 dBm: | Better than −35 dBc (typically better than −40 dBc) for carrier frequencies up to 62.5 MHz.<br>Better than −25 dBc (typically better than −35 dBc) for carrier frequencies above 62.5 MHz. |
| Sub-harmonics for output levels below 0 dBm: | None for carrier frequencies up to 500 MHz, better than −20 dBc for carrier frequencies above 500 MHz. |
| Non-harmonically related signals for output levels up to +7 dBm and at offsets from the carrier of 3 kHz or greater: | For carrier frequencies above 62.5 MHz, better than −70 dBc. For carrier frequencies below 62.5 MHz, better than −55 dBc in the band up to 150 MHz, and better than −40 dBc in the band above 150 MHz. |

Single sideband phase noise:

Typically less than –120 dBc/Hz at 470 MHz,
Typically less than –130 dBc/Hz at 150 MHz.

Residual FM:
(with FM off)

Less than 7 Hz RMS deviation in a 300 Hz to 3 kHz bandwidth from 250 to 499 MHz and improving by approximately 6 dB per octave with reducing carrier frequency down to 62.5 MHz.
Better than 3.5 Hz RMS below 62.5 MHz.

RF leakage:

Less than 0.5 µV 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:

The maximum deviation available varies with carrier frequency range as shown in the table below:

| Frequency range | Maximum deviation |
|---|---|
| 500 MHz – 1 GHz | 999 kHz |
| 250 to 500 MHz | 500 kHz |
| 125 to 250 MHz | 250 kHz |
| 62.5 to 125 MHz | 125 kHz |
| Below 62.5 MHz | 100 kHz |

Displayed resolution:

10 Hz for deviations up to 9.99 kHz.
100 Hz for deviations from 10 kHz to 99.9 kHz.
1 kHz for deviations from 100 kHz to 999 kHz.

Selection:

By front panel keyboard. Internal 400 Hz, 1 kHz or 3 kHz modulation or external input may be selected.

Deviation accuracy:

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

Frequency response:

±0.5 dB from 50 Hz to 50 kHz relative to 1 kHz, using external modulation input.

With ALC off the low frequency response is extended to 10 Hz with a peak deviation value limited to the lower of 999 kHz or
[0.047 x Modulation Freq. (in Hz) x {Carrier Freq. (in MHz) + 160 (if Carrier Freq. is below 62.5 MHz)}] kHz.

With ALC off can also be used for 10 Hz square wave switching with a peak deviation value limited to the lower of 999 kHz or 0.6 times the value obtained by the formula above.

Distortion: Less than 2% total harmonic distortion at 1 kHz modulation frequency and maximum deviation for any carrier above 250 kHz.
Less than 0.5% total harmonic distortion at 1 kHz modulation frequency for deviations up to 25 kHz for any carrier frequency above 250 kHz with ALC off.

External modulation: With modulation ALC on, the deviation is calibrated for input levels between 0.9 V and 1.1 V RMS. A HI or LO message is indicated in the modulation display if the applied level is outside the range of the ALC. With modulation ALC off, the deviation is calibrated for an input level of 1 V PD.

Input impedance is 100 kΩ nominal.

Indication: 3 digit LCD with units annunciators.

**Phase modulation**

Range: Peak deviation from 0 to 9.99 radians.

Displayed resolution: 0.01 radian.

Selection: By front panel keyboard. Internal 400 Hz, 1 kHz or 3 kHz modulation or external input may be selected.

Deviation accuracy: ±5% of deviation ±0.02 radian at 1 kHz modulating frequency excluding residual phase modulation.

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

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

External modulation: With modulation ALC on the deviation is calibrated for input levels between 0.9 and 1.1 V RMS. A HI or LO message is indicated in the modulation display if the applied level is outside the range of the ALC. With modulation ALC off the deviation is calibrated for an input level of 1 V PD.

Input impedance is 100 kΩ nominal.

Indication: 3 digit LCD with units annunciators.

### Amplitude modulation

Range: 0 to 99.5%.

Resolution: 0.5%.

Selection: By front panel keyboard. Internal 400 Hz, 1 kHz or 3 kHz modulation or external input may be selected.

Accuracy: For peak output power levels up to +9 dBm:
Better than ±(4% of depth setting +1%) for 1 kHz modulating frequency and depths up to 95% for carrier frequencies up to 62.5 MHz.
Better than ±(4% of depth setting +1%) for 1 kHz modulating frequency and depths up to 80% for carrier frequencies up to 400 MHz.

Frequency response: ±0.5 dB from 50 Hz to 15 kHz relative to 1 kHz at 80% depth using external modulation input, ALC on and DC coupled with ALC off.

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

External modulation accuracy: With modulation ALC on the modulation depth is calibrated for input levels between 0.9 and 1.1 V RMS. A HI or LO message is indicated in the modulation display if the level is outside the range of the ALC.
With modulation ALC off the modulation depth is calibrated for an input level of 1 V PD.
Input impedance is nominally 100 kΩ, DC coupled.

Indication: 3 digit LCD with units annunciators.

### Modulation oscillator

| | |
|---|---|
| Frequency: | 400 Hz, 1 kHz and 3 kHz. |
| Selection: | By repetitive pressing of the INT MOD FREQ key. |
| Frequency accuracy: | ±5%. |
| Distortion: | Less than 1% total harmonic distortion. |
| Indication: | One of three LEDs lights to indicate which frequency is selected. |

### Frequency standard

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

### Internal frequency standard

High stability, oven controlled oscillator.

| | |
|---|---|
| Frequency: | 10 MHz. |
| Temperature stability: | Better than ±0.05 ppm over the temperature range 0 to 40°C. |
| Aging rate: | Better than 0.3 ppm per year after one month's continuous use at constant ambient temperature. |
| Warm up time: | Within 0.5 ppm of final frequency 5 minutes from switch-on at ambient 20°C. |

### External frequency standard

External standard input: Accepts a 10 MHz signal of at least 1 V RMS into a 100 Ω nominal impedance.

A 5 MHz or 1 MHz signal can be accepted by changing an internal link. Connection is via a rear panel BNC socket.

### Auxiliary inputs and outputs

| | |
|---|---|
| Modulation input/output: | A front panel BNC socket provides an output from the modulation oscillator when internal modulation is selected and becomes the external modulation input when external modulation is selected. |
| Internal modulation oscillator output: | 1 V ±10% EMF from a nominal 600 Ω source. |
| External modulation input: | Input level nominally 1 V RMS into 100 kΩ – see under 'Modulation' for details. |
| Alternative RF output socket: | A blanked hole is provided so that the RF output socket can be fitted to the rear panel. |

Auxiliary modulation input: A rear panel BNC socket provides an auxiliary modulation input with a nominal sensitivity of 20% of the set modulation for a 1 V RMS input.

Input impedance 600 Ω nominal.

**GPIB interface:** A GPIB interface is available as an optional accessory and can be easily fitted by the user. All functions except the SUPPLY ON switch are remotely programmable.

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

**Conditions of storage and transport**

Temperature: –40°C to +70°C.

Humidity: Up to 90% relative humidity at 40°C.

Altitude: Up to 2500 m (pressurised freight at 27 kPa differential i.e. 3.9 lbf/in$^2$).

**Rated range of use (over which the full specification is met)**

Temperature: 0 to 55°C.

**Safety:** This instrument is designed to comply with the requirements of IEC/EN61010-1 for Class I portable equipment and is for use in a pollntion degree 2 environment. The equipment is designed to operate from installation supply category II.

**Electro-magnetic compatibility** Conforms to the protection requirements of EEC Council Directive 89/336/EEC by complying with the following standards:-

| | |
|---|---|
| EN 55011 Class B | CISPR 11 |
| EN 50082-1 | IEC 801-2, 3, 4 |
| EN60555-2 | IEC 555-2 |

**Power requirements**

AC supply: Switchable voltage ranges, all ±10%:-
105 to 110 V, 115 to 120 V,
210 to 220 V, 230 to 240 V.
45 to 400 Hz.
70 VA max.

## Dimensions and Weight

| | |
|---|---|
| Height: | 152 mm (6 in) |
| Width: | 256 mm (10 in) |
| Depth: | 367 mm (14.5 in) (Excluding handle projection) |
| Weight: | 7.5 kg (16.5 lb) |

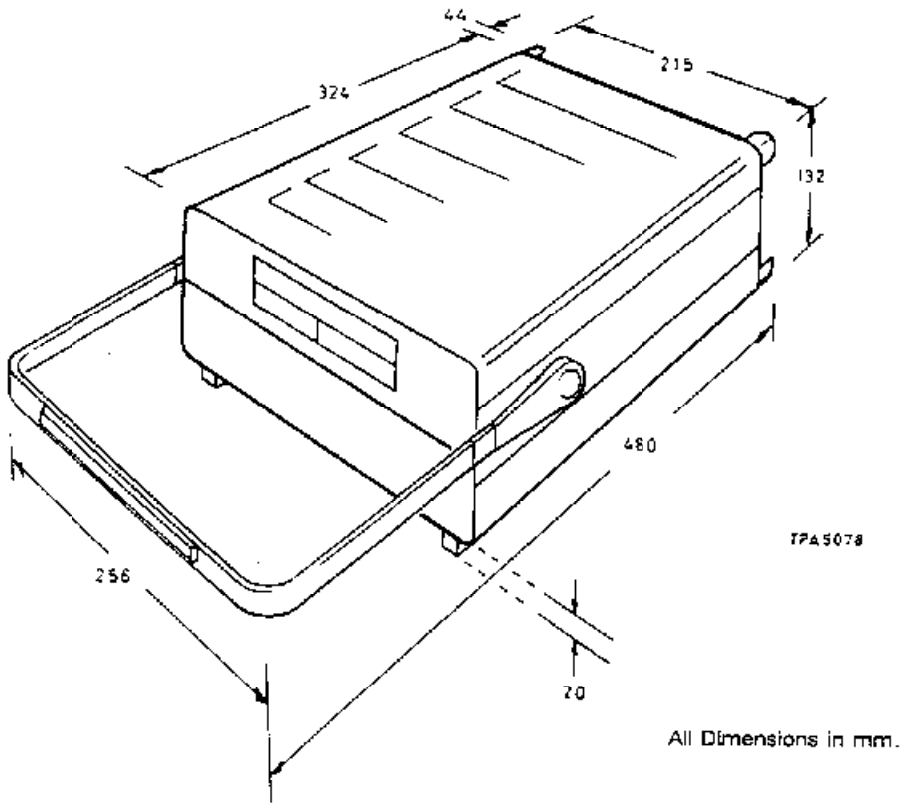


*Fig. 1–2 Case dimensions*

## OPTIONS

001 : GPIB interface fitted.

## ACCESSORIES

### Supplied accessories

| | Part no. |
|---|---|
| AC supply lead | 43129-003W |
| Operating Manual H 52022-003X (Vol. 1) | 46882-001W |

### Optional accessories

| | Part no. |
|---|---|
| Service Manual H 52022-003X (Vol. 2) | 46882-002D |
| GPIB module | 54433-003N |
| Front panel protective cover | 54124-023J |
| Rack mounting kit single | 46884-502Z |
| The GPIB Manual H 54811-010P (Contains details of general GPIB protocols) | 46881-365R |
| GPIB lead assembly | 43129-189U |
| Screened GPIB lead assembly (for enhanced RFI performance) | 46883-962H |
| GPIB IEEE/IEC connector adapter | 46883-408K |
| RF coaxial cable (N to N type) | 54311-095C |
| Coaxial adapter, type N to BNC | 54311-092P |
| Impedance adapter 50/75 Ω (25 Ω series resistor) BNC | 54411-051X |
| National Instruments Lab Window instrument drivers | 59000-183S |