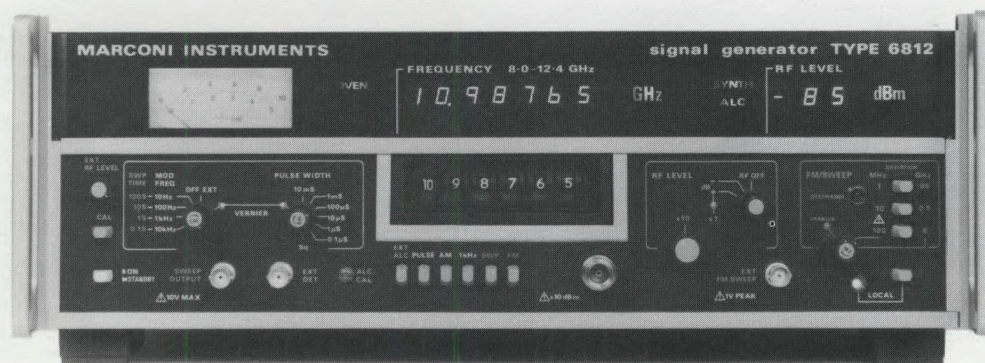


Microwave Signal Generator

6812



- ☐ Fast frequency switching
- ☐ Internal/external am/fm modulation
- ☐ Pulse capability
- ☐ IEEE-488 Data Bus Programming
- ☐ Good harmonic and noise performance
- ☐ Wide range attenuator

The 6812 microwave frequency solid state signal generator covers the 8.0 to 12.4 GHz band in a compact, standard 19" size.

This new generator provides one of the most versatile, calibrated, fully screened microwave X-Band sources available today.

The main features of this generator are the fast frequency switching speed and the wide range of internal and external amplitude and frequency modulation together with full band sweeping facility. These can be controlled via the front panel and also via the GPIB Bus interface for in-house ATE requirements.

Operation

The 6812 signal generator uses a YIG tuned oscillator and filter to provide a stable pure microwave signal which is referenced back in the locked mode to an internal low frequency crystal oscillator. In the FM and sweep modes, both narrow band and wide band, the low frequency oscillator output is locked and the microwave start or centre frequency is referenced to this signal, modulation can then be applied to allow up to full band frequency deviation at up to 100 Hz rate; or for operation at up to 1 MHz rate lower deviations are possible.

RFI screening

Each block within the instrument is fully screened on all power and signal lines as well as r.f. screened from one another. Although full screening has been used within the

instrument, clever design allows the instrument to hinge into two areas for extremely easy maintenance. The power supplies feature full protection which give front panel indication of fault conditions as well as instrumentation switch off in the unlikely event of a fault occurring.

RF output

Output power is controllable from +3 dBm to -119 dBm using a step attenuator and fine vernier, power level being displayed on a 2½ digit LED display, resulting in excellent resettability. The higher power output achieved is the direct result of careful r.f. output line design which allows +3 dBm minimum power at the front panel whilst still providing 75 dB modulation as a standard feature built into the instrument. In the unlevelled mode up to 8 mW is available.

Modulation

All the AM and FM features are independent, allowing full control of the signal in any mode. Internal AM provides both square wave and pulse over 10 Hz to 100 kHz with 10 ns rise and fall, with widths from 0.1 μ s to 100 ms.

External AM is available for both external detector input on the front panel and external pulse input on the rear panel. Internal sweep is provided to give deviations from 100 kHz to full band in six ranges at sweep rates from 0.01 s to 100 s. External FM and sweep use the same six ranges and allow modulation in the mode. Deviation which is linear with input voltage, is displayed on the front panel analogue meter.

Readouts

In addition to the 7 digit LED display of frequency, the 2½ digit LED display of power level and the analogue meter for power calibration FM or sweep deviation, the instrument contains indicators to inform the user of the status of the generator.

Once the main switch is closed then the following status are indicated:

- (i) ALC – levelled state
- (ii) SYNTH – lock – unlocked state

- (iii) SWP – non-locked mode for wide deviation
- (iv) FM – non-locked mode for narrow deviation
- (v) TRIP – fault condition – instrument automatically shutdown.

Programming

The instrument is compatible with standard bus control equipment (GPIB Bus) to give programming of frequency and power level together with r.f. on/off, external pulse AM enable, external FM enable, FM deviation.

FREQUENCY		
Range	8.0 to 12.4 GHz.	
	Overrange is possible in programming mode to reduced specification in range 7.95 to 12.45 GHz.	
Indicator	7 digit LED.	
Resolution	10 kHz.	
Time base (Internal)	10 MHz.	
Ageing Rate (External)	Depends upon internal standard	
	10 MHz TTL input on rear panel.	
SPECTRAL PURITY		
Harmonic	Better than -45 dBc.	
Spurii	Better than -60 dBc at greater than 10 kHz from carrier.	
Phase Noise	-55 dBc at 100 Hz.	
	-65 dBc at 1 kHz.	
	-70 dBc at 10 kHz.	
	-90 dBc at 100 kHz in the SSB in 1 Hz, CW mode.	
OUTPUT		
Power	Up to +9 dBm unlevelled.	
	+3 to -119 dBm levelled & calibrated.	
Indicator	2½ digit LED display, analogue meter for calibration position for external detector.	
Levelled Accuracy	At 0 dBm ±2.0 dB.	
10 dB switch	At -10 dBm ±2.5 dB.	
	At -20 dBm ±2.7 dB.	
1 dB switch	Below -30 dBm ±2.0 dB ±0.3 dB/10 dB.	
	±0.5 dB incremental worst error	
	±1 dB/10 dB.	
Switching Time	10 dB increment 20 ms.	
	1 dB increment 10 µs.	
AMPLITUDE MODULATION – INTERNAL PULSE		
Prepulse	TTL output 200 ns advance approx.	
Pulse Repetition	10– 100 Hz.	
Frequencies	100–1000 Hz.	
	1– 10 kHz.	
	10– 100 kHz.	
Pulse Rise and Fall	10 ns.	
Pulse Depth	75 dB min.	
Pulse Widths	1– 10 µs	
	10– 100 µs 1– 10 ms	
	100–1000 µs 10–100 ms	
AMPLITUDE MODULATION – INTERNAL SQUAREWAVE		
Squarewave	1 kHz ± 10% variation.	
Rise and Fall	10 ns.	
Pulse Depth	75 dB min.	
AMPLITUDE MODULATION – EXTERNAL SQUAREWAVE		
Input	Squarewave or pulse.	
Drive	TTL.	
Range	10 Hz to 100 kHz.	
Rise and Fall	10 ns.	
Depth	75 dB min.	
AMPLITUDE MODULATION – EXTERNAL LINEAR		
Linear	Up to ± 10 dB.	
Depth	10 mW per V.	
Drive	5 µs.	
Rise and Fall		
FREQUENCY MODULATION – EXTERNAL FM OR INTERNAL SWEEP MODE		
Indicator	Meter (indicated accuracy ±5%).	
Sensitivity	Range 1 MHz to 500 MHz/V (internal sweep). 6 Ranges ±100 kHz/V to ±5 GHz/V continuously variable (external FM/Sweep).	
FM/Sweep 3 dB	100 kHz up to ±100 MHz/V deviation.	
Bandwidth	5 MHz/hour.	
FM Drift	25 kHz rms.	
FM Residual		
POWER REQUIREMENTS		
AC Supply	375 VA (240 V 50 Hz or 115 V 60 Hz nominal, internal switch).	
DIMENSIONS AND WEIGHTS		
Height	161 mm	Width 427 mm
Depth	567 mm	Weight 30 kg
ENVIRONMENTAL		
Temperature Range	storage -40 to +70°C.	
	operating 0 to +50°C.	
	full specification 10 to +35°C.	
	Meets IEC 348 Safety.	
	Meets MIC 1070 General:	
	Vibration 3 axes 1 g 10 hrs.	
	Shock 6 axes 200 bumps.	
	Humidity 35°C 95% RH Full Spec.	
	40°C 95% RH 14 day storage.	
PROGRAMMING		
Via IEEE -488 Interface BUS Control:		
Frequency 10 kHz steps.		
Output level 10 dB and 1 dB steps.		
Carrier on, await lock.		
Modulation AM, 1 kHz pulse, FM Sweep.		
ALC internal or external.		
FM/Sweep deviation 1 MHz–5 GHz.		



Simple calibration facilities and fast diagnostic functions enable rapid testing of Marconi Instruments' signal generators, here seen prior to final factory test. The same features are a significant factor in their low cost-of-ownership.

Radio Test Sets

Introduction		30
Radio Communications Test Set (400 kHz to 1000 MHz)	2955	32
Programmable Interface Unit (500 kHz to 1040 MHz)	2306	35
AM/FM Radio Telephone Test Set (400 kHz to 520 MHz)	2952	38
Mobile Radio Test Set (24 to 180 MHz and 400 to 480 MHz)	2951	43
Mobile Radio Test Set (23 to 180 MHz and 400 to 520 MHz)	2950	48

Introduction

Radio Communication Test Sets

Field maintenance and workshop repair of mobile radios, hand portables and fixed base station equipment, demands test equipment able to perform an appropriate range of specific test functions, to a high standard and in many different environments. Continuous development of the mobile radio test set, by manufacturers in conjunction with mobile radio users, has produced a single piece of test equipment most suited to fulfil this demand.

The Radio Test Set

The advantages of using a test set that combines all the essential pieces of equipment for radio testing are obvious. A minimum number of interconnections are required and all the test functions are readily to hand, so measurements are faster, throughput is improved and costs are reduced.

Low cost and portability are offered by a range of Radio Test Sets available from Marconi Instruments, and where the flexibility of discrete instruments is at a premium, semi-automated transceiver test systems such as that offered by Marconi are an attractive proposition.

Test Sets for Field Service and Workshop Repair

In the field service environment the need is for a comprehensive, low-cost test set that can function in fixed or mobile workshops, or can readily be hand carried to remote locations for testing purposes. Here the flexibility to be able to use virtually any available power source – from NiCd battery packs, vehicle supplies to main voltage – is a distinct advantage. In addition, ease of use and low cost of ownership are high among user priorities.

Major repairs to mobile radio equipment are necessarily carried out in the service workshop, where additional testing facilities and spares are available. Here, a mobile radio test set must be capable of carrying out more detailed testing on the widest possible range of mobile equipment and ancillaries. That way it can be cost-effective, both now and in the future.

The functions required from a test set are the usual in-band transmitter and receiver measurements, so the instrument usually comprises at least:

- AM/FM Signal Generator and AF Oscillator for receiver tests;
- Modulation Monitor and RF Power Meter for testing transmitters;
- AF Voltmeter for general measurements.

Additional facilities can include RF and AF Frequency Counters, Oscilloscopes and SINAD Meters.

And further flexibility for future requirements is offered by programmable test sets, such as Marconi Instruments 2955, which offer the advantages of the latest technology. This type of test set enables consistent measurements to be made and test times to be reduced, so resulting in increased savings for the user.

The 2955 Radio Communications Test Set has been designed to meet the requirements of servicing and maintenance, both as a field service test set and a service workshop tool. Its design is geared to current radio technology and expected future developments, with a modular construction that enables it to be readily modified to incorporate new test facilities (e.g. cellular radio testing).

Simple Operation

Extensive ease-of-use features have been designed into 2955 to increase the efficiency of servicing and maintaining mobile radios. Non-volatile memory is provided to store complete front panel settings in all instrument modes, so set-ups can be stored and recalled when desired, reducing dramatically the time required to carry out a given test.

Simplicity of operation comes from a single c.r.t. display, which is used to indicate all analog and digital readings, as well as providing MENU displays and acting as a v.d.u. for instructional or message display. The front-panel HELP facility is a further aid to operator convenience.

Included in the 2955's design is a sequential tones encoder and decoder, which can deal with a number of tone standards as well as those generated and decoded using the USER DEFINE mode. This facility has even more capability when used in conjunction with the IEEE 488 bus, there being no practical limitation to the number and duration of tones that can be generated or decoded. The resulting flexibility means that the instrument is able to cope with all likely future developments in selective tone systems. All this makes the 2955 an extremely cost-effective test system.

The 2952, 2951 and 2950 Series of Radio Test Sets represent traditional solutions to these needs. Each instrument is designed for specific user requirements, combining as they do an appropriate variety of functions for transceiver testing. 2950 should appeal to those who only need a basic set of measurement functions, and who need the lighter weight and battery operation for portable applications. Where accurate frequency measurements are needed, the 2951 provides a built-in digital counter, and also has a distortion factor meter for these tests. And for the user who needs more comprehensive AM/FM facilities – typically those in the base station workshop – the 2952 has an integral 400 kHz to 520 MHz signal generator.

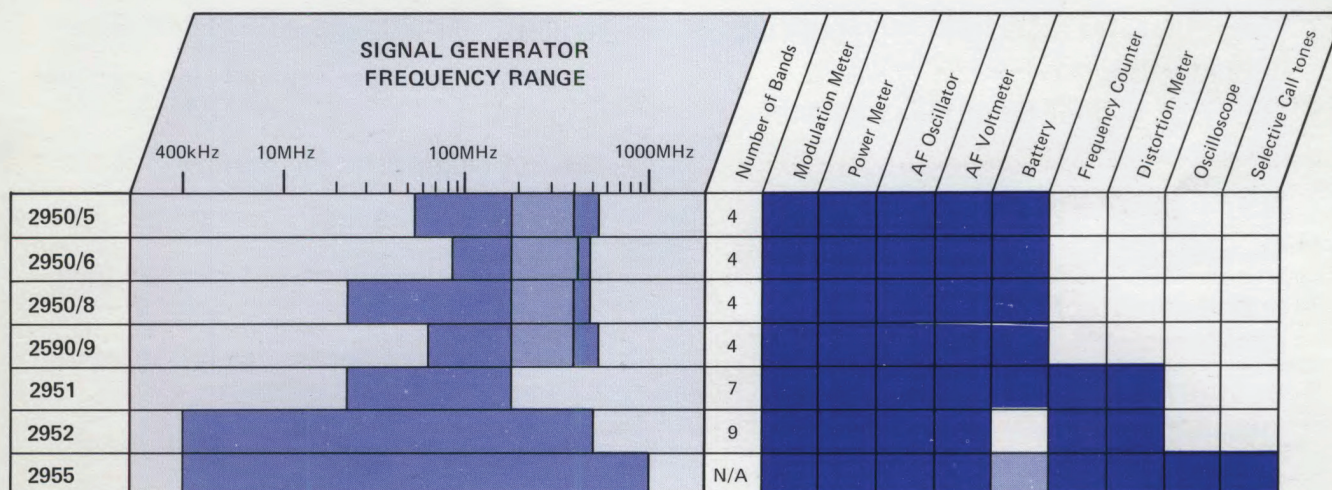
Test Sets for Production and Central Repair

Production testing of mobile radio equipment calls for the highest quality of test equipment available, to ensure that the systems under test meet design criteria. Test equipment should utilize the high per-

formance discrete instrumentation available from Marconi; and where the flexibility these offer is required, a complete test system can be offered which combines them.

Designated MISATT (Marconi Instruments Semi-Automatic Transceiver Test system), it serves the needs of fast production and maintenance testing by taking full advantage of the flexibility built-in to standard instruments, MISATT combines a 2018/19 series Signal Generator, 2305 Modulation Meter, GPIB controller and 2306 Programmable Interface Unit, to produce a complete system for both in-band and out-of-band tests.

The Interface Unit supplies d.c. power to the radio, provides switching to control the transceiver and r.f. routing for the test instruments. It comes complete with GPIB software for computer control, and can be readily configured to test any radio. Data preparation for test frequencies, r.f. levels, etc. requires no programming skill, and can easily be performed by the test engineer.



Comparison Chart for Radio Test Sets.

[Shaded box] OPTION

Radio Communications Test Set

2955



- ☐ Comprehensive radio transceiver testing from a single unit
- ☐ Clear c.r.t. display for all measurement details
- ☐ Simple colour coded keys
- ☐ 'Help' facility for easy familiarization
- ☐ Independent tuning for one and two port duplex systems
- ☐ Built-in AF distortion, S/N and SINAD measurements
- ☐ Complete frequency cover up to 1000 MHz
- ☐ Bench or portable use with battery option
- ☐ Bar charts, oscilloscope and alphanumeric displays
- ☐ Soft key menu-driven operation
- ☐ Optional GPIB control
- ☐ Selective calling tones encoder/decoder including sub-audible frequencies
- ☐ Twin 8-digit counter display for measuring a.f. and r.f. signals
- ☐ AM FM and ØM measurements and generation

Combining all the instruments required for comprehensive transceiver testing, within a single unit, the 2955 Radio Communication Test Set is designed for bench or portable use. It operates from standard a.c. or d.c. supplies. Applications include the testing of mobile, marine and airborne radiotelephone equipment in the maintenance workshops

of manufacturers, public services, military and commercial users.

The Test Set comprises eleven separate instruments : Signal Generator, Modulation Meter, RF Frequency Counter, AF Counter, RF Power Meter, AF Generator, AF Voltmeter, AF Distortion Meter, SINAD Meter, Tones Encoder/Decoder

and Oscilloscope.

The clear display provides the operator with all his measurement detail, making the 2955 an outstanding test equipment for ease of operation.

All the necessary interconnections are made internally, eliminating the many external connections required when using separate instruments. Function selection and data entry is conveniently made by colour coded front panel keys, arranged in logical sequence. Clear presentation of measurement settings and results is ensured by a c.r.t. that combines alphanumeric information, oscilloscope graphics and autoranging bar charts on a single display. A 'HELP' key provides the operator with guidance which together with 'menu' driven and 'soft key' selection provides fast user familiarization and measurement convenience.

Two frequency counters on the display cover the ranges 10 Hz to 20 kHz and 1.5 to 1000 MHz respectively, enabling a.f. and r.f. measurements to be made simultaneously.

All the standard mobile receiver tests are available using an integral 1000 MHz signal generator, which provides a.m., f.m. and \emptyset .m. signals with a comprehensive range of depths, deviations and modulation frequencies.

The instrument's modulation monitor features automatic tuning and levelling for measurements in receiver testing. Thanks to independent tuning, modulation measurements are easily made on duplex systems. Modulation asymmetry may be checked using a bar chart on the display, which gives a clear indication of peak and trough values. Demodulated output is available from the built-in loudspeaker, or may be monitored using an external loudspeaker, headphones or other device.

Power measurements are given on the digital readout, or an autoranging bar chart, and offer high accuracy for

continuous power levels up to 30 W. Power in excess of 100 W may be measured for short durations.

The distortion and SINAD filters both operate at 1 kHz modulating frequency. Results may be shown on bar charts in addition to the digital display.

The Radio Communications Test Set also enables selective tone calling equipment to be checked. Encoders and decoders may be tested and the 2955 is capable of generating/receiving four defined tone frequencies: standard CCIR, ZVEI 1, ZVEI 2, EIA, in addition to a fifth user-defined tone. Provision is made to send and receive a sequence of up to 10 allocated tones from a group of 15. For receiver testing, the tones may be generated in single-step, tone burst or continuous cycles. For testing transmitters, each tone received is compared with standard frequencies held in memory and if it is within pre-defined limits its tone number and frequency error are displayed. Sub-audible tones (CTCSS) are also available.

2955 is provided with 38 non-volatile stores each being capable of storing a complete front panel set-up. One storage location is used by the instrument to retain the last set of front panel settings in the event of a mains or battery failure.

Complete GPIB programming via an optional interface allows remote operation of all front panel key buttons with additional write-to-screen capability.

Cost of ownership is significantly reduced by the built-in self-test facility which identifies faulty sections to either major module level or groups of components thus reducing mean time to repair.

Calibration factors are stored in non-volatile memory and may be accessed via the front panel, key buttons or via the GPIB bus, permitting rapid recalibration when necessary.

RF GENERATOR

FREQUENCY	
Range	0.4 MHz to 1000 MHz.
Resolution	50 Hz up to 530 MHz. 100 Hz up to 1000 MHz.
Accuracy	As internal standard.
OUTPUT LEVEL	
Range	-140 dBm to 0 dBm.
Resolution	0.1 dB.
Accuracy	± 2 dB.

AUDIO GENERATOR

OUTPUT IMPEDANCE	Less than 5 Ω nominal.
FREQUENCY	
Range	50 Hz to 15 kHz (Usable 20 Hz to 20 kHz).
Resolution	0.1 Hz (50 Hz to 3.25 kHz). 1 Hz (3.25 kHz to 20 kHz).
Accuracy	As internal standard.
DISTORTION	Better than 2% to 15 kHz.
FIXED FREQUENCY	1 kHz.
Distortion	Better than 1%.
TWO TONE SETTING	1 kHz + AF Generator setting frequency.
OUTPUT LEVEL (e.m.f.)	
Range	1 mV to 2.5 V (to 5 kHz). 1 mV to 2 V (to 20 kHz).
Accuracy	$\pm 5\% \pm 1$ count to 15 kHz.

MODULATION

AMPLITUDE MODULATION	
CW range	1.5 to 400 MHz usable to 400 kHz.
Mod. Depth range	0 to 70%.
Resolution	1%.
Accuracy	$\pm 6\%$ reading ± 1 digit at 1 kHz.
AM EXTERNAL INPUT	
Sensitivity	1 V p-p for 20% a.m. at 1 kHz. $\pm 8.5\%$ reading $\pm 1\%$ a.m. (50 Hz to 15 kHz).
FREQUENCY MODULATION	
CW range	0.4 to 1000 MHz.
Deviation range	0 to 25 kHz.
Resolution	25 Hz (<6.25 kHz dev.). 100 Hz (<25 kHz dev.).
Accuracy	$\pm 7\% \pm 10$ Hz.
FM EXTERNAL INPUT	
Sensitivity	2 V p-p for 10 kHz dev. $\pm 10\%$.
PHASE MODULATION	
CW range	0.4 to 1000 MHz.
Mod. frequency range	300 Hz to 3.4 kHz.
Range	0 to 10 rad.
Accuracy	$\pm 8\%$ at 1 kHz.

RF FREQUENCY METER

FREQUENCY	
Range	1.5 MHz to 1000 MHz
Resolution	1 Hz or 10 Hz to 200 MHz. 10 Hz 200 MHz to 1000 MHz.
INPUT	
Sensitivity	5 mW/0.05 mW (N-type). 50 mV (BNC).
Accuracy	As internal standard.

RF POWER METER

INPUT	
Range	50 mW to 30 W. (100 W for limited period).
Resolution	2/3 digits to 500 MHz.
Accuracy	±10% ±1 count to 500 MHz. ±15% ±1 count to 1000 MHz.

MODULATION METER

INPUT	
Frequency range	1.5 to 1000 MHz.
Sensitivity	0.05 mW (BNC). 5 mW (N-type).
FREQUENCY MODULATION	
Deviation range	0 to 25 kHz.
Accuracy	±5% ±1 digit at 1 kHz.
AMPLITUDE MODULATION	
Mod. depth range	0 to 90% below 100 MHz. 0 to 80% 100 to 400 MHz.
Accuracy	±6% ±1 digit at 1 kHz.
PHASE MODULATION	
Accuracy	±6% ±1 count.

SINAD METER

Range	0 to 18,0 to 50 dB.
Resolution	0.1 dB.
Accuracy	±1 dB.

S/N METER

Range	0 to 30, 0 to 100 dB.
Resolution	0.1 dB.
Accuracy	±1 dB.

DISTORTION METER

Frequency	1 kHz.
Range	0 to 10,0 to 30% dist.
Accuracy	±5% of reading ±1% dist.

AF LEVEL METER

Input impedance	1 MΩ in parallel with 40 pF.
Frequency range	50 Hz to 20 kHz (or d.c.).
Level range	1 mV to 100 V.
Accuracy	3% ± 1 digit.

AF COUNTER

Range	10 Hz to 20 kHz.
Resolution	0.1 Hz/0.01%.
Sensitivity	50 mV.
Accuracy	Its internal standard ± 1 digit.
INTERNAL FREQUENCY STANDARDS	
Choice of TCXO, OCXO or Ext. Std.	

DIGITAL STORAGE OSCILLOSCOPE

For viewing demodulated audio (plus external input option). Measures AM, FM, ØM.	
Frequency range	DC to 50 kHz (from 3 Hz on a.c.)
Voltage range	10 mV/div. to 20 V/div.
Accuracy	±5%.
Trigger	Repetitive or single shot storage

LIMIT RANGE OF OPERATION	0 to 50°C.
---------------------------------	------------

CONDITIONS OF STORAGE AND TRANSPORT	
Temperature	-40°C to +70°C.
Humidity	Up to 90% humidity.
Altitude	Up to 2500 m (pressurized freight at 27 kPa differential, i.e. 3.9 lbf/sq. in).

DIMENSIONS AND WEIGHT				
Height	Width	Depth	Weight	
180 mm	350 mm	480 mm	15kg	
7.1 in	13.8 in	18.9 in	33 lb	

ACCESSORIES

Supplied

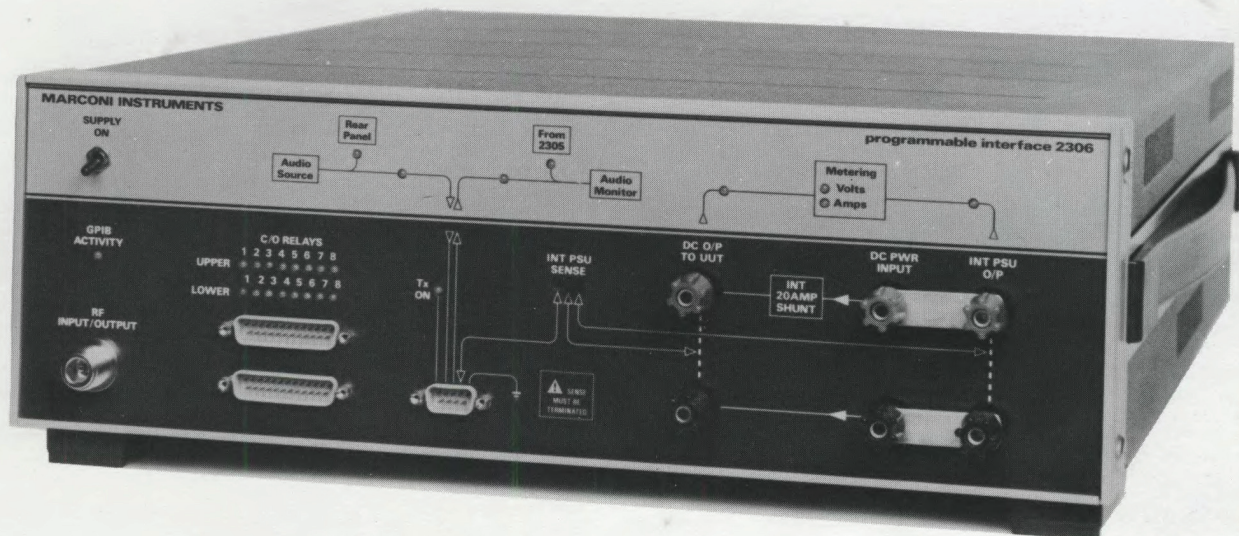
Stowage cover
Mains Lead
DC Supply Lead
Operating manual

Optional

Viewing hood
GPIB interface unit
GPIB support bracket
GPIB adapter, IEEE male to IEC female
GPIB lead assembly, IEEE connectors
Aerial, telescopic, BNC
Transit case
Service manual
GPIB manual
(Contact factory for other options)

Programmable Interface Unit

2306



- ☐ Combines with standard test equipment to form a programmable radio transceiver system.
- ☐ Powerful software package provides wide range of in-band and out-of-band tests.
- ☐ DC power supply for transceiver under test.
- ☐ Current & voltage monitoring.
- ☐ Tones signalling/decoding capability.
- ☐ 16 relays for control of radio.

2306 is a Programmable Interface Unit intended to be used in conjunction with a standard 2018/19 Series AM/FM Signal Generator, a standard 2305 automatic Modulation Meter (fitted with the Distortion/Weighting option) and a GPIB controller (HP-85 series) to form the Marconi Instruments Semi-Automatic Transceiver Test system (MISATT).

The 2306 is supplied complete with software, written in a form which allows straightforward entry of transceiver

test data without the need for any specialist controller experience. Test modules within the operating programs cover all of the routine tests – sensitivity, signal-to-noise ratio, power, frequency, etc. – and a range of “extended” tests such as adjacent channel rejection, image rejection, i.f. rejection, etc. is also included. An additional low-noise signal source (the 2017 Signal Generator) is used for these “extended” tests.

PROGRAMMABLE INTERFACE UNIT

The interface unit provides a programmable d.c. power supply to the transceiver under test, a d.c. voltmeter/ammeter, two audio sources, a tones decoder, audio switching, r.f. signal routing, and a switching matrix to control the radio, together with external connections to other parts of the system.

The 2306 includes an attenuator rated up to 25 W, but facilities are provided for inserting additional high-power attenuators to extend the power monitoring range.

Programmable Power Supply & Volts/Amps Monitoring

DC power supplies to the transceiver are programmable in 0.1 V steps from 1 V to 30 V, with output current capability of 5 A at 15 V and 2.5 A at 30 V. Provision is also made for connection to a user-supplied source where higher powers are required.

Voltage and current of the power supply are monitored to high resolution, and read back over the GPIB.

Audio Sources

Two a.f. sources provide simulation of the audio microphone signal during transmitter testing and supply tones for either sequential calling (up to 15 tones in length) or sub-audible signalling systems, as well as normal receiver test signals. The first audio synthesizer covers the range 25 Hz to 25 kHz, while the second audio oscillator provides provides 60 Hz to 3.2 kHz output.

Two audio output connections are provided – one to simulate the microphone signal for the transmitter and the other for use as an external modulation signal for the signal generator. Output from the two a.f. sources can be combined freely to provide the two outputs.

Tones Decoding

The 2306 includes a decoder facility to measure the frequency of tones in a sequential tones signal recovered from a transmitter.

Audio Switching

The 2305 audio socket, on its rear panel, is used for audio measurements on the receiver, and a connection from the rear panel of the interface allows signals to be routed to the 2305 for this purpose.

Radio equipment control switching

Sixteen pairs of changeover contact closures are available to control radio functions such as channel selection, mute disable, etc. A relay on the interface unit provides a contact closure simulating the action of a "press-to-talk" switch.

GPIB interface

Interfacing to the General Purpose Interface Bus is a standard feature of the 2306, and the bus address is pre-set by internal DIP switches. The unit supports serial polling and will respond with status information. Service requests (SRQs) are generated where appropriate, e.g. for bus errors, incorrect characters received, etc.

Software

Software for the Transceiver Test system is written in BASIC to run on an HP-85 series controller. It is supplied on tape cartridge but this can be transferred by the user to disk where faster program loading is required.

Software comprises self-checking, data preparation and operating programs.

Self-check

The self-check routine can be run at any time and carries out tests on the instruments and interface to ensure correct functioning and correct lead connection. Any problems identified are reported to the operator, with suggestions for remedial action where appropriate.

The self-check routine supports the 2017 Signal Generator where this forms part of the system.

Data Preparation

The program is used by the test engineer to "teach" MISATT what the measurement requirements are. It generates a database for use with the normal operating program, including details such as test frequencies, special operator messages, test limits, etc. Programming time is saved by the facility to amend information on the database without having to re-enter all the data.

The data preparation facility can be used without having the measurement equipment connected to the controller, and is designed to be used by a test engineer with no computing skills. It is possible to secure the database and operating program against unauthorized amendment or erasure.

Operating program

When the operating program is run it loads the relevant database for the radio to be tested. The cassette is not then required until the transceiver type is changed or a power-down condition occurs.

The operating program allows automated testing, completing the test regardless of errors detected. Hard copy printout of all results (with clear indication of any failures) can be obtained, or an abbreviated printout may be given showing just the failures. Facilities also exist for stopping the tests once a failure is detected, to allow for rectification of the fault before finishing the tests.

Measurement routines allow for either Iterative or Directed Testing. In Iterative testing the stimulus conditions are varied until a desired end-result is

achieved (e.g. varying the signal generator output until a 12 dB SINAD ratio is achieved). In Directed testing the stimulus condition is fixed and the end result simply measured (e.g. the generator output is fixed, while the receiver SINAD ratio is measured and reported).

All the normal in-band and out-of-band tests are included in the software.

Software allows for interactive operator input (e.g. to specify the measurement frequency, radio serial number etc.) but restricts user access to keys that would cause a system fault.

Where a hard copy is required of measurement results, printout is available either to the controller's thermal printer or to a suitable external printer with GPIB interface.



AM/FM Radiotelephone Test Set

2952



14752/1

- ☐ Test set for transceivers in v.h.f. and u.h.f. bands
- ☐ AM/FM Signal Generator: 400 kHz to 520 MHz
- ☐ Built-in synchronizer for high stability
- ☐ Frequency Counter: 10 Hz to 520 MHz
- ☐ AM/FM Modulation Monitor
- ☐ AF Generator: 250 Hz to 7 kHz
- ☐ AF Voltmeter: 0 to 30 V
- ☐ Distortion Factor Meter: 10% and 30%
- ☐ RF Power Meter: 2 W and 25 W

The 2952 is a very comprehensive and versatile test set combining in one case all of the measurement facilities required for testing radiotelephone units in the v.h.f. and u.h.f. bands. Its main application will be for testing mobile, marine and airborne radiotelephone equipment in the maintenance workshops of radiotelephone manufacturers, public services, military and commercial users.

Seven separate instruments are included in the test set:

Signal Generator, Frequency Counter, AF Generator, AF Voltmeter, Distortion Factor Meter, Modulation Monitor and RF Power Meter. The function selector switches organise all the necessary interconnections, eliminating the need for the many external connections required when separate instruments are used. The front panel is divided into sections corresponding to the major facilities offered, with a layout designed to permit simple and rapid operation.

Signal Generator

The signal generator has continuous frequency coverage from 400 kHz to 520 MHz, allowing measurements to be made at receiver intermediate frequencies as well as at their tuned input frequencies, and also permitting checks to be made of receiver spurious responses.

A novel tuning system is used which combines all the benefits of analogue tuning with the high stability offered by the digital control of the built-in synchronizer. When the main coarse tuning control is touched the frequency locking system is automatically disabled and the operator has full analogue control over the oscillator. Releasing the tuning control allows the digital frequency locking system to regain control and stabilise the output frequency. The final fine tuning is then carried out with a pair of concentric controls until the desired frequency is indicated by the digital display. The ability to be able to alter the output frequency while the instrument is operating under locked conditions is particularly useful when bandwidth measurements are being made on a receiver.

RF output level is controlled by a directly calibrated attenuator system, consisting of a coarse attenuator switching in 20 dB steps and a continuously variable fine attenuator providing interpolation between the steps. The output is calibrated in $\mu\text{V}/\text{mV}$ and dB relative to 1 μV and the front panel switch provides a choice of e.m.f. or p.d. calibrations – a particularly useful feature when working with receivers produced by different manufacturers. Output to the receiver under test is normally taken from the central output socket but higher levels can be obtained using the direct output socket immediately beneath the attenuator. Both output sockets are protected against the accidental application of r.f. power, the central socket by a high power attenuator pad and the direct output socket by a fast-acting relay.

Comprehensive modulation facilities include amplitude, frequency and phase modulation in ranges which are optimized for narrow band radio applications. The modulation source can be either the internal oscillator with a range of fixed and variable frequencies between 250 Hz and 7 kHz or an external source enabling receivers using special calling techniques (for example sequential tone coding) to be tested.

An output socket is fitted to provide a power supply for the range of oscillator probes available as optional accessories to assist in tuning to receivers fitted with squelch or battery economizer circuits.

Frequency Counter

A built-in frequency counter operates over the range 10 Hz to 520 MHz with frequency indication by an eight-digit l.e.d. display. When used in its internal mode the operation of the counter is controlled by the main function switch which automatically routes the correct signal to the counter for measurement. When tuning the signal generator or monitoring a transmitter output the counter is used to measure radio frequencies but it also measures audio frequencies from the a.f. generator or modulation monitor sections. Sockets are also provided for measurement of the frequency of external signals.

A rapid warm-up, oven-controlled crystal oscillator provides the reference frequency for the counter and

also provides the comparison frequencies used in the phase-lock circuits associated with the signal generator.

AF Generator

A low distortion audio frequency generator provides six fixed frequencies between 300 Hz and 6 kHz as well as two variable frequency ranges covering the band 250 Hz to 7 kHz. Using the frequency counter the variable frequency can be set to an accuracy of ± 1 Hz.

The generator output can be used to modulate the signal generator output and is also available at a front panel socket for testing transmitters. Output level of the generator is monitored by the internal voltmeter and is continuously variable from less than 1 mV up to 3 volts in six switched ranges.

AF Voltmeter

The a.f. voltmeter section can be used to measure the audio signals developed by the receiver and also those derived from the modulation monitor section, allowing transmitter signal-to-noise ratio and modulation bandwidth measurements to be made. Voltages from 0 to 30 volts can be measured in eight switched bands over the frequency range 100 Hz to 20 kHz, and with a choice of four input impedances.

A filter with a CCITT P53 telephone psophometric weighting network is included for making the weighted measurements required in testing modern radio receivers.

Distortion Factor Meter

The distortion factor meter operates at a frequency of 1000 Hz, with an automatic levelling system overcoming the need for manual adjustment of level. Two distortion ranges are provided, 0 to 10% for receiver and transmitter modulation distortion measurements and 0 to 30% for SINAD indications associated with receiver sensitivity tests. Results of the distortion measurements are displayed on a meter which also has markings for 12 dB and 20 dB SINAD. For weighted distortion or SINAD measurements the CCITT P53 weighting network can be switched into circuit.

Modulation Monitor

Automatic levelling and frequency control are features of the modulation monitor which provides accurate measurement of amplitude, frequency and phase modulation over the carrier frequency range of 25 to 500 MHz, covering all radio telephone transmitter frequencies. Modulation is indicated on a panel meter, and a demodulated output is available at a front panel socket for external monitoring if desired. This demodulated output is also connected to an internal loudspeaker with volume control and on/off switch for audible monitoring.

RF Power Meter

RF power can be measured over the carrier frequency range of 25 to 520 MHz in two power ranges of 0 to 2 W, suitable for hand-held portable equipment, and 0 to 25 W for vehicle mounted transmitters and base station units. Higher powers can be measured by the use of external high power attenuators.

SIGNAL GENERATOR

FREQUENCY	
Range	400 kHz to 520 MHz in nine switched bands: 0.4 to 31 MHz 124 to 180 MHz. 31 to 45 MHz 176 to 260 MHz. 45 to 65 MHz 260 to 360 MHz. 62 to 90 MHz 360 to 520 MHz 88 to 130 MHz.
Indication	8 digit frequency counter.
Accuracy	As for frequency counter.
Resolution	Using 1 s gate time the resolution is 1 Hz up to 31 MHz and 10 Hz above. Using 0.1 s gate time the resolution is 10 Hz up to 31 MHz and 100 Hz above.
Stability	After 10 min operation at constant ambient temperature with the synchronizer switched on: $\pm 5 \times 10^{-7}$ per 30 min above 31 MHz. $\pm 5 \times 10^{-6}$ \pm 500 Hz per 30 min below 31 MHz. After 2 hours operation at constant ambient temperature with the synchronizer switched off: $\pm 5 \times 10^{-5}$ per 5 min above 31 MHz. $\pm 5 \times 10^{-5}$ \pm 500 Hz per 5 min below 31 MHz.
Synchronization	When the synchronizer is switched on, touching the main tuning control automatically inhibits the synchronizing system allowing manual tuning. The generator reverts to synchronized operation when the control is released.
FM/PHASE MODULATION	
FM ranges	0 to 5 kHz and 0 to 25 kHz peak deviation.
Phase modulation ranges	0 to 2.5 radians and 0 to 10 radians.
Accuracy	$\pm 5\%$ f.s.d. at 1 kHz modulation frequency.
Modulation frequency range	250 Hz to 7 kHz derived from internal a.f. generator or from external source.
Modulation distortion	Less than 1% total harmonic distortion at 1 kHz modulation frequency.
AMPLITUDE MODULATION	
AM range	0 to 100% full scale.
Accuracy	$\pm 5\%$ modulation depth at 1 kHz for indications up to 80%. Usable at reduced accuracy up to 90%.
Modulation frequency range	250 Hz to 7 kHz derived from internal a.f. generator or from external source.
Modulation distortion	At 1 kHz modulation frequency less than 1% t.h.d. for a.m. up to 50%; less than 2% t.h.d. for a.m. up to 80%.
OUTPUT	
Indicated level	0.1 μ V to 200 mV p.d. from direct output socket. 0.01 μ V to 20 mV p.d. from normal connecting socket.
Calibration	dB μ V, μ V and mV e.m.f. or p.d., switch selected.
Accuracy (above 2 μ V e.m.f.)	± 2.5 dB total level accuracy at normal output socket (with selector switch in e.m.f. calibration position).
Impedance	50 Ω . VSWR at normal output socket is less than 1.15:1.

Protection	Normal output socket is automatically protected by the 25 W power attenuator. The direct output socket is protected by a relay which automatically disconnects the generator from the socket when an overload is detected. The relay resets after the overload is removed.
Leakage	Up to 520 MHz with a receiver sensitivity set at 1 μ V, a 25 mm diameter 2 turn loop feeding the receiver cannot detect a signal of this level at a distance greater than 25 mm from the generator. This permits measurements to be made on receivers with sensitivities down to 0.1 μ V.
IF Probe output	A 2-pin, non-reversible DIN 41529 connector fitted to the front panel provides a d.c. output supply of 20-7 V for the optional IF Probes.
SPURIOUS SIGNALS	
Harmonically related signals	Not worse than 30 dB relative to the carrier.
FM on CW	With telephone psophometric weighting the equivalent deviation is less than 20 Hz.
AM on CW	With telephone psophometric weighting, less than 0.1% equivalent modulation depth.
AM on FM	Less than 1% equivalent modulation depth for a deviation of 25 kHz at a modulation frequency of 1 kHz.
FM on AM	Less than 200 Hz equivalent deviation for a modulation depth of 30% at a modulation frequency of 1 kHz.
Sideband noise	Better than 120 dB/Hz at an offset of 20 kHz from the carrier.

FREQUENCY COUNTER

INPUT	
Signal routing	Signals are automatically routed to the frequency counter within the test set. A switch allows the counter to be used to measure low level signals from external sources.
Sensitivity	<i>Internal routing:</i> an input level between 0.2 and 25 W to the central socket at frequencies between 25 and 520 MHz will allow the counter to function correctly. <i>High impedance input:</i> using a front panel control the sensitivity can be varied from 20 mV to 25 V for input signals in the range 10 Hz to 30 MHz. <i>Low impedance input:</i> 20 mV to 2 V for signals in the range 15 to 520 MHz.
Impedance	10 Hz to 30 MHz input: approximately 100 k Ω in parallel with 30 pF. 15 to 520 MHz input: 50 Ω nominal.
DISPLAY	
Eight digit with memory using seven segment LEDs of 10 mm height. Frequency indication in kHz with automatic positioning of the decimal point.	
FREQUENCY	
Range	10 Hz to 520 MHz.
Resolution	Using the 1 s gate time a resolution of 1 Hz is obtained for the 10 Hz to 30 MHz input and 10 Hz for the 15 to 520 MHz input. Use of the 0.1 s gate time provides resolutions of 10 Hz and 100 Hz respectively.

Accuracy ± 1 count \pm stability of frequency standard.

FREQUENCY STANDARD

Type A fast warm-up 5 MHz crystal oscillator contained in a proportionally controlled oven.

Short term stability ± 5 in 10^{10} in a 1 s time interval.

Long term stability ± 5 in 10^8 over a period of 24 hours.

Ageing rate 3 in 10^9 per day after 30 days continuous operation.

Temperature stability ± 1 in 10^7 over the temperature range 13 to 33°C.

Stability with supply variations ± 1 in 10^8 for a.c. supply variations of $\pm 10\%$ around 110 or 220 V.

Warm-up time Stabilizes to within 1 in 10^6 of the final frequency in 5 min from switch on, and to within 1 in 10^7 of the final frequency after 10 min from switch on.

AF GENERATOR

FREQUENCY

Range 250 Hz to 7 kHz with two variable frequency ranges (0.25 to 1.3 kHz and 1.3 to 7 kHz) and six fixed frequencies (300, 400, 1000, 2700, 3000 and 6000 Hz).

Accuracy ± 1 Hz using the frequency counter. Fixed frequencies are set to an accuracy of better than $\pm 1\%$ during manufacture.

OUTPUT

Level 0 to 3 V in six switched ranges with full scale values of 10, 30, 100, 300 mV, 1 and 3 V. A variable control allows precise output level settings to be made.

Monitor Output level is automatically monitored by the internal audio voltmeter.

Accuracy $\pm 3\%$ of f.s.d. using the internal voltmeter.

Distortion Less than 0.3% at 1 kHz.

Impedance 40 Ω nominal.

AF VOLTMETER

VOLTAGE

Range 0 to 30 V in eight switched ranges with full scale indication of 10, 30, 100, 300 mV, 1, 3, 10 and 30 V. The dB scale indicates from -60 to +32 dBm in 600 Ω .

Accuracy $\pm 3\%$ of f.s.d.
+20 dB switch Increases voltmeter sensitivity by 20 dB and automatically disables the signal generator modulation so that the 20 dB signal to noise ratio of a receiver may be checked.

Filter A CCITT telephone noise weighting filter may be switched into circuit to make weighted noise measurements.

INPUT

Frequency range 0.1 to 20 kHz.

Impedance 4, 200, 600 Ω and 100 k Ω switch selected.

Maximum input levels 4 Ω impedance: 4 V.

200 Ω impedance: 10 V.

Other impedances: 30 V.

Selection

The voltmeter may be used to monitor signals present at the AF Voltmeter input socket or from the modulation monitor.

DISTORTION FACTOR METER

DISTORTION

Ranges Two single ranges, with 10% and 30% full scale indications.

Accuracy $\pm 7\%$ of f.s.d.

Frequency 1 kHz.

SINAD Marks are provided on the 30% distortion scale showing 12 dB and 20 dB SINAD ratio values.

INPUT

Selection A switch allows the distortion factor meter to monitor signals present at the AF Voltmeter terminals or from the modulation monitor.

Level Automatic level control obviates the need for reference level adjustments and operates over an input voltage range of 0.5 to 2 V at the AF Voltmeter input sockets and over the same level range derived from the output of the Modulation Monitor.

Filter A CCITT telephone noise weighting filter may be switched into circuit to make weighted noise measurements.

MODULATION MONITOR

FM/PHASE MODULATION MEASUREMENT

FM ranges 0 to 5 kHz and 0 to 25 kHz peak deviation.

Phase modulation ranges 0 to 2.5 radians and 0 to 10 radians.

Accuracy $\pm 5\%$ of f.s.d. ± 250 Hz (f.m.).
(at 1 kHz modulation rate) $\pm 5\%$ of f.s.d. ± 0.1 radians (phase mod.).
Frequency range 250 Hz to 7 kHz.

Signal-to-noise ratio Measured using a CCITT telephone noise weighting network relative to 3 kHz deviation:
Better than 50 dB for carrier frequencies up to 190 MHz and better than 45 dB for carrier frequencies up to 500 MHz.
Measured in a flat bandwidth of 250 Hz to 7 kHz and relative to 3 kHz deviation the ratio is:
Better than 45 dB for carrier frequencies up to 180 MHz and better than 40 dB for carrier frequencies up to 500 MHz.

AM MEASUREMENT

AM range 0 to 100% full scale.

Accuracy $\pm 5\%$ modulation depth for indications up to 80%. Usable at reduced accuracy up to 90%.

Frequency range 250 Hz to 7 kHz.

Signal-to-noise ratio Measured in a flat bandwidth of 250 Hz to 7 kHz and relative to 50% modulation depth the signal-to-noise ratio is better than 40 dB.

INPUT

Selection Switch selection of either a direct input socket or from a tapping on the 25 W load.

Impedance 50 Ω .

Frequency range	25 to 500 MHz in nine switched ranges, with continuous frequency coverage.
Sensitivity	Using the central input socket the modulation monitor will give a correct indication for input power levels between 0.1 and 25 W. Using the direct input socket the sensitivity is typically 10 mV for input frequencies up to 180 MHz and 20 mV for frequencies between 400 and 500 MHz.
Maximum input	25 W using the central input socket. 1 V using the direct input socket.
OUTPUT	
LF	250 mV to 2 V nominal for full-scale deflection from front panel socket, adjustable by a front panel control.
Loudspeaker	A built-in loudspeaker is provided for monitoring purposes and is controlled by a front panel on/off switch and volume control.

RF POWER METER

POWER	
Ranges	0 to 2 W and 0 to 25 W (the scale extends to 30 W).
Accuracy	± 5% of range.
INPUT	
Frequency range	25 to 520 MHz.
Impedance	50 Ω. VSWR less than 1:15:1.
Maximum input	25 W continuous rating.

GENERAL

SAFETY	Complies with IEC 348.
RADIO FREQUENCY INTERFERENCE	Conforms with the requirements of EEC Directive 76/889 as to limits of r.f. interference.
POWER REQUIREMENTS	
AC supply	215 to 240 V ± 6% or 105 to 120 V ± 6%; 45 to 60 Hz, 65 W.
DIMENSIONS AND WEIGHT	
Height	340 mm 13.4 in
Width	490 mm 19.3 in
Depth	375 mm 14.8 in
Weight	25 kg 55 lb

VERSIONS AND ACCESSORIES

When ordering please quote eight-digit code numbers

Ordering numbers 52952-900P	Versions AM/FM Radiotelephone Test Set 2952. 2952. NATO version. Ref. No. 6625-99-173-8083.
	Supplied Accessories Operating Manual 46881-366B (H52952-900P Vol. 1). Mains Lead.
54451-061Y 54451-071S 54451-121B 46881-367K 54451-167U	Optional Accessories IF Probe, 470 kHz. IF Probe, 10.7 MHz. IF Probe, 455 kHz. Service Manual (H52952-900P Vol. 2) High Impedance Counter Probe.

Made in West Germany

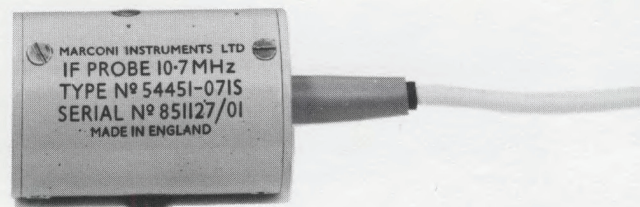
IF Probes

54451 series

- ☐ Range covers commonly-used intermediate frequencies
- ☐ Crystal-controlled oscillators simplify tuning to receivers

These three IF Probes consist of crystal-controlled oscillators available at the most commonly used intermediate frequencies. The probes are powered, via their attached leads, from supply outlets on the generators.

The probes make it easy to tune in to receivers fitted with squelch or battery economizer circuits by activating the receiver when they are brought into close proximity



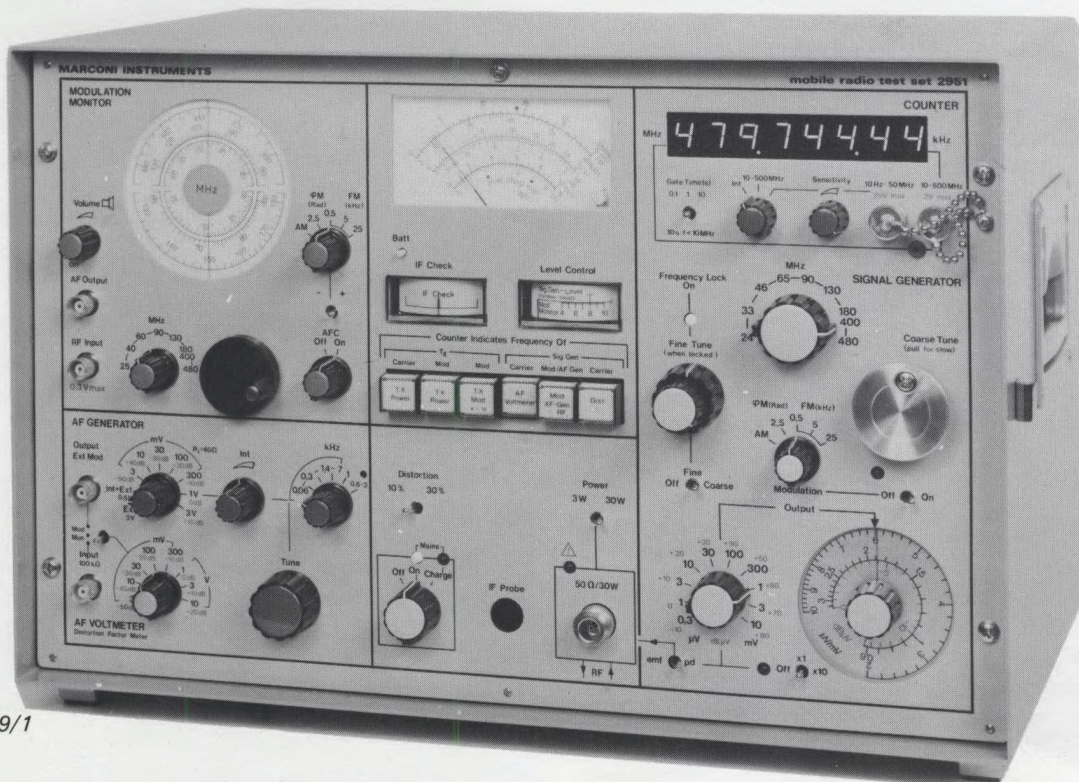
with the IF strip. A second use is for ensuring that the generator is accurately tuned to the r.f. circuits in the receiver. With the generator tuned to the nominal channel frequency any difference between the receiver i.f. and the probe frequency will produce a beat note in the receiver output. The generator tuning can then be adjusted to give zero beat.

ORDERING NUMBER	54451-121B	54451-061Y	54451-071S
NOMINAL FREQUENCY	455 kHz	470 kHz	10.7 MHz
FREQUENCY ACCURACY (at 20°C)	±1 in 10 ⁴	±1 in 10 ⁴	±2 in 10 ⁵
TEMPERATURE COEFFICIENT OF FREQUENCY (0 to 55°C)	Less than ±10 p.p.m. per °C	Less than ±10 p.p.m. per °C	Less than ±1 p.p.m. per °C

OUTPUT	Suitable for introducing a signal into the receiver IF strip by proximity of radiated r.f. field.
CONNECTOR	2-pin, non-reversible DIN 41529 to fit power socket on the generator.
POWER REQUIREMENTS	
DC supply	+19 V to +24 V, 2 mA. Obtained from socket on the generator via cable attached to probe.
DIMENSIONS	
Length	45 mm 1.75 in
Diameter	27 mm 1.06 in
Lead Length	1067 mm 42 in

Mobile Radio Test Set

2951



15259/1

- ☐ Combines all radio servicing instruments in one compact and portable unit
- ☐ AM, FM, and phase modulation measurements
- ☐ Semi and full duplex measurements
- ☐ Built-in synchronizer for high stability
- ☐ Operates from a.c. supply, external battery or internal rechargeable battery
- ☐ Ideal for field and workshop measurements on hand-held, mobile and base station radio telephones
- ☐ Facility for summing external and internal AF source
- ☐ Sub-audio tone facility down to 60 Hz

2951 is a comprehensive test set combining in one case all of the measurement facilities required for testing mobile radio equipment in the v.h.f. and u.h.f. bands. Its main application will be for maintenance and servicing of hand-held, mobile and base station simplex and duplex radio telephones using frequency, amplitude or phase modulation and having sub-audio tone access facilities.

Seven separate instruments are included in the test set: signal generator, frequency counter, a.f. generator, a.f. voltmeter, distortion factor meter, modulation selector and r.f. power meter. The function selector switches organise all the necessary interconnections eliminating the need for the many

external connections required when separate instruments are used. Each instrument can also be operated independently as required. The front panel is divided into sections corresponding to the major facilities offered, with a layout designed to permit simple and rapid operation.

Signal Generator

The signal generator covers seven frequency bands from 24 to 180 MHz and from 400 to 480 MHz, with the frequency being displayed on an eight-digit l.e.d. counter readout. A switchable frequency synchronizer is included to give high frequency stability. When the generator is

operating in the synchronized mode, touching the main COARSE TUNE control automatically disables the synchronizer to allow full manual tuning. Releasing the control causes the synchronizer to regain control and stabilize the output frequency. Fine tuning can then be carried out with the FINE TUNE control. The ability to be able to alter the output frequency while the instrument is operating under locked conditions is particularly useful when bandwidth measurements are being made on a receiver.

RF output level is controlled by a ten-stage divider giving outputs from 0.1 μ V to 100 mV, switch selected for e.m.f. or p.d. across 50 Ω output level is displayed on a meter.

Comprehensive modulation facilities include amplitude, frequency and phase modulation. The modulation source can be either the internal a.f. generator with three variable frequency ranges, one fixed frequency and one pre-settable frequency, or an external source. The external and internal sources can be added for either two-tone or sub-audio access modulation tests. Modulation frequency can be displayed on the counter and modulation level on the meter. A modulation on/off switch is included to assist in making signal-to-noise ratio checks.

Operation of the signal generator is totally independent of the other instruments, so the generator can provide an output signal at one frequency while simultaneous modulation or power measurements are made at another frequency. This permits true duplex measurements to be made on systems including a duplexer.

An output socket is fitted to provide a power supply for the range of oscillator probes available as optional accessories to assist in tuning to receivers fitted with squelch or battery economizer circuits.

Frequency Counter

A built-in frequency counter operates over the frequency range 10 Hz to 500 MHz with frequency indication by an eight digit l.e.d. display. When used in its internal mode signals are automatically routed to the counter for measurement. It can measure generator carrier frequency, or signals from the a.f. generator, modulation monitor or r.f. power meter. The counter can also be used to measure signals from an external source.

A rapid warm-up, oven-controlled crystal oscillator provides the reference frequency for the counter and also provides the comparison frequencies used in the phaselock circuits associated with the signal generator.

AF Generator

The a.f. generator provides three variable frequency ranges covering 60 Hz to 7 kHz, a single 1 kHz fixed frequency and one front panel screw-slot presettable frequency in the range 0.6 to 3 kHz.

An external audio source can be added to, or used instead of, the internal AF generator.

The generator output can be used to modulate the signal generator output and is also available at a front panel socket for testing transmitters. Output level of the

generator is monitored by the internal voltmeter and is continuously variable in seven switched ranges from 3 mV to 3 V full scale.

AF Voltmeter

The a.f. voltmeter section can be used to measure the audio signals developed by the receiver and also those derived from the modulation monitor section, allowing transmitter signal-to-noise ratio and modulation bandwidth measurements to be made. Voltages from 0 to 10 volts from external sources can be measured in eight switched bands over the frequency range 60 Hz to 20 kHz. A three-position switch routes the a.f. voltmeter to measure the level at the input socket, the a.f. generator volts or the modulation monitor a.f. output level.

Distortion Factor Meter

The distortion factor meter operates at a frequency of 1 kHz, with an automatic levelling system overcoming the need for manual adjustment of level. Two distortion ranges are provided: 1 to 10% for receiver and transmitter modulation measurements and 0 to 30% for SINAD indications associated with receiver sensitivity tests. Results of the distortion measurements are displayed on a meter which also has markings for 12 dB and 20 dB SINAD.

Modulation Monitor

Automatic levelling and frequency control are features of the modulation monitor which provides accurate measurement of amplitude, frequency and phase modulation over the carrier frequency ranges of 25 to 180 MHz and 400 to 480 MHz. Modulation level is indicated on a panel meter and the modulation frequency is displayed on the counter readout. A demodulated output is available at a front panel socket for external monitoring if desired. This demodulated output is also connected to an internal loudspeaker with volume control and on/off switch for audible monitoring.

RF Power Meter

RF power can be measured over the frequency range of 25 to 500 MHz in two power ranges of 0 to 3 W, suitable for hand-held portable equipment, and 0 to 30 W for vehicle mounted transmitters and base station units.

Power Supply

A front panel switch with three positions – OFF, ON and CHARGE – controls the power supply to the test set. When connected to the mains and switched to the ON position, the internal batteries are automatically trickle charged by the mains. When the switch is moved to the CHARGE position the batteries are placed on charge but the test set itself is switched off. Protection circuits are fitted to prevent overcharging and to prevent excessive discharge of the battery. The condition of the battery at any time can be checked by means of the front panel BATT push button. The battery "state" is then shown on the test set's main meter.

SIGNAL GENERATOR

FREQUENCY	24 to 180 MHz and 400 to 480 MHz in seven switched bands:
Range	24 to 33 MHz. 33 to 46 MHz. 46 to 65 MHz. 65 to 90 MHz. 90 to 130 MHz. 130 to 180 MHz. 400 to 480 MHz.
Indication	8 digit frequency counter.
Accuracy	As for frequency counter.
Resolution	Using 10 s gate time resolution is 1 Hz. Using 1 s gate time resolution is 10 Hz. Using 0.1 s gate time resolution is 100 Hz.
Fine tuning (when synchronized)	<i>Fine:</i> 0.02% of carrier. <i>Coarse:</i> 0.08% of carrier.
Stability	With synchronizer switched on and after 10 minutes warm-up, the frequency drift will be better than 2×10^{-7} per 10 minute period.
Synchronization	When the synchronizer is switched on, touching the main tuning control automatically inhibits the synchronizing system allowing manual tuning. The generator reverts to synchronized operation when the control is released.
FM/PHASE MODULATION	
FM ranges	0 to 500 Hz, 0 to 5 kHz and 0 to 25 kHz peak deviation.
Phase modulation range	0 to 2.5 radians.
Accuracy	$\pm 5\%$ f.s.d. at 1 kHz modulation frequency.
Modulation frequency range	60 Hz to 7 kHz derived from internal a.f. generator or from external source.
Modulation distortion	Less than 1.5% total harmonic distortion at 1 kHz modulation frequency up to 15 kHz deviation and less than 2% total harmonic distortion up to 25 kHz deviation.
AMPLITUDE MODULATION	
Carrier frequency range	24 to 180 MHz.
AM range	0 to 90%.
Accuracy	$\pm 7\%$ f.s.d. at 1 kHz modulation frequency.
Modulation frequency range	300 Hz to 7 kHz derived from internal a.f. generator or from external source.
Modulation distortion	At 1 kHz modulation frequency: Less than 2% t.h.d. for a.m. up to 30%. Less than 5% t.h.d. for a.m. up to 80%.
OUTPUT	
Indicated level	0.1 μ V to 100 mV p.d. or e.m.f. as selected by front panel switch.
Fine attenuator	<i>Range:</i> 15 dB continuously variable. <i>Accuracy:</i> ± 1.0 dB.
Coarse attenuator	<i>Range:</i> 90 dB in 10 dB steps. <i>Accuracy:</i> ± 1.5 dB.
Calibration	Direct reading in μ V or mV.
Protection	Central socket automatically protected by the 30 W power attenuator.
Impedance	50 Ω . VSWR less than 1.15 : 1 (typically less than 1.1 : 1).
Leakage	With a receiver sensitivity set at 1 μ V, a 25 mm diameter 2 turn loop feeding the receiver cannot detect a signal of this level at a distance greater than 25 mm from the generator. This permits measurements to be made on receivers with sensitivities down to 0.1 μ V.

IF Probe output	A 2-pin non-reversible DIN 41529 connector fitted to the front panel provides a d.c. output supply of 15 V for the optional i.f. probes.
SPURIOUS SIGNALS	
Harmonically related signals	Better than -25 dBc (typically -30 dBc).
FM on CW	With telephone psophometric weighting equivalent deviation is less than 20 Hz.
AM on CW	With telephone psophometric weighting less than 0.1% equivalent modulation depth.
AM on FM	Less than 1% equivalent modulation depth for a deviation of 25 kHz at a modulation frequency of 1 kHz.
FM on AM	Less than 200 Hz equivalent deviation for a modulation depth of 30% at a modulation frequency of 1 kHz.
Sideband noise	Better than -115 dBc/Hz at an offset of 20 kHz from the carrier.

FREQUENCY COUNTER

INPUT	
Signal routing	Signals are automatically routed to the frequency counter within the test set. A switch allows the counter to be used to measure low level signals from external sources.
Sensitivity	<i>Internal routing:</i> an input level between 0.1 and 30 W to the central socket at frequencies between 10 MHz and 500 MHz will allow the counter to function correctly. <i>High impedance input:</i> using a front panel control the sensitivity can be varied from 20 mV to 25 V for input signals in the range 10 Hz to 50 MHz. <i>Low impedance input:</i> 20 mV to 2 V for signals in the range 15 to 500 MHz.
Impedance	<i>10 to 500 MHz input:</i> 50 Ω nominal. <i>10 Hz to 50 MHz input:</i> high impedance (> 30 k Ω) in parallel with 100 pF.
DISPLAY	Eight digit with memory using seven segment LED's of 10 mm height. Frequency indication in kHz and MHz with automatic positioning of the decimal points.
FREQUENCY	
Range	10 Hz to 500 MHz.
Resolution	Using the 10 second gate time a resolution of 0.1 Hz is obtained for the 10 Hz to 50 MHz input (cut off < 10 MHz) and 1 Hz for the 10 to 500 MHz input. Using the 1 second gate time a resolution of 1 Hz is obtained for the 10 Hz to 50 MHz input and 10 Hz for the 10 to 500 MHz input. Use of the 0.1 second gate time provides resolutions of 10 Hz and 100 Hz respectively.
Accuracy	± 1 count \pm stability of frequency standard.
FREQUENCY STANDARD	
Type	Crystal oscillator: a fast warm-up 5 MHz crystal oscillator contained in a proportionally controlled oven and having the following specifications.
Short-term stability	$\pm 5 \times 10^{-10}$ in a 1 s time interval.
Long-term stability	$\pm 5 \times 10^{-8}$ over a period of 24 h.
Ageing rate	3×10^{-9} per day after 30 days continuous operation.

Temperature stability	$\pm 1 \times 10^{-7}$ over the temperature range 13 to 33°C.
Stability with supply variations	$\pm 1 \times 10^{-8}$ for a.c. supply variations of $\pm 10\%$ around 110 and 220 V.
Warm-up time	Stabilizes to within 1×10^{-6} of the final frequency in 5 min. from switch on and within 1×10^{-7} of the final frequency after 10 min. from switch on.

AF GENERATOR

FREQUENCY	Range	60 Hz to 7 kHz with three variable frequency ranges (60 to 300 Hz, 0.3 to 1.4 kHz and 1.4 to 7 kHz), a fixed frequency of 1 kHz and a screw-slot presettable frequency in the range 0.6 to 3 kHz.
	Accuracy	Using frequency counter ± 0.1 Hz. Fixed frequencies are set to an accuracy of better than $\pm 2\%$ during manufacture.
OUTPUT	Level	Seven switched ranges 3, 10, 30, 100, 300 mV, 1 and 3 V f.s.d. Calibrated also from -70 to +12 dBm into 600 Ω .
	Accuracy	$\pm 3\%$ of f.s.d.
	Distortion	Less than 0.8% t.h.d.
	Impedance	40 Ω nominal on all ranges.

AF VOLTMETER

VOLTAGE	Ranges	0 to 3, 10, 30, 100, 300 mV, 1, 3, 10 V. Calibrated also from -70 to +22 dBm into 600 Ω .
	Accuracy	$\pm 3\%$ of f.s.d.
INPUT	Frequency range	60 Hz to 20 kHz.
	Impedance	100 k Ω nominal.

DISTORTION FACTOR METER

Ranges	0 to 10%, 0 to 30%.
Accuracy	7% of f.s.d.
Frequency	1 kHz.
SINAD	Marks are provided on the 30% distortion scale showing 12 dB and 20 dB SINAD ratio values.

MODULATION MONITOR

FM/PHASE MODULATION MEASUREMENT	
FM ranges	0 to 500 Hz, 0 to 5 kHz and 0 to 25 kHz peak deviation.
Phase modulation range	0 to 2.5 radians.
Accuracy	$\pm 5\%$ of f.s.d. at 1 kHz modulation frequency.
Frequency range	60 Hz to 7 kHz.
Signal-to-noise ratio	Better than 35 dB relative to 3 kHz deviation for carrier frequencies up to 180 MHz and better than 30 dB for carrier frequencies up to 470 MHz. Measured using a CCITT telephone noise weighting network.

AM MEASUREMENT

AM range	0 to 90% modulation depth.
Accuracy	$\pm 7\%$ f.s.d. at 1 kHz modulation frequency.
Frequency range	300 Hz to 7 kHz.
Signal-to-noise ratio	Better than 35 dB relative to 30% a.m. for carrier frequency up to 180 MHz. Measured using a CCITT telephone noise weighted network.

INPUT

Selection	Switch selection of either a direct input socket or from a tapping on the 30 W load.
Impedance	50 Ω nominal.
Frequency range	25 to 180 MHz and 400 to 480 MHz in six switched bands: 25 to 40 MHz. 40 to 60 MHz. 60 to 90 MHz. 90 to 130 MHz. 130 to 180 MHz. 400 to 480 MHz.

Sensitivity: AM/FM/Phase via the central socket

The modulation monitor will give a correct indication for input power levels between 0.1 W and 30 W.

via the direct input socket

The sensitivity is typically 10 mV for input frequencies up to 180 MHz. For FM and phase modulation only the sensitivity is 20 mV for frequencies between 400 and 480 MHz.

Frequency response Maximum input

From 300 Hz to 5 kHz flat within ± 0.2 dB.
30 W using central input socket.
300 mV using direct input socket for a.m.
1 V using direct input socket for f.m.

OUTPUT

LF	0 to 1 V nominal from the front panel socket, dependent on the level of modulation.
Loudspeaker	A built-in loudspeaker is provided for monitoring purposes and is controlled by a front panel on/off switch and volume control.

RF POWER METER

Frequency range	25 to 500 MHz.
Power range	0 to 3 W, 0 to 30 W.
Minimum indication	20 mW.
Accuracy	$\pm 8\%$ f.s.d.

LOAD (Central socket)

Impedance	50 Ω , VSWR less than 1.15 : 1 (typically 1.1 : 1).
Maximum input	30 W.

GENERAL

SAFETY RADIO FREQUENCY INTERFERENCE

Complies with IEC 348.

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