

Contains

Operating Manual

for

COMMUNICATIONS SERVICE MONITOR

2945A

**Part number 46882-311D
Issue 4**

Creation date 11-Nov-99

COMMUNICATIONS SERVICE MONITOR 2945A

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About this manual

This manual explains how to use the Communications Service Monitor 2945A. It applies to instruments fitted with main software version 4.xx and cellular software version 4.xx.

Intended audience

People who need to test mobile radio systems and associated equipment.

Structure

Chapter 1

General information and performance specification.

Chapter 2

Gives installation instructions, including connection of peripheral equipment.

Chapter 3

Operating instructions. Setting up and use.

Chapter 4

Brief technical description.

Chapter 5

Acceptance testing procedure for the Service Monitor.

Appendix A

Use of the Directional Power Heads, 54421/002 and 54421/003.

Appendix B

Use of the Light-weight Directional Power Heads 54421/016 and 54421/018.

Document conventions

The following conventions apply throughout this manual:-

[Tx TEST]	Hard key titles are shown verbatim, using normal lettering in square brackets.
[Tx freq]	Soft key titles are shown verbatim using italic lettering in square brackets.
RF IN/OUT	Titles on the instrument panels are shown verbatim using capital letters.
	Text displayed on screen. See below [†]

[†] References to text displayed on the screen of the Service Monitor are given verbatim, using a font that resembles the displayed text. e.g. GEN FREQ: , Ref Level: , **Ref Level:**

Associated publications

Other manuals that cover specific aspects of this service monitor are:-

- Programming Manual (46882-318B) provides programming information for remote control of the Service Monitor using MI-BASIC and GPIB.
- Maintenance Manual (46882-310W) provides servicing information for the Communications Service Monitor 2945A and Avionics Communication Service Monitor 2946A.

contd./...

About this manual (continued)

Associated publications (continued)

Operating manual supplements provide operating details for specific system test software.

- **EDACS Repeater** (46882-300N)
- **AMPS Supplement** (46882-313P)
- **PMR Supplement** (46882-315M)
- **MPT1327 Supplement** (46882-317R)
- **EDACS Radio Supplement** (46882-301L)
- **TACS Supplement** (46882-314X)
- **NMT Supplement** (46882-316C)

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Precautions

WARNING

CAUTION

Note

These terms have specific meanings in this manual:

WARNING

information to prevent personal injury.

CAUTION





information to prevent damage to the equipment.

Note

important general information.

Hazard symbols

The meaning of hazard symbols appearing on the equipment is as follows:

Symbol	Description
	General hazard
	Dangerous voltage
	Toxic hazard
	Hot surface

General conditions of use

This product is designed and tested to comply with the requirements of IEC/EN61010-1 'Safety requirements for electrical equipment for measurement, control and laboratory use', for Class I portable equipment and is for use in a pollution degree 2 environment. The equipment is designed to operate from an installation category I or II supply.

Equipment should be protected from the ingress of liquids and precipitation such as rain, snow, etc. When moving the equipment from a cold to a hot environment, it is important to allow the temperature of the equipment to stabilise before it is connected to the supply to avoid condensation forming. The equipment must only be operated within the environmental conditions specified in Chapter 1 'Performance data', otherwise the protection provided by the equipment may be impaired.

This product is not approved for use in hazardous atmospheres or medical applications. If the equipment is to be used in a safety-related application, e.g. avionics or military applications, the suitability of the product must be assessed and approved for use by a competent person.

WARNING



Electrical hazards (AC supply voltage)

This equipment conforms with IEC Safety Class I, meaning that it is provided with a protective grounding lead. To maintain this protection the supply lead must always be connected to the source of supply via a socket with a grounded contact.

Be aware that the supply filter contains capacitors that may remain charged after the equipment is disconnected from the supply. Although the stored energy is within the approved safety requirements, a slight shock may be felt if the plug pins are touched immediately after removal.

Do not remove covers, no user serviceable parts inside. See list of IFR Ltd International Service Centres at rear of manual.

Fuses

Note that the internal supply fuse is in series with the live conductor of the supply lead. If connection is made to a 2-pin unpolarized supply socket, it is possible for the fuse to become transposed to the neutral conductor, in which case, parts of the equipment could remain at supply potential even after the fuse has ruptured.

WARNING



Fire hazard

Make sure that only fuses of the correct rating and type are used for replacement.

If an integrally fused plug is used on the supply lead, ensure that the fuse rating is commensurate with the current requirements of this equipment. See under 'Performance Data' in Chapter 1 for power requirements.

WARNING



Toxic hazards

Some of the components used in this equipment may include resins and other materials which give off toxic fumes if incinerated. Take appropriate precautions, therefore, in the disposal of these items.

WARNING



Lithium

A Lithium battery (or a Lithium battery contained within an IC) is used in this equipment:

As Lithium is a toxic substance, the battery should in no circumstances be crushed, incinerated or disposed of in normal waste.

Do not attempt to recharge this type of battery. Do not short circuit or force discharge since this might cause the battery to vent, overheat or explode.

WARNING



Beryllium copper

Some mechanical components within this instrument are manufactured from beryllium copper. This is an alloy with a beryllium content of approximately 5%. It represents no risk in normal use.

The material should not be machined, welded or subjected to any process where heat is involved.

It must be disposed of as "special waste".

It must NOT be disposed of by incineration.

WARNING



Lead-acid battery pack

Battery usage

A lead-acid battery pack is supplied with the instrument as an accessory. This contains both lead and sulphuric acid. Lead is a toxic substance and sulphuric acid is corrosive and a skin irritant which can cause chemical burn damage to exposed skin. The battery pack should in no circumstances be disposed of in normal waste.

Do not charge at an ambient temperature of greater than 40°C.

Do not dispose of in a fire. Do not short circuit. Do not crush, puncture, open, dismantle or otherwise mechanically interfere with. Do not store at temperatures in excess of 60°C.

Do observe the correct polarity and connect correctly.

During normal service, small quantities of hydrogen and oxygen may be vented from the battery pack. Adequate ventilation must be provided around the instrument to allow these gases to disperse naturally.

The battery pack must only be charged using the charging facility in the instrument, or by using an approved sealed lead-acid battery charger.

The normal 'End of Life' condition is reached when capacity of the battery pack falls to 50% of its rated capacity. This is shown in the performance specification in Chapter 1 of this manual. Battery packs should be withdrawn from service when this condition is reached.

Battery storage

Any sealed lead-acid battery naturally self-discharges when in storage. Its service life and capacity may be adversely affected if it becomes over-discharged. Refer to the performance specification in Chapter 1 of this manual for storage time and conditions.

Stored battery packs should be periodically 'Top Charged' to optimize performance and service life. Before 'Top Charging', the open circuit voltage must be measured, and if this is below the minimum shown in the performance specification in chapter 1 of this manual, the battery pack must not be recharged.

WARNING



Hot Surfaces

Take care when touching the RF Input Type N connector after the application of high levels of continuous power. If 50 W is exceeded for a prolonged period, the temperature of the connector can become excessive.

WARNING



RF hazard

When measuring high VSWR ratios, hazardous voltages may be present on the line due to standing waves. Under these conditions, it is dangerous to operate the equipment with the covers removed.

WARNING



Tilt facility

When the equipment is in the tilt position, it is advisable, for stability reasons, not to stack other equipment on top of it.

Chapter 1

GENERAL INFORMATION

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Purpose and features

2945A is a portable Communications Service Monitor for carrying out production, routine and maintenance testing on radio transmitters, receivers and two way radio communication equipment. The Service Monitor contains modules to provide facilities equivalent to the following instruments:-

RF generator, two audio generators, specialised tones generator, RF power meter, modulation meter, RF counter, AF counter, AF voltmeter, distortion meter, large screen digital oscilloscope, spectrum analyzer and monitoring receiver.

Distortion measuring filters, AF post demodulation filters and IF passband filters, are built in for inclusion in relevant measurement paths.

The signal obtained from the demodulators, when in Tx test mode, is fed to an AF amplifier and can be monitored on the built-in loudspeaker, on headphones connected to the accessory socket, or taken from the DEMOD OUT connector to other equipment.

The monitor has a wide range of test capabilities including base station, mobile and transponder commissioning and servicing, radio telephone system and radio pager testing, as well as production testing to all of the above.

The selection of a test mode configures the modules into set-ups ready for connection to the equipment to be tested and produces the appropriate set-up screen on the display. The set-up screen shows the settings of the active modules, records changes to settings as they are made and gives readouts of test results both digitally and on barcharts.

The modules of the monitor can each be used to perform as individual test instruments.

A hard copy of most screens can be made to a suitable printer using the screen capture feature. This is one of the functions accessed after pressing the [DISPLAY HOLD] key on the front panel. See Front panel layout, DISPLAY HOLD key, in Chapter 3.

A memory facility allows instrument settings and test results to be stored within the instrument. With the memory card option fitted, these can be stored on memory cards. This also allows settings to be exchanged between instruments.

The memory card option also includes a real time clock which provides date/time stamping to stored results and to screen-capture printouts.

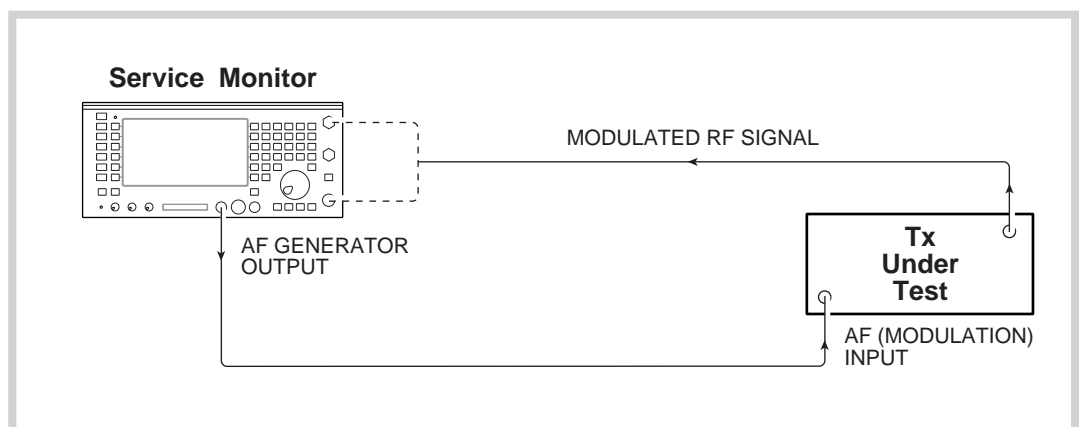
The RS232 control facility permits operation of the instrument by remote or automatic control as an alternative or supplement to the conventional front panel local control.

IEEE 488.2 GPIB remote control is available as an option.

RS232 and GPIB control facilities are detailed fully in the Programming Manual supplied.

The test modes are outlined in the following descriptions, with interconnection diagrams showing the principles of the test procedures.

Transmitter testing



C3240

Fig. 1-1 Transmitter test setup

The transmitter test procedure uses:-

The AF generators, to provide a source of modulation for the transmitter under test.

The RF power meter, to measure the mean output power level of the transmitter.

The RF counter, to obtain the mean RF frequency of the transmitter output.

The modulation meter, to measure the modulation depth or the deviation level and to provide a demodulated output signal. Single sideband transmissions can be demodulated when the SSB option is implemented.

The AF counter, to measure the frequency of the demodulated signal.

The distortion meter, to obtain the signal to noise level, the modulation distortion percentage or the modulation SINAD level of the transmitter.

The oscilloscope, to view the demodulated signal and to measure the modulation levels.

The tones generator, to modulate transmitters of systems using tone calling.

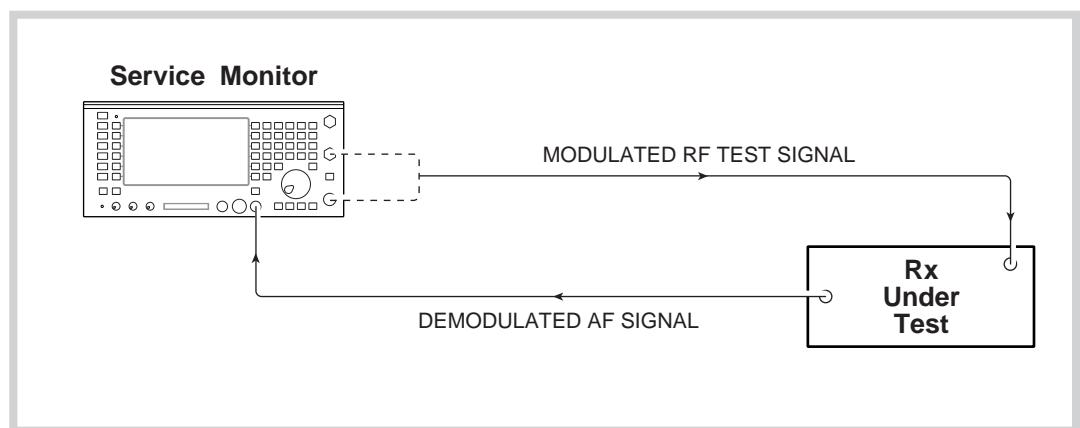
The tones decoder, to demodulate tones generated by the transmitter.

The AF amplifier and loudspeaker, to monitor the demodulated signal.

Cellular radio-telephones can be tested using the SYSTEMS mode. (See 'System testing').

The spectrum analyzer facility, which is a separate operating mode (SPEC ANA), can be used to study the sidebands and any harmonics produced by the transmitter, either by direct connection or by off-air monitoring.

Receiver testing



C3241

Fig. 1-2 Receiver test setup

The receiver test procedure uses:-

The RF generator and the AF generators, to produce a transmission with defined parameters.

The AF voltmeter, to measure the level of the demodulated signal from the receiver.

The distortion meter, to obtain signal-to-noise ratio, SINAD levels and distortion percentage figures.

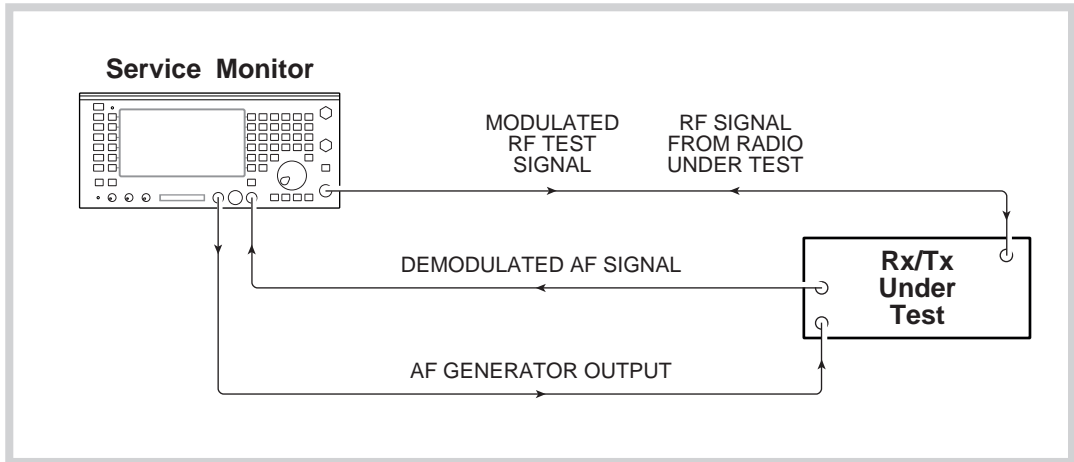
The tone generator and tone detector, to produce and decode specialised calling tones to test tone recognition circuits.

The oscilloscope, to view and measure the demodulated signal or other waveforms.

The RF signal from the Service Monitor is coupled to the receiver and the demodulated signal from the receiver taken to the AF input of the Service Monitor. By measuring the levels of the AF signal from the receiver, the sensitivity of the receiver can be checked. The distortion levels introduced by the receiver can be measured.

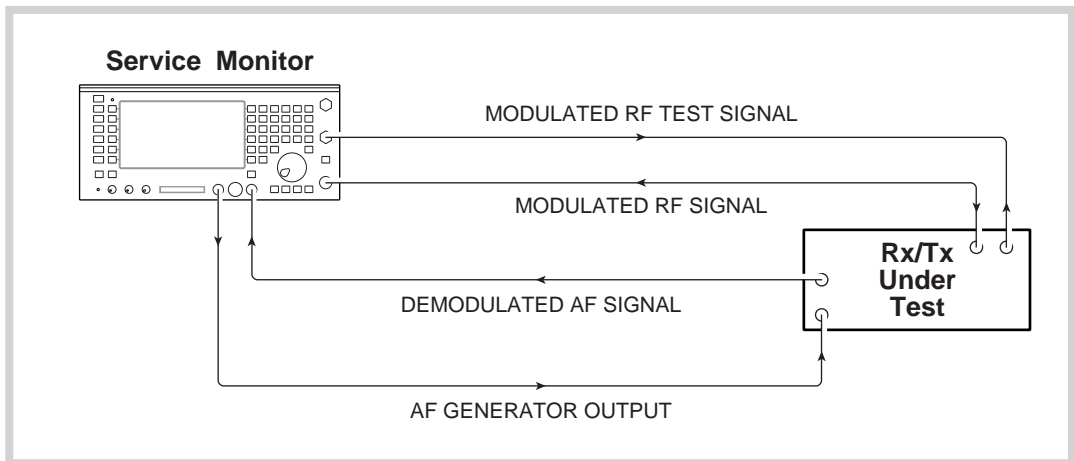
During all of the above procedures, the RF levels, the distortion levels and modulation levels can be displayed on bar charts as well as being provided as a digital read-out. The AF waveforms can also be studied using the digital oscilloscope facility.

Duplex testing



C3242

Fig. 1-3 One port duplex test setup



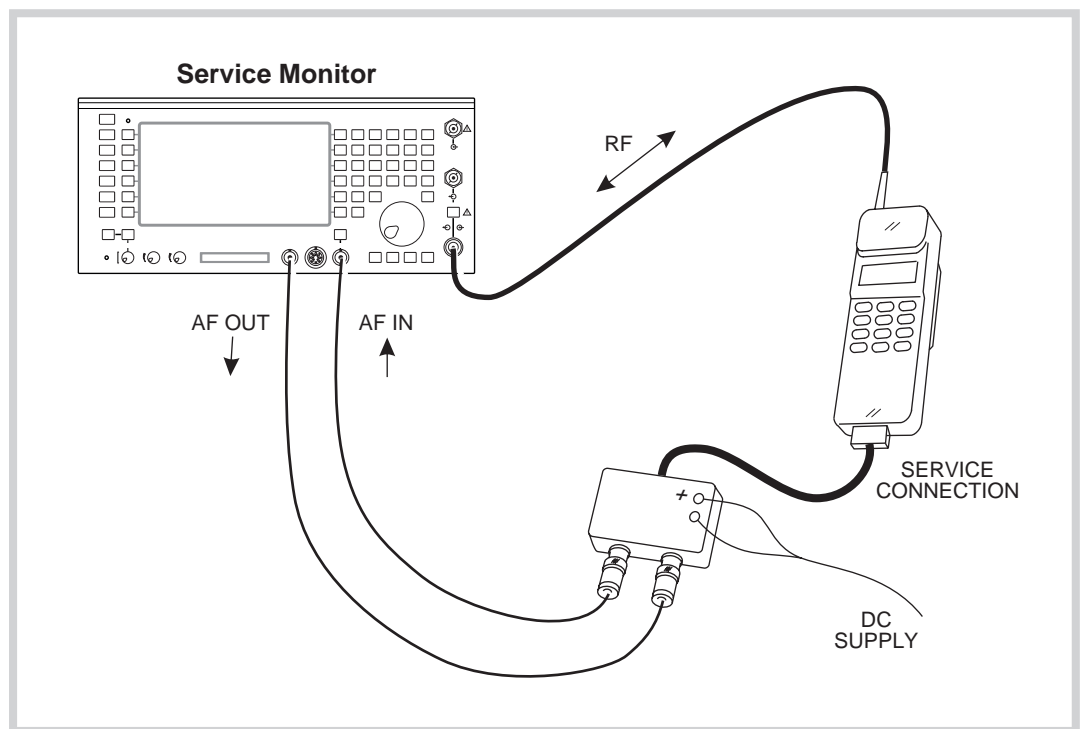
C3243

Fig. 1-4 Two port duplex test setup

Using the Duplex test facility, parameters for transmitter testing and receiver testing can be set-up and displayed on one screen. This gives the capability to study the performance of duplex transceivers. Both one port and two port units can be tested.

Systems testing

Cellular and trunked radio-telephone systems



C3253

Fig. 1-5 Cellular radio-telephone test setup

With the appropriate cellular or trunked mobile telephone option included, the monitor has built-in software to generate and interrogate signals of the various cellular or trunked telephone systems. This gives the facility for testing all aspects of these systems.

Inbuilt test programs and user programming facilities give speed and flexibility to these tests.

Operating instructions for each of the SYSTEM test options is given in separate supplements to this manual. These supplements are supplied, as appropriate, with instruments fitted with SYSTEM testing options.

Spectrum analyzer

The SPEC ANA mode allows 'off air' and directly coupled RF signals to be studied and monitored.

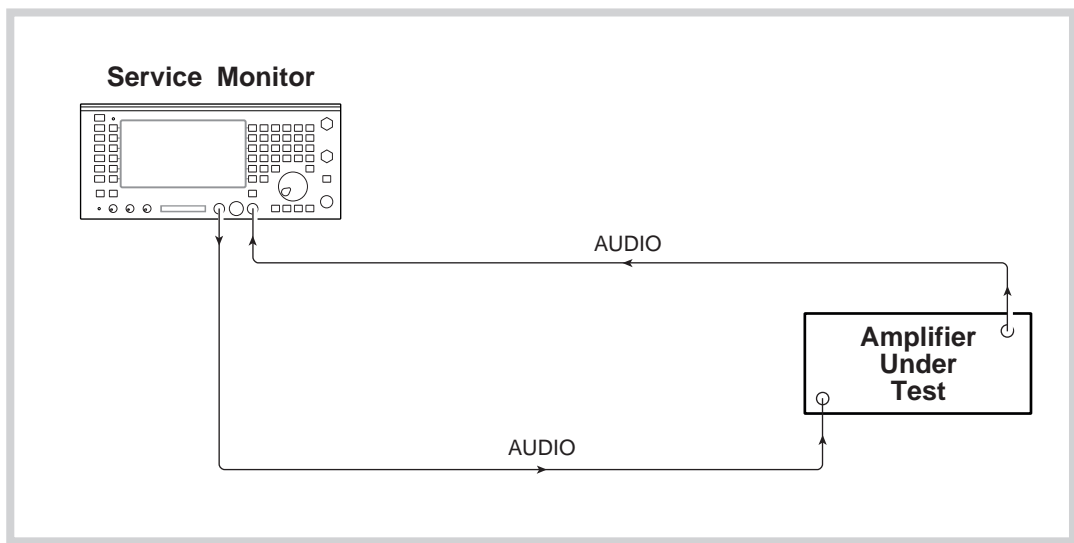
Sideband spread, harmonic levels and RF interference can be examined.

The frequency range of the spectrum analyzer is from 100 kHz to 1.0 GHz with the start and stop frequencies of the sweep infinitely variable from within this range.

The tracking generator permits frequency response tests to be made to frequency dependent circuits and the frequency offset facility extends this capability into the area of frequency shifting circuits, such as mixers.

The 'Look and Listen' function gives the ability to demodulate a signal displayed on the spectrum analyzer and monitor the signal obtained on the built-in loudspeaker, on headphones or other data output equipment.

AF testing



C3244

Fig. 1-6 AF test setup

The AF testing mode allows the dual AF generators and the tones generator to be used as a signal source. The AF voltmeter, distortion meter, bar chart displays and the AF counter can all be used to provide data relating to signals applied to the AF input connector. The digital oscilloscope is also available for studying AF waveforms.

Performance data

Receiver measurements

RF signal generator

Frequency

Range	400 kHz to 1.05 GHz
Resolution	10 Hz
Indication	10 digit display
Setting	Keyboard entry, delta increment / decrement function and rotary control
Accuracy	As frequency standard

Output Level

Range	Rx Test: N-Type socket: -141 dBm to -21 dBm BNC socket: -115 dBm to +5 dBm. (usable to +7 dBm)
Resolution	0.1 dB
Indication	4 digits plus sign (dBm, dB μ V, μ V, mV, PD/EMF).
Accuracy	± 2 dB for level above -127 dBm on N-Type socket up to 1 GHz

Reverse Power Protection

N-Type: 50 W for 10 minutes, normal operation. 150 W for 1 minute at 20°C.
Overload indicated by audible and visual warning.
BNC: 5 W Tripping indicated by audible and visual warning.

Output Impedance

Nominally	50 Ω
VSWR N-Type	Better than 1.2:1 up to 500 MHz Better than 1.35:1 up to 1.05 GHz
VSWR BNC	Better than 2.2:1 up to 1.05 GHz

Spectral Purity

Residual FM	Less than 15 Hz RMS (0.3 to 3.4 kHz) up to 500 MHz. Less than 20 Hz RMS (0.3 to 3.4 kHz) up to 1000 MHz (with OCXO) Less than 22 Hz RMS (0.3 to 3.4 kHz) up to 1000 MHz, over the range 18 to 28°C (with TCXO)
Harmonics	Better than -20 dBc
Spurious signals	Better than -30 dBc (± 10 kHz to 1.5 MHz offset from carrier frequency or over range 600-700 MHz). Better than -40 dBc from 400 kHz to 1 GHz
SSB phase noise (20 kHz offset)	Better than -95 dBc / Hz up to 1 GHz
RF carrier leakage	Less than 0.5 μ V PD generated in a 50 Ω load by a 2 turn loop 25 mm from the case. Output level less than -40 dBm into a sealed 50 Ω load.

Amplitude Modulation - Internal

Frequency range	400 kHz to 1.05 GHz
AM depth range	0 to 99 %
Resolution	1 %
Indication	2 digits
Setting	Keyboard entry, delta increment / decrement function and rotary control

GENERAL INFORMATION

Accuracy	$\pm 7\% \pm 1$ digit, for mod freq of 1 kHz, CW 1.5 MHz to 400 MHz. $\pm 10\% \pm 1$ digit for mod freq of 50 Hz to 5 kHz, CW 1.5 MHz to 400 MHz. $\pm 15\% \pm 1$ digit, for mod freq of 50 Hz to 15 kHz, CW 1.5 MHz to 400 MHz.
Distortion	Less than 2% at 1 kHz for 30%, CCITT Weighted
Modulation Frequency Range	20 Hz to 20 kHz
Amplitude Modulation - External	
Input impedance	Nominally 10 k Ω in parallel with 40 pF
Frequency Range	As internal AM
Modulation Frequency Range	As internal AM
Sensitivity	1.0 V RMS for 0 to 100% AM
Frequency Modulation - Internal	
Frequency range	400 kHz to 1.05 GHz
Maximum deviation	75 kHz
Indication	3 digits
Setting	Keyboard entry, delta increment / decrement function and rotary control
Accuracy †	$\pm 5\% \pm 10$ Hz at 1 kHz modulating frequency $\pm 10\%$ at modulating frequencies from 50 Hz to 15 kHz.
Distortion	Less than 1% at 1 kHz for deviation of 5 kHz, CCITT Weighted.
Resolution	25 Hz
Pre-emphasis	750 μ s selectable
Mod Frequency Range	20 Hz - 25 kHz
Frequency Modulation - External	
Input impedance	Nominally 10 k Ω in parallel with 40 pF
Frequency Range	As internal FM
Modulation Frequency Range	DC to 100 kHz
Pre-emphasis	750 μ s selectable
Sensitivity	1 V RMS for 0 to 75 kHz deviation
Microphone Input	
Input Level	2 mV to 200 mV (AGC levelled)
Input Impedance	Nominally 150 Ω
Press To Talk (PTT)	When using the optional microphone in Tx Test mode, the PTT will switch instrument to Rx Test.

† At low modulation levels the residual AM / FM may become significant

Audio analyzer

Audio Voltmeter

Input Impedance	Nominally 1 M Ω in parallel with 40 pF
Frequency Range	DC and 20 Hz to 50 kHz AC only 20 Hz to 50 kHz Polarized DC (below 1 Hz)
Level Ranges	0-100 mV to 0-100 V RMS in a 1,3,10 sequence
Resolution	1 mV or 1% of reading
Indication	3 digits and bargraph
Accuracy	$\pm 3\% \pm 3$ mV \pm resolution

Audio Frequency Meter

Frequency Range	20 Hz to 20 kHz
Resolution	0.1 Hz, less than 10 kHz 1 Hz, at 10 kHz and above
Indication	5 digits
Accuracy	As frequency standard ± 1 digit \pm resolution
Sensitivity	50 mV

Audio SINAD Meter

Frequency	1 kHz
Range	0 to 18 dB and 0 to 50 dB
Resolution	0.1 dB
Indication	3 digits and barcharts
Accuracy	± 1 dB
Sensitivity	50 mV (100 mV for 40 dB SINAD). Reading suppressed if audio voltage is less than 5 mV

Audio Distortion Meter

Frequency	1 kHz
Range	0 to 10 %, 0 to 30 % and 0 to 100 %
Resolution	0.1 % distortion
Indication	3 digits and barcharts
Accuracy	± 5 % of reading ± 0.5 % distortion
Sensitivity	50 mV (100 mV for 1 % distortion). Reading suppressed if audio voltage is less than 5 mV

Audio S/N Meter

Range	0 to 30 dB and 0 to 100 dB
Resolution	0.1 dB
Indication	3 digits and barchart
Accuracy	± 1 dB
Sensitivity	50 mV (100 mV for 40 dB S/N). Reading suppressed if audio voltage is less than 5 mV

Audio Oscilloscope

Operating Modes	Single or repetitive sweep
Frequency Range	DC to 50 kHz, 3 Hz to 50 kHz AC coupled
Voltage Range	10 mV to 20 V per division in a 1,2,5 sequence
Voltage Accuracy	± 5 % of full scale
FM Ranges	± 75 , 30, 15, 6, 3 and 1.5 kHz deviation full scale, ± 10 % accuracy
AM Ranges	20, 10 and 5 % per division, ± 10 % accuracy
Timebase	50 μ s/div to 5 s/div in a 1,2,5 sequence
Graticule	10 Horizontal by 6 Vertical divisions
Special features	Built in antialiasing circuitry

Audio Barcharts

Barchart Displays	AF Voltage, SINAD, Distortion, S/N
Vertical Resolution	2 % of full scale
Ranging	Autoranging, range hold or manual selection 1, 2, 5, sequence with hysteresis

Audio and Modulation Filters

- 300 Hz Lowpass
- 300 Hz Highpass
- 3 kHz Lowpass
- 300 Hz to 3.4 kHz Bandpass
- 15 kHz Lowpass
- 750 μ s de-emphasis. (NOT available in Audio Mode)

Transmitter measurements

RF Frequency Meter

- Frequency Range 100 kHz to 1.05 GHz
- Resolution 1 Hz or 10 Hz, selectable
- Indication Up to 10 digits
- Accuracy As frequency standard \pm resolution
- Acquisition Time Less than 1 second (manual).
Typically 3 seconds (autotune),
operates over 10 MHz - 1.0 GHz
- Sensitivity Autotuned: 5 mW (N-Type) 0.05 mW BNC (antenna port)
Manual Tuned: -34 dBm (N-Type), -60 dBm BNC (antenna port)
- VSWR N Type <1.2:1 to 500 MHz
<1.25:1 to 1000 MHz
BNC (antenna port) <3:1 to 1000 MHz

RF Power Meter (Broadband)

- Frequency Range 200 kHz to 1.05 GHz
- Dynamic Range 5 mW to 150 W (N-Type)
0.05 mW to 250 mW BNC (antenna port)
- Indication Units Watts, dBm or dBW
- Indication 3 digits or bargraph
- Resolution 0.1 dB
- Accuracy \pm 10 % \pm resolution (N-Type)
BNC (antenna port) specification is typically as for N-Type specification.
- Maximum Power Handling N-Type: 150 W for limited periods, typically 1 minute at 20°C.
- Maximum Continuous Power 50W at 20°C (Note N-Type connector temperature may exceed 70°C after typically 10 minutes.)
Overload indicated by audible and visual warning.
BNC (antenna port) input 5 W maximum.

Harmonic Measurement

- Max. harmonic frequency 1050 MHz
- Dynamic range 0 to -60 dBc (depends on filter b/w selected).

Transient Power Analysis

- Displays power profile against time.
- Frequency range 1 to 1050 MHz
- Dynamic range 60 dB below spectrum analyzer reference level.
- Scale (power) 10 dB/div.
- Scale (time) 50 μ s/div to 5 s/div.
- Trigger level Adjustable over full dynamic range +ve or -ve trigger.
- Pre-trigger 0, 25%, 50%, 75% or 100% of displayed period.

Modulation Meter

Sensitivity	Autotuned: 5 mW (N-Type) 0.05 mW BNC (antenna port) Manual Tuned: -34 dBm(N-Type) -60 dBm BNC (antenna port)
Audio filters	300 Hz Lowpass 300 Hz Highpass 3 kHz Lowpass 300 Hz to 3.4 kHz Bandpass 15 kHz Lowpass 750 μ s de-emphasis

Amplitude Modulation

Frequency Range	100 kHz to 1.05 GHz
Modulation Frequency Range	10 Hz to 15 kHz
AM Depth Range	0 to 99% (manually tuned) 0 to 90% below 100 MHz 0 to 80% from 100 to 400 MHz
Resolution	1% AM
Indication	2 digits and bargraph
Accuracy †	$\pm 5\% \pm 1$ digit at 1 kHz $\pm 8.5\% \pm 1$ digit from 50 Hz to 10 kHz
Demodulation Distortion †	Less than 2 %, at 1 kHz & 30% AM, (CCITT Weighted)
Residual AM	Less than 1 % (300 Hz to 3.4 kHz)

Frequency Modulation

Frequency Range	100 kHz to 1.05 GHz
Modulation Frequency Range	10 Hz to 15 kHz
Deviation Range	0 to 75 kHz
Resolution	10 Hz below 2 kHz deviation, 1% above 2 kHz deviation
Indication	3 digits and bargraph
Accuracy †	$\pm 5\% \pm$ resolution at 1 kHz modulation frequency $\pm 7.5\% \pm$ resolution for modulation frequencies 50 Hz to 10 kHz
Demodulation Distortion	Less than 2 % at 1 kHz and 5 kHz FM, (CCITT Weighted)
Residual FM	Less than 30 Hz (300 Hz to 3.4 kHz)
Demodulation Output Socket (de-emphasis function available)	200 mV peak to peak $\pm 10\%$ per 1 kHz deviation

† At low modulation levels the residual AM / FM may become significant

RF spectrum analyzer

Frequency Range	100 kHz to 1.0 GHz
Spans	Continuously variable, 1 kHz / division to 100 MHz / division. 1,2,5,10 increments. Start / Stop frequency entry.
Resolution Bandwidth	300 Hz, 3, 30, 300 kHz, 3 MHz
Reference Level (top of screen)	-50 dBm to +52 dBm
On screen dynamic range	80 dB
On Screen Linearity	Typically ± 2 dB \pm resolution (10 dB/div) (10 dB above the noise floor)
Vertical resolution	0.1 dB on 2 dB / division 0.5 dB on 10 dB / division
Level Flatness	± 1 dB \pm resolution over 50 MHz span

GENERAL INFORMATION

Intermodulation Distortion	Better than 70 dB for two signals at -30 dBm into first mixer																					
Sweep speeds	10 ms/div minimum (Optimum sweep speed and bandwidth selected according to span)																					
Update Rate	Using "AUTO" resolution B/W selection																					
	<table border="0"> <thead> <tr> <th>SPAN</th> <th>RES B/W</th> <th>UPDATE</th> </tr> </thead> <tbody> <tr> <td>10 kHz</td> <td>300 Hz</td> <td>5 SWEEP/sec</td> </tr> <tr> <td>100 kHz</td> <td>3 kHz</td> <td>9 SWEEP/sec</td> </tr> <tr> <td>1 MHz</td> <td>30 kHz</td> <td>9 SWEEP/sec</td> </tr> <tr> <td>10 MHz</td> <td>300 kHz</td> <td>9 SWEEP/sec</td> </tr> <tr> <td>100 MHz</td> <td>300 kHz</td> <td>5 SWEEP/sec</td> </tr> <tr> <td>1000 MHz</td> <td>3 MHz</td> <td>5 SWEEP/sec</td> </tr> </tbody> </table>	SPAN	RES B/W	UPDATE	10 kHz	300 Hz	5 SWEEP/sec	100 kHz	3 kHz	9 SWEEP/sec	1 MHz	30 kHz	9 SWEEP/sec	10 MHz	300 kHz	9 SWEEP/sec	100 MHz	300 kHz	5 SWEEP/sec	1000 MHz	3 MHz	5 SWEEP/sec
SPAN	RES B/W	UPDATE																				
10 kHz	300 Hz	5 SWEEP/sec																				
100 kHz	3 kHz	9 SWEEP/sec																				
1 MHz	30 kHz	9 SWEEP/sec																				
10 MHz	300 kHz	9 SWEEP/sec																				
100 MHz	300 kHz	5 SWEEP/sec																				
1000 MHz	3 MHz	5 SWEEP/sec																				
Marker Indication	Single marker for frequency and level display Function for Δ level and Δ frequency from centre.																					
Features	Simultaneous 'Look and Listen' Span 100 kHz, 200 kHz, 500 kHz, 1 MHz 2 μ V Sensitivity																					

Tracking generator

Tracking Generator Offset	0-999 MHz
Output Level	N-Type socket: -141 dBm to -21 dBm BNC socket: -115 dBm to +5 dBm

Audio generators

Frequency

Frequency Range	10 Hz to 25 kHz
Waveform	Sine or square wave
Setting	Keyboard entry, delta increment / decrement function and rotary control
Indication	5 digits
Resolution	0.1 Hz below 3.25 kHz 1 Hz above 3.25 kHz
Accuracy	0.01 Hz \pm frequency standard <180 Hz 0.1 Hz \pm frequency standard >180 Hz

Level

Level Range	0.1 mV to 4 V RMS
Setting	Keyboard entry, delta increment / decrement function and rotary control
Indication	4 Digits
Resolution	0.1 mV below 409 mV 1 mV above 409 mV
Accuracy	\pm 5% \pm resolution 50 Hz - 15 kHz
Output impedance	Nominally 5 Ω (Minimum load impedance 25 Ω)
Signal Purity	
Distortion	Less than 0.5 % at 1 kHz Less than 1 % from 50 Hz to 15 kHz

Signalling Encoder / Decoder

Sequential Tones Functions	Encodes and decodes up to 40 tones. CCIR, ZVEI, DZVEI, EEA, EIA or user defined. Any of the tones may be extended. Continuous, burst and single step modes available.
----------------------------	--

User Defined Tones	Up to two sequential tones frequency plans may be defined and stored within the Service Monitor. Any of the standard tone frequency plans may be copied to user defined and modified. Tone length 20 ms to 1 s. Standard tone frequencies may be selected from a menu.
DTMF	Generation and decoding of DTMF tones.
DCS	Generation and decoding of Digitally Coded Squelch, DCS.
POCSAG	Generation of POCSAG code CCIR No. 1 Rec 584. Bit rates from 400 to 4800 bit/s. Inversion available.
Audio Monitor	Demodulated signals and audio signals may be monitored via the internal loudspeaker and via the accessory socket output on the front panel.

General features

Keyboard and Display

Display size

Logical colour coded keyboard with bright high resolution LCD
160 x 85 mm

RS232C

Connector

RS232C interface is provided for printing or remote instrument control.
9 way male 'D' Type

Frequency standard

Internal Frequency Standard (TCXO)

Frequency

10 MHz

Temperature stability

Better than 0.5 in 10⁶, 0 to 50 °C

Ageing Rate

Better than 1 in 10⁶ per year

Warm up

1 minute to specified accuracy

External Frequency Standard Input

Frequency

1, 2, 5 and 10 MHz

Input Level

Greater than 1 V peak to peak

Input Impedance

Nominally 1 kΩ

General

Power Requirements

AC Supply Voltage

90 V to 265 V

90 V to 132 V

AC Supply Frequency

45 Hz to 67 Hz

45 Hz to 440 Hz

Maximum AC Power

190 VA

DC Supply Voltage

11 to 32V

Maximum DC Power

100W

Low battery indicator

Indication of low battery voltage provided.

Charge Output

13.8V at 6A max to charge a 12V sealed lead acid battery

Electro-Magnetic Compatibility

Conforms with the protection requirements of the EEC Council Directive 89/336/EEC.

Complies with the limits specified in the following standards:

EN 55011 Class B	CISPR 11
EN50082-1	IEC 801-2,3,4
EN60555-2	IEC 555-2.

GENERAL INFORMATION

Safety	This instrument is designed to comply with the requirements of EN61010-1 / IEC1010-1, for Class 1 Portable equipment and is for use in a pollution degree 2 environment. The equipment is designed to operate from an installation categories 1 or 2 supply.
Environmental	
Rated range of use	0°C to 50°C and up to 95% relative humidity at 40°C
Storage and transport	
Temperature	-40°C to +71°C
Altitude	Up to 2500m (pressurised freight at 27 kPa differential)
Dimensions and Weight	
Height	178 mm
Width	380 mm
Depth	457 mm (including handle, feet and covers)
Weight	Less than 11.4 kg, (Less than 25 lb)

Options and accessories

Options

Option 1	600 Ω Matching Unit	
Option 2	Analog Systems Card	
Option 3	High Stability OCXO	
Option 4	Parallel Interface	
Option 5	GPIB Interface	
Option 6	Memory Card Drive and Date/Time Stamp	
Option 8	SSB Demodulator	
Option 10	NMT	} Requires Option 2 to be fitted
Option 11	AMPS	
Option 12	TACS	
Option 13	MPT1327	
Option 14	PMRTEST	
Option 15	EDACS Radio Test	
Option 16	EDACS Repeater Test	
Option 21	Demodulation filters	
Option 22	POCSAG decode	
Option 23	CCITT Filter	
Option 24	CMESS Filter	
Option 30	Bail arm and front panel stowage cover	

600 Ω Matching Unit (Option 1)

Features	Switchable 600 Ω balanced. AF input and output. Switchable 20 dB attenuator on AF generator output.
----------	---

Analog Systems Card (Option 2)

Required for Options 10 to 16.
For performance data refer to respective handbook supplement.

High Stability Internal Frequency (OCXO) Standard (Option 3)

Frequency	10 MHz
Temperature Stability	Better than 5 part in 10 ⁸ , 5 to 55°C
Ageing Rate	Better than 1 part in 10 ⁷ per year, after 1 month continuous use.
Warm-up Time	Less than 10 minutes to within 2 parts in 10 ⁷ at 20°C.

Parallel Interface (Option 4)

Allows direct connection of a parallel printer. Additionally provides 4 software programmable output lines.

Printer port	
Connector	25 way female D-type.

Printers supported	75,100,150 dots per inch laser printers FX80, FX100 Epson format.
Accessory port	
Connector	9 way female D-type.
Outputs	4 independently programmable output lines, each one configurable as a logic line or as a relay contact closure. +5V supply available.
 GPIB (Option 5)	For remote instrument control.
Capability	Complies with the following subsets defined by IEEE488:- SH1, AH1, T6, L4, SR1, RL1, E1, DC1, DT0
Memory Card (Option 6)	The memory card facility allows the storage of results, set-ups, screen dumps and user programs. Meets PCMCIA 2 standard. Allows the current date and time to be stored with results to the memory card and/or printed with a screen dump.
SSB Demodulator (Option 8)	Provides demodulation of SSB signals (upper and lower sideband.)
Modulation Meter	
Frequency range	400 kHz to 1 GHz
AF demodulation range	10 Hz to 15 kHz
Detection range	2 μ V to 150 W
Features	Automatic detection of USB or LSB. BFO can be used for tuning of carrier for AM and FM radios.
Demodulation filters (Option 21)	Provides a range of high selectivity channel filters in Tx Test and Spectrum Analyzer Look and Listen modes. Shape factor approximates to ETSI requirements.
Bandwidths	5 kHz, 12.5 kHz, 25 kHz, 50 kHz and 300 kHz.
POCSAG Decode (Option 22)	Decoding of POCSAG messages. Can decode a message as it is received, or decoding can be triggered from a user-selectable RIC code or fixed message pattern.
Bit Rate	Automatically decodes any standard bit rate up to 4800 bit/s. Numeric and Alphanumeric decoding is provided. Number of received errors is displayed.
CCITT (Option 23)	CCITT weighted filter
C-MESSAGE (Option 24)	C-MESSAGE weighted filter
Supplied Accessories	AC Supply lead † 43138/755 DC Supply lead 46882/311 Operating Manual 46882/318 Programming Manual
	† The AC supply lead provided with the Service Monitor will depend on the destination country. See <i>Power requirements</i> , <i>Power cords</i> , in chapter 2 of this manual

GENERAL INFORMATION

Optional Accessories

44991/145	Microphone with PTT
43113/021	Battery Pack
54431/023	20 dB AF attenuator (BNC)
46884/728	Rack Mounting Kit
54421/001	Antenna BNC
46662/571	Ever Ready Case
46880/079	Service Manual
54421/002	Directional Power Head 1 to 50 MHz
54421/003	Directional Power Head 50 to 1000 MHz
54421/016	70 to 1000 MHz Lightweight Directional Power Head and Adaptor
54421/018	400 to 1000 MHz Lightweight Directional Power Head and Adaptor
46884/789	Power Head Adaptor
54432/012	Wideband Amplifier
43130/590	1m 7 way DIN lead Assy.
43130/591	3m 7 way DIN lead Assy
59000/189	Memory Card (128 kbyte)

contd./...

Optional Accessories (continued)

54442/004	Remote control head kit
46662/616	Soft case for bail arm version
46884/648	Serial cable 9 way female to 25 way male
46884/649	Serial cable 9 way female to 25 way female
46884/650	Serial cable 9 way female to 9 way female

Battery Pack

Type	12V Sealed lead-acid
Normal capacity when new	≈30 minutes instrument operation from full charge
Charge time from instrument	16 hrs
Minimum open circuit voltage	12 V
Capacity	7 AH
Shelf life:-	
0° C to 20° C	12 months
21° C to 30° C	9 months
31° C to 40° C	5 months
Weight	3 kg

EC Declaration of Conformity

Certificate Ref. No.

EEA00016

The undersigned, representing:

Manufacturer:	IFR Ltd.
Address:	Longacres House, Norton Green Road, Stevenage, Hertfordshire, U. K. SG1 2BA

Herewith declares that the product:

Equipment Description:	Communications Service Monitor
Model No.	2945A
Options:	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 13, 14, 15, 16, 21, 22, 23, 24, 30 and Ever Ready Case, Battery Pack and microphone (44991-145)

is in conformity with the following EC directive(s)
(including all applicable amendments)

Reference No.	Title:
73/23/EEC	Low Voltage Directive
89/336/EEC	EMC Directive

and that the standards and/or technical specifications referenced below have been applied:

Safety:	EMC:	
IEC/EN61010-1	EN55011:1991 Class B	
	EN50082-1:1992	
	EN60555-2:1987	

IFR Stevenage _____ (Place)

21st May 1998 _____ (Date)

Alan Smithies

(Signature)

Alan Smithies - Product Liability Manager

Chapter 2 INSTALLATION

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Introduction

This chapter deals with preparing the Service Monitor for use for the first time and with the checks to be made when the Service Monitor may have been used under unknown conditions.

The latter situation could well apply where the Service Monitor is used by several users for differing tasks.

Initial visual inspection of new instruments

After unpacking the Service Monitor and before making any connections to a power source, inspect for any signs of mechanical damage. Refer to the questionnaire at the front of this manual.

Ventilation

The Service Monitor is force cooled by a fan located in the rear panel. The cooling air is drawn into the Service Monitor through the fan and expelled through ventilator grills located on the right and on the underside. An air filter over the fan inlet prevents the ingress of dust and other particles.

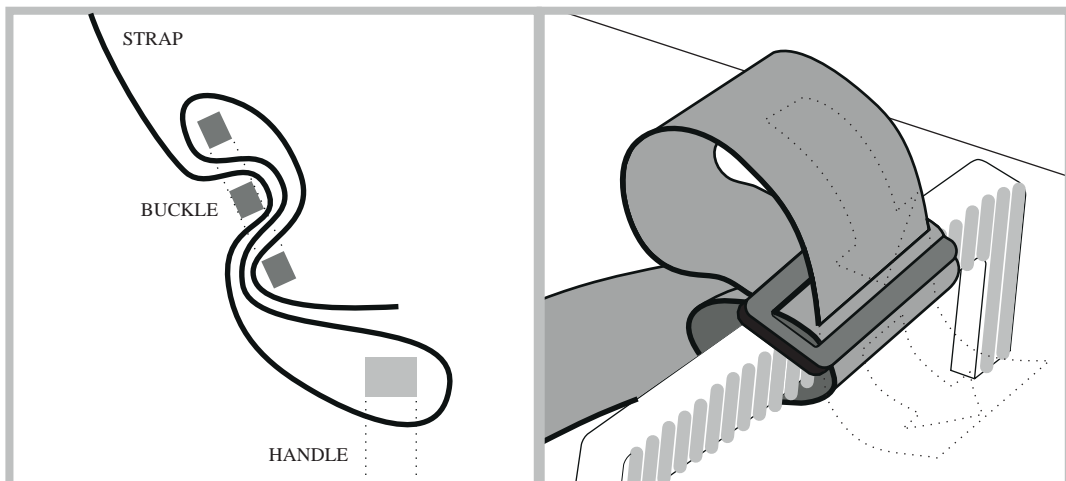
CAUTION

The Service Monitor requires an unrestricted airflow to ensure that its performance meets the specification. Before switching the Service Monitor on, check that the air inlet on the rear panel is not restricted and that there is no loose material close by which could be sucked into the fan. Refer to *Routine Maintenance* later in this chapter for details of cleaning and replacing the air filter.

The optional 'Ever-ready' case has ventilation apertures which align with those of the Service Monitor. Ensure that these are not obstructed.

'Ever-ready' case shoulder strap

The shoulder strap supplied with the 'Ever-ready' case should be attached to the front handles of the Service Monitor. When fitting the strap, always loop the tails of the strap through the buckles in the reverse direction. This will prevent the strap from slipping through the buckle. See *Fig. 2-1, Preventing strap buckle from slipping*.



C2509

Fig. 2-1 Preventing strap buckle from slipping.

Bail arm option

If the bail arm carrying handle is fitted, the Service Monitor will not fit into the optional Ever Ready Case, 46662/571. Do not attempt to attach the shoulder strap supplied with this Ever Ready Case to a Service Monitor fitted with a bail arm carrying handle.

Power requirements

The Service Monitor can be powered from a wide range of power sources, both AC and DC.

AC supplies must be within the range 90 V to 265 V, at a frequency of between 45 Hz and 67 Hz; or within the range 90 V to 132 V, at a frequency of between 45 Hz and 440 Hz

The maximum power consumption is 190 VA

Voltage selection is not necessary as the AC power supply module within the Service Monitor is designed to handle this wide spread of input variations.

For DC operation, the Service Monitor requires a supply within the range 11 V to 32 V. A range switch adjusts the input circuits of the DC supply module for either 11 V to 20 V or 18 V to 32 V. The maximum DC power requirement is 100 W.

Fuses

The AC input circuit is fed through a single fuse fitted to the rear panel of the Service Monitor, within the AC input connector. This should be a 2 A anti-surge, 5 × 20 mm glass cartridge fuse.

The DC input circuit is also fed through a single fuse. This is fitted within the fuseholder adjacent to the DC input connector. This should be a 10 A anti-surge, 5 × 20 mm glass cartridge fuse.

Class I power cords (3-core)

General

When the equipment has to be plugged into a Class II (ungrounded) 2-terminal socket outlet, the cable should either be fitted with a 3-pin Class I plug and used in conjunction with an adapter incorporating a ground wire, or be fitted with a Class II plug with an integral ground wire. The ground wire must be securely fastened to ground. Grounding one terminal on a 2-terminal socket will not provide adequate protection.

In the event that a moulded plug has to be removed from a lead, it must be disposed of immediately. A plug with bare flexible cords is hazardous if engaged in a live socket outlet.

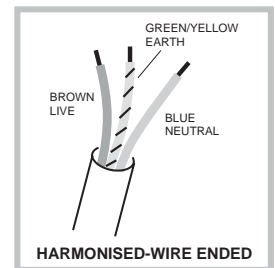
Power cords with the following terminations are available from IFR Ltd. Please check with your local sales office for availability.

This equipment is provided with a 3-wire (grounded) cordset which includes a moulded IEC 320 connector for connection to the equipment. The cable must be fitted with an approved plug which, when plugged into an appropriate 3-terminal socket outlet, grounds the case of the equipment. Failure to ground the equipment may expose the operator to hazardous voltage levels. Depending upon the destination country, the colour coding of the wires will differ:-

Wire ended

Country	IEC 320 plug type	IFR part number
Universal	Straight through	23424-158
Universal	Right angled	23424-159

	North America	Harmonised
Line (Live)	Black	Brown
Neutral	White	Blue
Ground (Earth)	Green	Green/Yellow



C3509

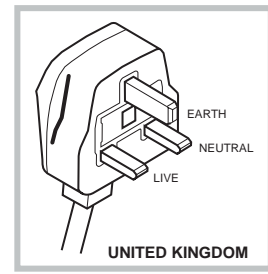
British

Country	IEC 320 plug type	IFR part number
United Kingdom	Straight through	23422-001
United Kingdom	Right angled	23422-002

The UK lead is fitted with an ASTA approved moulded plug to BS 1363.

A replaceable 13 A fuse to BS 1362 is contained within the plug. This fuse is only designed to protect the lead assembly. Never use the plug with the detachable fuse cover omitted or if the cover is damaged.

The fuse(s) or circuit breaker to protect the equipment is fitted at the back of the equipment.

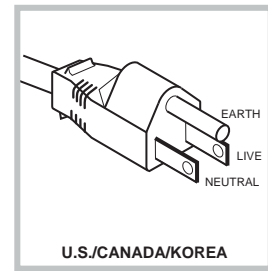


C3510

North American

Country	IEC 320 plug type	IFR part number
North American	Straight through	23422-004
North American	Right angled	23422-005

The North American lead is fitted with a NEMA 5-15P (Canadian CS22.2 No 42) plug and carries approvals from UL and CSA for use in the USA and Canada.

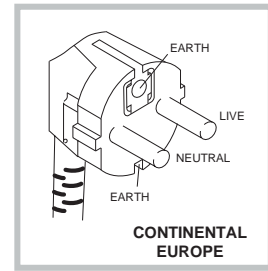


C3511

Continental Europe

Country	IEC 320 plug type	IFR part number
Europe	Straight through	23422-006
Europe	Right angled	23422-007

The Continental European lead is fitted with a right angle IEC83 standard C4 plug (CEE 7/7) which allows it to be used in sockets with either a male earth pin (standard C 3b) or side earth clips (standard C 2b) the latter is commonly called the German ‘Schuko’ plug. In common with other Schuko style plugs, the plug is not polarized when fitted into a Schuko socket. The lead carries approvals for use in Austria, Belgium, Finland, France, Germany, Holland, Italy, Norway and Sweden. Note that this plug will not fit Italian standard CEI 23-16 outlets. The lead should not be used in Denmark given that the earth connection will not be made.



C3512

Français

Le câble d'alimentation d'Europe Continentale est muni d'un connecteur mâle à angle droit type CEI83, standard C4 (CEE 7/7), qui peut être utilisé dans une prise femelle à ergot de terre (standard C 3b) ou à clips latéraux (standard C 2b), cette dernière étant communément appelée prise "Schuko" allemande. De la même façon que les autres connecteurs de type Schuko, celui-ci n'est pas polarisé lorsqu'il s'adapte à une prise femelle Schuko. Ce câble d'alimentation est homologué en Allemagne, Autriche, Belgique, Finlande, France, Hollande, Italie, Norvège et Suède. À noter que ce connecteur n'est pas compatible avec les prises de courant italiennes au standard CEI 23-16. Ce câble ne doit pas être utilisé au Danemark à cause du défaut de connexion de masse.

Deutsch

Das kontinentaleuropäische Netzkabel ist mit einem rechtwinkligen Stecker nach IEC83 C4 (CEE7/7) Standard versehen, welcher sowohl in Steckdosen mit Erde-Stift (Standard C 3b) oder seitlichen Erdklemmen, im allgemeinen "Schukosteckdose" genannt, paßt. Üblicherweise ist der Schukostecker bei Verwendung in Schukosteckdosen nicht gepolt. Dieses Netzkabel besitzt Zulassung für Österreich, Belgien, Finnland, Frankreich, Deutschland, Holland, Italien, Norwegen und Schweden.

Hinweis: Dieser Schukostecker paßt nicht in die italienischen Standardsteckdosen nach CEI 23-16 Norm. Dieses Netzkabel sollte nicht in Dänemark verwendet werden, da hier keine Erdeverbindung hergestellt wird.

Español

El cable de alimentación tipo Europeo Continental dispone de una clavija C4 normalizada IEC83 (CEE 7/7) que permite su utilización tanto en bases de enchufe con toma de tierra macho (tipo C 3b) o con toma de tierra mediante contactos laterales (tipo C 2b) que, en este último caso, suele denominarse "Schuko". Al igual que cualquier otra clavija tipo Schuko, las conexiones a red no están polarizadas cuando se conectan a una base tipo Schuko. El cable lleva autorización para su uso en Austria, Bélgica, Finlandia, Francia, Alemania, Holanda, Italia, Noruega y Suecia. Observe que este cable no se adapta a la norma italiana CEI 23-16. El cable no debe utilizarse en Dinamarca en el caso de no efectuarse conexión a tierra.

Italiano

I cavi d'alimentazione per l'Europa continentale vengono forniti terminati con una spina ad angolo retto del tipo C4 secondo lo standard IEC83 (CEE 7/7) che può essere usato in prese in cui la terra può essere fornita o tramite connettore maschio (C 3b) o tramite clips laterali (C 2b), quest'ultima comunemente detta di tipo tedesca "Schuko". Questa spina, quando collegata ad una presa Schuko, non è polarizzata.

Il cavo può essere usato in Austria, Belgio, Finlandia, Francia, Germania, Olanda, Norvegia, Svezia ed Italia. E' da notare che per l'Italia questo non risponde allo standard CEI 23-16.

Questa spina non dovrebbe invece essere usata in Danimarca in quanto non realizza il collegamento di terra.

Connecting to a DC supply and fitting batteries

If the Service Monitor is to be used from a DC voltage source it should be connected using the supplied DC connecting lead, part no. 43138-755 The polarity of the connections must be correct, RED to POSITIVE, BLACK to NEGATIVE, and the DC input voltage selector set to the appropriate range for the supply.

The negative connection of the DC supply is directly connected to the chassis of the Service Monitor and therefore to all screen connections of input and output connectors. Note however, that the AF ports are isolated under some operating conditions.

The Service Monitor will function from any supply with a voltage within the range given under Power requirements above, but must be capable of delivering a current in the order of 9 amps at the lowest voltage.

Ensure that the supply lead connections are sound and cannot short together.

The accessory battery pack has an output lead fitted with a connector for direct connection to the DC input connector.

The accessory battery pack should be fitted into the battery pocket of the 'Ever-ready' case. The battery lead can be left connected to the Service Monitor.

When fitting a battery pack or reconnecting the battery to the Service Monitor for any reason, ensure that all surplus battery connecting lead is contained within the Service Monitor compartment of the 'Ever-ready' case. Do not leave a loop of cable which could become snagged when the Service Monitor is being carried.

A fully charged battery pack will power the Service Monitor for approximately 30 minutes between charges. The Service Monitor will recharge the battery in approximately 16 hours if connected to a mains supply and the mains power switch put to the 'CHARGE' position.

When the DC supply powering the Service Monitor falls to a level indicative of battery pack discharge, a 'Battery Low' warning is displayed on the screen.

RF and AF connections

All RF and AF connections should be made using good quality connectors correctly fitted to appropriate cable. All connectors should be locked to the Service Monitor using the bayonet or threaded locking rings. Do not use leads that have damaged connectors or cable as this can cause poor performance and might damage the Service Monitor.

RF leakage levels in a test set-up can be aggravated by the use of poor quality connector leads. A double screened lead, 1 metre in length and terminated with male BNC connectors, IFR Part No 43137-052Y and a 1 metre, 'Ntype' male to 'Ntype' male, connector lead 54311-095C are both available from IFR sales offices.

WARNING

Hot Surfaces

Take care when touching the RF Input Type N connector after the application of high levels of continuous power. If 50 W is exceeded for a prolonged period, the temperature of the connector can become excessive.

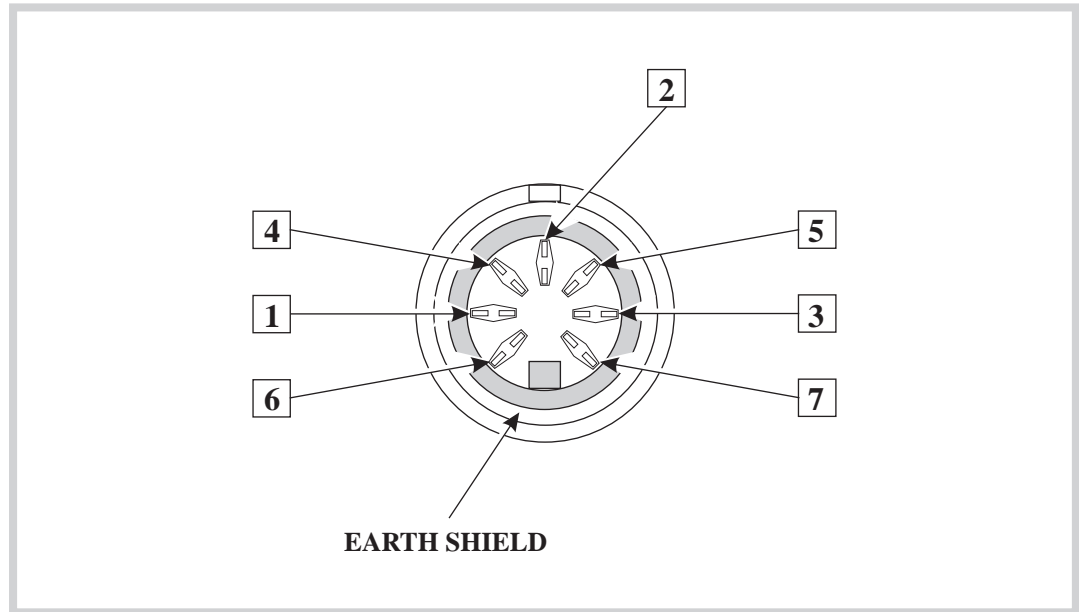
Accessory socket connections

The accessory socket located on the front panel, is of the 7 pin DIN, 45° configuration. The function of each of the pins on this socket is shown in the following table. The pin numbering is shown in *Fig. 2-2 Accessory in/out socket pin numbers*, and is as viewed from the front of the Service Monitor.

Table 2-1 Accessory socket pin numbering, location and functions.

Din pin No	Function
6	Logic
1	Mic input/PTT-logic
4	Forward power
2	12 V DC at approx 100 mA
5	Reverse power
3	Logic
7	Loudspeaker output

The pin numbering of the Accessory socket, as seen from the front of the Service Monitor, is shown in *Fig. 2-2 Accessory in/out socket pin numbers*.



C1785

Fig. 2-2 Accessory in/out socket pin numbers

The socket is used for connecting dedicated accessories such as directional power heads and microphones with press to talk switching capabilities.

Selection logic [or data signals] on pins 1,3 and 6 enables the Service Monitor to recognise the connections of an external accessory. The appropriate pins are at TTL levels and are active low (L) as shown below:

Table 2-2 Accessory socket logic and applications

Accessory	Pin 1	Pin 3	Pin 6
Nothing connected	High	High	High
Microphone (press to talk)	Low	High	High
External power: Auto zero	High	Low	Low
External power: Peak power	High	High	Low
External power: CW power	High	Low	High

Refer to chapter 3, *Operation*, for details of using the socket.,

A 3.0 metre lead assembly (part No. 43130/591B) is available as an optional accessory.

Remote control connections

RS232

The serial port connection requires a 9 way female 'D' Type connector. This should be correctly fitted to appropriate cable and the locking screws should be used to prevent undue strain from being applied to the connector housing.

The pin connections are listed below and the pin locations shown in *Fig. 2-3 RS232 serial port connections (as seen facing panel)*.

Contact	Function	Contact	Function
1	Not connected	6	DSR
2	Rx data in	7	RTS
3	Tx data out	8	CTS
4	DTR	9	Not connected
5	Ground		

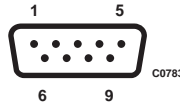
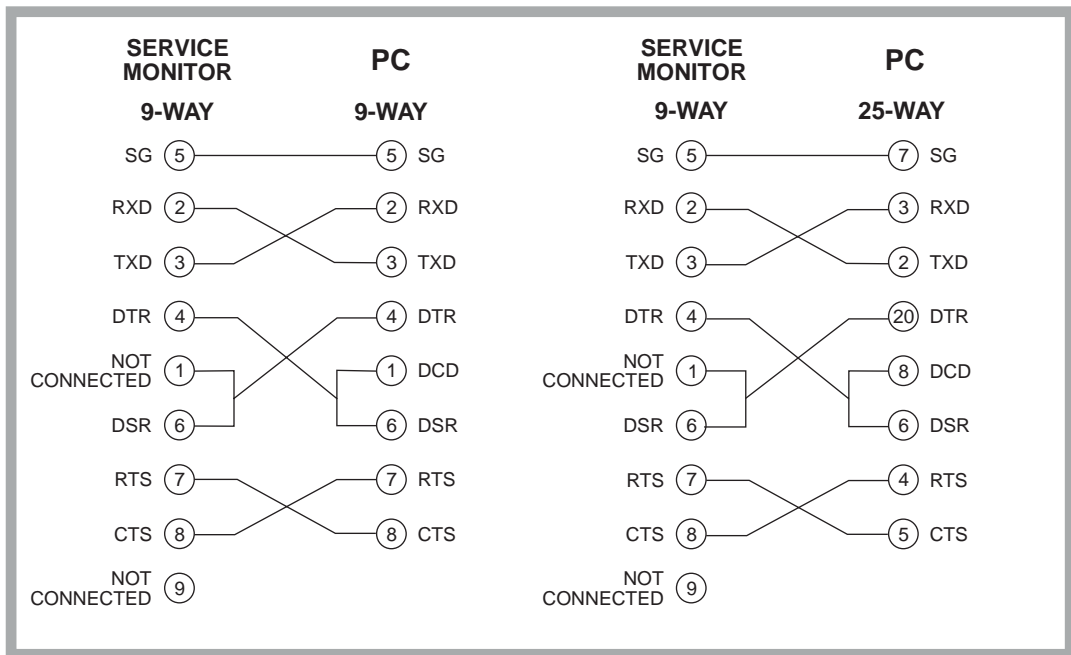


Fig. 2-3 RS232 serial port connections (as seen facing panel)

The use of a NULL MODEM cable assembly is required for connecting to control equipment such as PCs.

The connections for 9 way to 9 way and 9 way to 25 way versions is shown in *Fig. 2-4*.



C3383

Fig. 2-4 Null modem connections

GPIB

When the optional GPIB interface unit has been fitted, connections are made to it using a 24-way IEEE 488 male connector. If a stackable connector is used in order to interconnect more than two pieces of equipment, ensure that no physical damage to the Service Monitor connector will result.

The pin connections are listed below and the pin locations shown in *Fig. 2-5 IEEE488 parallel port connections (as seen facing panel)*.

Contact	Function	Contact	Function
1	Data I/O 1	13	Data I/O 5
2	Data I/O 2	14	Data I/O 6
3	Data I/O 3	15	Data I/O 7
4	Data I/O 4	16	Data I/O 8
5	EOI	17	REN
6	DAV	18	Pair with 6
7	NRFD	19	Pair with 7
8	NDAC	20	Pair with 8
9	IFC	21	Pair with 9
10	SRQ	22	Pair with 10
11	ATN	23	Pair with 11
12	Ground shield	24	Logic ground

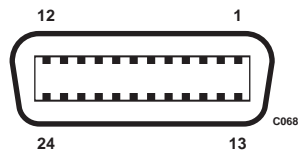


Fig. 2-5 IEEE488 parallel port connections (as seen facing panel)

Self tests and acceptance tests

The service monitor incorporates a self test program which allows users to verify its condition at any time. This program is described below.

When it is necessary to prove that the performance of the Service Monitor meets the published performance data, the *Acceptance tests*, described in Chapter 5, should be carried out.

Self tests

The built in Self Test program measures the output parameters of the RF generator using the transmitter test functions. The RF generator output is coupled internally and no external connections are required.

The self test program is accessed through the help/set-up menu and comprises 17 tests, which are listed on the display when the *[Self Test]* key is pressed.

Before running the program, the Service Monitor should be reset to the factory preset state. This is done by pressing the *[MEM]* key, to display the STORE/RECALL screen and menu. The message 'Recall Store No' is shown. key in and enter the digits '01'. The Service Monitor will now be ready to run the self test program.

To run the program the *[GO]* key is pressed and the tests are carried out consecutively. The legend 'ACTIVE' is displayed against each test as it is carried out, which changes to 'PASS' or 'FAIL' as each test is completed. If a particular test fails, the reason is given alongside the 'FAIL' legend, together with the measurement.

The tests carried out, the related set-ups and the functions verified are listed below.

- Test No 1** Broadband power. 500 MHz
- Test No 2** Transmitter Frequency. 500 MHz
- Test No 3** Broadband power. 1 GHz
- Test No 4** Transmitter Frequency. 1 GHz
- Test No 5** Broadband power. 10 MHz

Test No 6 Transmitter Frequency. 10 MHz

The above tests compare the generated power and frequency against the broadband power meter and the frequency meter at each of the frequencies specified.

Related set-up. Manual tune

The functions verified by the above tests are:-

Signal generator frequency and level accuracy.

Power meter accuracy.

Test No 7 to 14

Narrow band power meter. Power level +10 dBm. (Test No 7) to -60 dBm. (Test No 14)

These tests compare the generated power levels against the narrowband power meter readings.

Related set-ups. Frequency, 10 MHz, IF Bandwidth, 30 kHz.

The functions verified by the above tests are:-

Signal generator level accuracy.

Signal generator attenuators.

Spectrum analyzer level accuracy.

Receiver attenuators.

Test No 15 FM deviation. 50 kHz

This test checks the signal generator FM deviation against the modulation meter reading.

Related set-ups. Frequency 10 MHz, level -26 dBm, IF bandwidth 300 kHz, audio bandwidth 0.3 - 3.4 kHz, FM demodulation.

The functions verified by the above tests are:-

Signal generator FM accuracy, modulation meter FM accuracy, modulation generator (audio generator) level accuracy

Test No 16 Modulation frequency. 1 kHz.

This test checks the modulation generator output frequency against the audio counter reading.

Related set-ups. Related set-ups. Frequency 10 MHz, level -26 dBm, IF bandwidth 300 kHz, audio bandwidth 0.3 - 3.4 kHz, FM demodulation.

The functions verified by the above tests are:-

modulation generator (audio generator) frequency accuracy

Test No 17 AM Depth. 50%

This test checks the signal generator AM against the modulation meter reading.

Related set-ups. Frequency 10 MHz, level -26 dBm, IF bandwidth 0.3 - 3.4 kHz, AM demodulation.

The functions verified by the above tests are:-

Signal generator AM accuracy, modulation meter AM accuracy, audio generator frequency accuracy, audio generator level accuracy, audio filters, audio counter.

Using the Service Monitor

The monitor can be used as a bench instrument, either flat standing or inclined using the elevating front feet. The monitor can also be used as a field service instrument while left in the 'Ever-ready' case. It can be operated in any position convenient to the operator. See the **Caution** under *Ventilation*, earlier in this chapter.

Routine maintenance

Ventilation fan and filter

The ventilator fan on the rear of the Service Monitor is fitted with a filter to prevent the ingress of foreign matter into it. This should be inspected and cleaned at regular intervals. The procedure for this is as follows:-

Disconnect the Service Monitor from the mains supply and from any DC supply.

Remove any other connections to the Service Monitor.

WARNING Failing to disconnect the power source before removing the filter could result in the fan becoming switched on accidentally.

Stand the Service Monitor face down on a firm, non-scratch flat surface so that it is supported on the front handles.† The rear of the Service Monitor, with the fan housing, should be at a safe and accessible working height.

Remove the two M4 screws holding the fan filter to the rear of the Service Monitor and lift the filter away.

Take the filter to a suitably ventilated location and remove as much dust and other foreign matter as is practical. Do not wet or wash the filter.

Refit the filter to the Service Monitor, using the reverse procedure as appropriate.

If the filter is damaged or blocked, a replacement is available as IFR part No. 35907/675.

† If the bail arm carrying handle has been fitted, this should be positioned over the top of the Service Monitor before standing the instrument face down, supported on the front bumpers.

Routine safety testing and inspection

In the UK the 'Electricity at Work Regulations' (1989) section 4(2) places a requirement on the users of equipment to maintain it in a safe condition. The explanatory notes call for regular inspections and tests together with a need to keep records.

The following electrical tests and inspection information is provided for guidance purposes and involves the use of voltages and currents that can cause injury. It is important that these tests are only performed by competent personnel.

Prior to carrying out any inspection and tests the Service Monitor must be disconnected from the mains supply and all external signal connections removed. All tests should include the Service Monitor's own supply lead, all covers must be fitted and the supply switch must be in the 'ON' position.

The recommended inspection and tests fall into three categories and should be carried out in the following sequence:

1. Visual inspection
2. Earth Bonding Test (Class I equipment only)
3. Insulation Resistance test.

1. Visual inspection

A visual inspection should be carried out on a periodic basis. This interval is dependent on the operating environment, maintenance and use, and should be assessed in accordance with guidelines issued by the Health and Safety Executive (HSE). As a guide, this Service Monitor, when used indoors in a relatively clean environment, would be classified as 'low risk' equipment and hence should be subject to safety inspections on an annual basis. If the use of the equipment is contrary to the conditions specified, you should review the safety re-test interval.

As a guide, the visual inspection should include the following where appropriate:

Check that the equipment has been installed in accordance with the instructions provided (e.g. that ventilation is adequate, supply isolators are accessible, supply wiring is adequate and properly routed).

The condition of the mains supply lead and supply connector(s).

Check that the mains supply switch isolates the Service Monitor from the supply.

The correct rating and type of supply fuses.

Security and condition of covers and handles.

Check the supply indicator functions (if fitted).

Check the presence and condition of all warning labels and markings and supplied safety information.

Check the wiring in re-wireable plugs and appliance connectors.

If any defect is noted this should be rectified before proceeding with the following electrical tests.

2. Earth bonding tests

Earth bonding tests should be carried out using a 25A (12V maximum open circuit voltage) DC source. Tests should be limited to a maximum duration of 5 seconds and have a pass limit of 0.1Ω after allowing for the resistance of the supply lead. Exceeding the test duration can cause damage to the equipment. The tests should be carried out between the supply earth and exposed case metalwork, no attempt should be made to perform the tests on functional earths (e.g. signal carrying connector shells or screen connections) as this will result in damage to the equipment.

3. Insulation tests

A 500 V DC test should be applied between the protective earth connection and combined live and neutral supply connections with the equipment supply switch in the 'on' position. It is advisable to make the live/neutral link on the appliance tester or its connector to avoid the possibility of returning the Service Monitor to the user with the live and neutral poles linked with an ad-hoc strap. The test voltage should be applied for 5 seconds before taking the measurement.

IFR Ltd employs reinforced insulation in the construction of its products and hence a minimum pass limit of $7 M\Omega$ should be achieved during this test.

Where a DC power adapter is provided with the Service Monitor the adapter must pass the $7 M\Omega$ test limit.

We do not recommend dielectric flash testing during routine safety tests. Most portable appliance testers use AC for the dielectric strength test which can cause damage to the supply input filter capacitors.

4. Rectification

It is recommended that the results from the above tests are recorded and checked during each repeat test. Significant differences between the previous readings and measured values should be investigated.

If any failure is detected during the above visual inspection or tests, the Service Monitor should be disabled and the fault should be rectified by an experienced Service Engineer who is familiar with the hazards involved in carrying out such repairs.

Safety critical components should only be replaced with equivalent parts, using techniques and procedures recommended by IFR Ltd.

The above information is provided for guidance only. IFR Ltd designs and constructs its products in accordance with International Safety Standards such that in normal use they represent no hazard to the operator. IFR Ltd reserves the right to amend the above information in the course of continuing its commitment to product safety.

Cleaning

Before commencing any cleaning, switch off the Service Monitor and disconnect it from the supply. The exterior surface of the case may be cleaned using a soft cloth moistened in water. Do not use aerosol or liquid solvent cleaners.

Chapter 3

LOCAL OPERATION

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About this chapter

This chapter deals with using the Communications Service Monitor as a ‘stand alone’ instrument.

The front panel layout is described and a brief explanation of all controls and connections is given.

The connectors and occasional controls on the rear panel are identified.

An introduction to each of the test modes explains the principles behind tests that can be carried out and suggests some applications for the use of the monitor.

The power up and setup procedure is explained.

The operating sequences for each of the test modes is explained and the relevant menus outlined.

The internal setup and results memories are described and their use explained.

The use of the optional memory card facility is explained.

Producing hard copy of results on an external printer is described.

Before using the instrument, familiarise yourself with the power requirements and powering up procedure described in Chapter 2, *Installation*.

Front panel layout

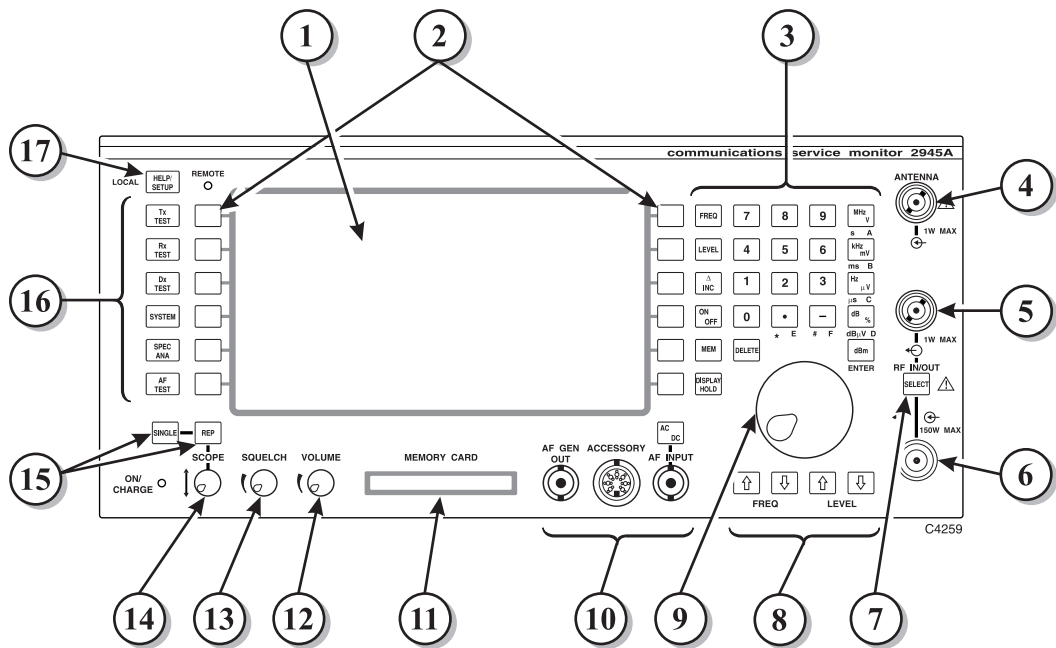


Fig. 3-1 Front panel

- (1) **Display.** The dominant feature of the front panel is the display screen, used to give information as to the operation of the instrument.

Information relating to the state of the instrument, the mode of operation and results of measurements and tests are all given visually on the display screen. See Fig. 3-2, *Typical displays*.

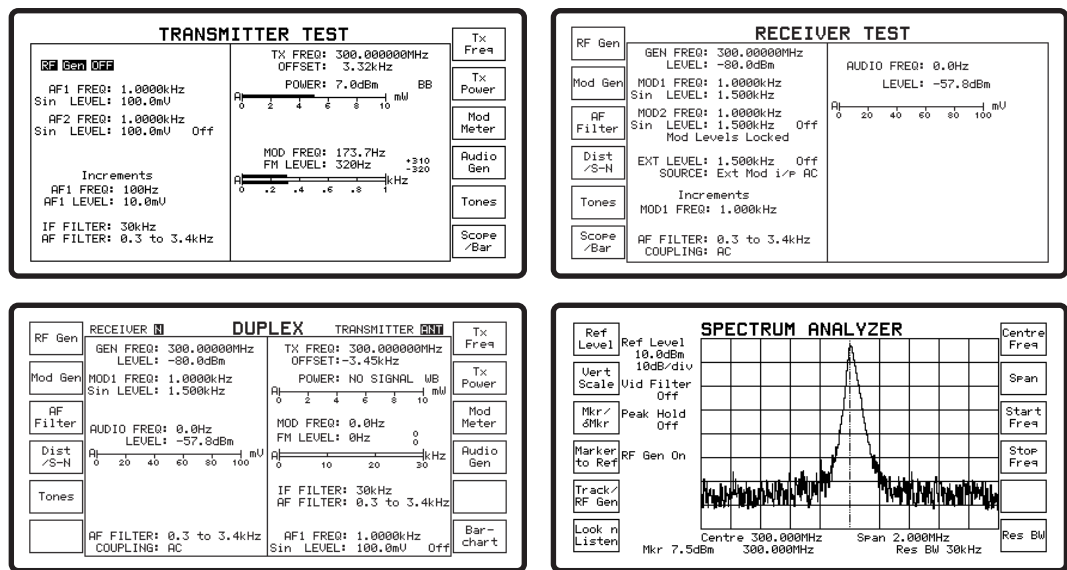
The screen is divided into four main areas. They are:-

The **information display area**, which shows the parameters relating to the test, together with settings and results, including bar charts. When the oscilloscope function is called up, all bar charts are removed from the display and the standard or expanded oscilloscope screen displayed.

When the SPEC ANA test mode is selected, the display changes to the SPECTRUM ANALYZER screen.

The **test title area**, where the current test description is displayed. LED indicators adjacent to each RF connector show the assignment of the connectors. This information is also shown in the test title area of the display when in Dx TEST mode.

Soft key menus, left and right. These areas each have menus of soft key labels designated to the adjacent soft keys. Some modes of operation only require one menu area of six selections. For example, the Tx TEST mode and the AF TEST mode both display and use only the right hand soft keys, the Rx TEST mode only the left hand soft keys. The Dx TEST mode uses the right hand soft keys for transmitter test functions and the left hand soft keys for receiver functions.



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Fig. 3-2 Typical displays

The various keys on the front panel are grouped according to their use or located adjacent to associated items.

- (2) **Soft keys.** To each side of the display screen are six unmarked keys. These are the ‘Soft’ keys referred to in the display description above. The specific function of each of these keys is defined by the instrument software and is indicated by the legend on the label immediately adjacent to it on the display screen.
- (3) **Data Input keys.** The right hand area of the front panel contains the ‘Data Input’ keys. These keys are used to key in data for the various test parameters. They are arranged in three groups:-
Function keys on the left of the group are coloured orange. They are used to define the parameter to be addressed; frequency, level, increment change or memory store location; before any digits are entered. The [ON/OFF] function key acts directly on the selected function.

Digit keys are in the centre of the group and include the minus sign and decimal point. These two keys have alternative symbols printed beneath them on the front panel which can be entered as data where appropriate. No action other than a normal keypress is required, as only one of the three options for each of these keys is relevant to the entry at any one time. The ‘Delete’ key back-spaces over figures entered on the display to correct any errors. Corrections cannot be made to an entry after a terminator key has been pressed for that entry. The original setting will be retained if an entry is not completed. The incomplete entry will be replaced on the display by the original setting when a keypress is made that confirms to the program that the setting being made has been aborted.

Terminator keys used to conclude a parameter value are on the right of the group. They are coloured orange.

When setting a modulation level, the entry is completed using the Hz, kHz, MHz or % key. The appropriate modulation type, FM or AM, is automatically selected.

(4), (5) & (6) RF input and output connectors.

The three sockets at the right hand edge of the front panel are the RF input/output connectors. Refer to the *Performance data* section in Chapter 1 for measurement accuracy, maximum power input levels and reverse power limits. The nominal impedance of all RF input and output circuits is 50 W.

- (4) **ANTENNA connection.** This is a female BNC connector, for 'Off Air' measurements and monitoring, using a suitable antenna. This connector can also be used for direct input of low level signals.
- (5) **BNC RF output connector.** This provides output from the RF signal generator.
- (6) **N type RF connector.** This is dual function, input and/or output. A 20 dB Delta attenuator is incorporated within the Service Monitor. This inter-connects the 'N type' connector with the RF generator output and the measuring receiver input, through the input/output selector switching.

WARNING

Hot surfaces

Take care when touching the RF Input N Type connector after the application of high levels of continuous power. If 50 W is exceeded for a prolonged period, the temperature of the connector can become excessive.

- (7) **RF input select key.** The [SELECT] key switches through all the RF connector combinations available. The current selection is indicated by LEDs. The \odot symbol shows the RF output connector and the \ominus symbol shows the RF input connector.
- (8) **Increment adjustment keys.** Under the variable control are the two pairs of increment adjustment keys, **FREQ** (frequency): [\uparrow] and [\downarrow], and **LEVEL**: [\uparrow] and [\downarrow].

These enable the frequency and level of the RF generator or a selected AF generator to be adjusted in pre-defined steps. The assignment and the value of the steps is shown on the display.

The **FREQ** [\uparrow] and [\downarrow] keys can be assigned to the Tx frequency value or either of the audio generators when in the Tx TEST mode, the RF generator or either of the modulation generators when in the Rx TEST mode, or either of the AF generators when the AF TEST mode is active.

The **LEVEL** [\uparrow] and [\downarrow] keys have the same options. The frequency keys and the level keys do not have to be assigned to the same generator.

The **FREQ** [\uparrow] and [\downarrow] keys can be assigned to the RF generator frequency or transmitter frequency as channel increments.

When operating in Dx TEST mode the increment keys are disabled.

The **SPEC ANA** mode uses the **FREQ** [\uparrow] and [\downarrow] keys for span range and centre frequency adjustment. The **LEVEL** [\uparrow] and [\downarrow] keys are used for reference level adjustment. See page 3-64.

The span is ranged up or down in a 1, 2, 5 sequence, from 1.0 kHz to 1.0 GHz.

Adjustment to the span by these keys is linear about the centre frequency and will not adjust below zero or above the top frequency limit.

The **LEVEL** [\uparrow] and [\downarrow] keys adjust the reference level range of the spectrum analyzer in either 2 dB or 10 dB steps depending on the setting of the reference level vertical range.

- (9) **Variable control.** The large rotary control under the data input keys is used to make adjustments to frequencies and levels that require a finite change such as when matching a test signal to an

undefined signal, or assessing the squelch operating level of a receiver. It has no mechanical stops. This control is also used to select items or digits from displayed lists, in conjunction with TONES and SYSTEM modes.

(10) Audio connections.

AF GEN OUT socket. The signal available at this BNC socket is the combined output from both or either of the AF generators and/or the tones generator.

AF INPUT socket. Signals fed into this BNC socket can be measured using the AF counter, the AF voltmeter and the distortion measuring circuits. It is also the input for the digital oscilloscope.

ACCESSORY socket. Used for connecting Directional Power Heads and other accessories. The presence of these is automatically detected. The socket is also used for direct connection of a headset, allowing modulation of the signal generator by a microphone and audio signal monitoring through headphones.

When using the accessory microphone with PTT switch, automatic switching between Tx and Rx modes using the PTT switch is possible.

DISPLAY HOLD key. To the left of the variable control is the [DISPLAY HOLD] key. Pressing this key at any time will freeze the display and prevent any adjustment to parameters displayed on the screen. The soft key menu changes to show two keys, [Store] and [Print].

The [Store] key, gives access to the STORE/RECALL screen and menu. The use of this feature is explained on page 3-82

The [Print] key is used to start the Screen Print function. This causes a hard copy of the held screen to be printed onto a suitable printer. If the memory card option is fitted, the current time and date, as held in the Real Time Clock, are printed on the hard copy.

The use of the Screen Print feature is explained under the heading 'Printer' on page 3-89.

AC/DC. AF input coupling option key Located above the AF input socket, this key toggles the AF input circuit between direct and capacitive coupling. The option selected is displayed on the screen.

(11) Memory card slot. Instruments with the optional memory card interface fitted, can make use of memory cards for the storage and retrieval of results and settings.

Details of the use of memory cards is given under later in this chapter under *Stores, settings and results* on page 3-82 and *Memory Card* on page 3-84.

(12) Volume. This control varies the level of the AF signal fed to the loudspeaker.

(13) RF receiver squelch level control. When monitoring the demodulated output through the loudspeaker or headphones, the RF level below which signals are isolated from the AF circuits can be controlled. Clockwise rotation of the squelch control raises this level and anti-clockwise rotation decreases it.

(14) Scope trace vertical position. This adjusts the vertical position of the trace within the graticule.

(15) Oscilloscope sweep mode keys. The [SINGLE] and [REP] keys, located above the scope vertical position control, select the oscilloscope sweep mode.

(16) Test mode select keys. On the left of the front panel are six blue keys. These are the 'Test Mode Select' keys, used to put the instrument into one of the basic test modes. They are active whenever the instrument is powered up and under local control.

(17) HELP/SETUP key. Above the test mode select keys is the 'HELP/SETUP' key.

Pressing this key will cause the HELP/SETUP access screen to be displayed if the instrument is under local control. This does not interrupt any on-going function of the Service Monitor. See *HELP/SETUP* on page 3-10

When the instrument is under remote control, pressing this key will return control to LOCAL *unless* an instruction to prevent local operation has been sent from the remote control device.

Rear panel controls and connectors

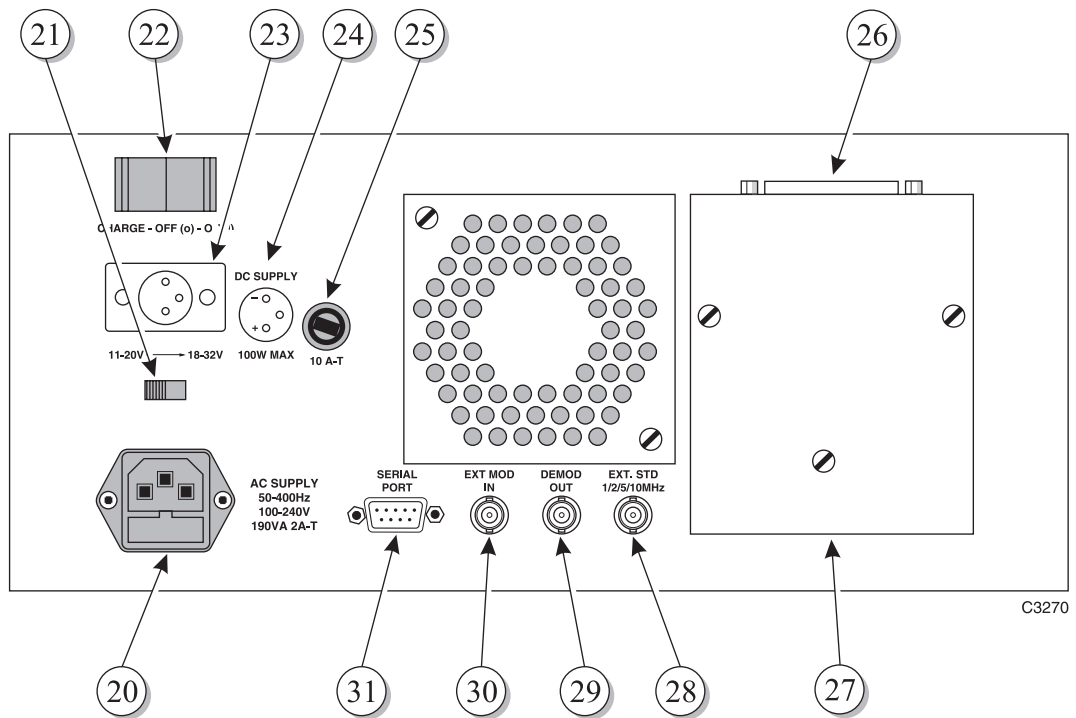


Fig. 3-3 Rear panel layout, (with optional GPIB fitted)

On the rear panel of the instrument are: -

- (20) **AC power supply input connector.** One range for all mains voltages. See the *Performance data* section in Chapter 1. The AC supply fuse is contained within this connector.
- (21) **DC input voltage selector.** Switches the power supply DC input circuits to match the available supply voltage. Ranges are 11-20 V and 18-32 V.
- (22) **Power switch.** The power switch has three positions ON, OFF, CHARGE. The ON position connects the power source to the instrument, the CHARGE position allows the Service Monitor power supply to recharge the accessory battery pack (if connected) from the AC mains supply. See *Getting started*; on Page 3-9.
- (23) **DC supply input voltage connector.** For direct connection of optional accessory battery pack and for powering the instrument from other DC supplies. See *Performance data*, in Chapter 1.
- (24) **DC supply pin connection diagram.** Shows the polarity of the DC power connector
- (25) **DC supply fuse.**
- (26) **GPIB interface connector.** This connector is only present when the GPIB interface option is fitted. Connection details are given in Chapter 2, under *Remote control connections, GPIB*.
- (27) **GPIB interface unit.** Optional. See (26) above.
- (28) **External frequency standard input.** This can be 1, 2.5 or 10 MHz; the Service Monitor will identify the applied frequency. In the event of external standard failure, control will revert to the internal standard.
- (29) **Demodulated signal output.** The demodulated signal removed from the input RF signal is brought to this connector for feeding to external equipment.
- (30) **EXT MOD IN (External modulation input).** A signal applied to this connector can be used as a modulation source for the receiver test signal. The input level of the applied signal should be 1.00 V (RMS sinewave) in order to maintain the correlation with the modulation level calibration. The frequency of the signal should be within the range of the internal modulation source of 20 Hz to 20 kHz (AM), DC to 100 kHz (FM).

- (31) **Serial port.** The SERIAL PORT connector provides RS232 interface facilities for remote control. It is also used for the serial output to a printer. Connection details are given in Chapter 2, under *Remote control connections, RS232*.

Getting started

(Applying power and selecting test modes)

The power ON/OFF switch, located on the rear of the instrument, has three positions.

Pressing the inside toggle will power up the instrument, from either AC or DC supply.

If both AC and DC supplies are connected, the AC supply will take precedence. A small trickle charge is also supplied to the DC supply.

Pressing the toggle nearest the edge of the instrument will supply a charging current of up to 7 A peak to the accessory battery pack from the AC mains supply.

The centre position is OFF.

With a power source connected, switching on the instrument will cause the cooling fan to operate and one of the test mode menus to be displayed. Which screen is displayed will depend on which store is selected as the 'Power Up From' store on setup page 2.

The low battery warning is activated when the voltage at the DC terminals falls to approximately 11 volts. The user selectable 'Power Up From' settings will be found useful when using the instrument from a battery pack. This will ensure that after replacing a battery pack, the instrument returns to the settings best suited to the tests being performed. See *Setup page 2* on page 3-12.

If you are unfamiliar with the instrument a few minutes spent exploring the setup menus and test modes is helpful.

The following explanation of keys and menus will assist in this.

Test mode screens and menus

The six test modes are selected by pressing the appropriate MODE key. These are light blue, with dark blue lettering. (Item 16 in Fig. 3-1, *Front panel*). Select each in turn and observe the display presented.

Each area of six soft key labels forms a menu. Various menus are called up as a result of selecting a change of test mode or by pressing a soft key within a test mode.

Fold out diagrams will be found at the end of this chapter, which show the screens displayed when each of the mode keys is pressed. These also show branching to the second or third level screens and menus. A diagram of the screens accessed from the HELP/SETUP key is also included.

These fold out diagrams are numbered to correlate with the associated key position as follows:-

- (1.0) HELP/SETUP
- (2.0) Tx TEST
- (3.0) Rx TEST
- (4.0) Dx TEST
- (5.0) SYSTEM
- (6.0) SPEC ANA
- (7.0) AF TEST

References in the manual to specific screens on the fold out diagrams is given as in the following example:-

Fold out diagram (2-2-3). This is the screen shown after pressing the [Tx TEST] mode key, then the [*Tx Power*] key (second key down), followed by the [*Harmonic analysis*] key (third key down). Where there are keys on both sides of a screen, keys 1 to 6 are on the left, keys 7 to 12 on the right.

To move to the top level menu of any test mode, including the currently active mode, press the relevant 'MODE' key.

For detailed use of specific TEST MODES see the section later in this chapter relating to that test mode.

HELP/SETUP

Pressing the [HELP/SETUP] key, at any time, will display the screen shown in fold out diagram (1-0), or a variation of it. Displaying the HELP/SETUP screen does not interrupt any ongoing operation or test.

The centre panel of the screen lists the following information:-

Serial number of the Service Monitor.

Software fitted, with the version codes and IFR part numbers.

Options fitted to the Service Monitor (except Option 3).

Help

The help facility is accessed by using the [HELP] key. Each soft key in the help menu displays 'On Screen Help' relating to the blue system key to the left of it. The [Return] key removes the on screen help and displays the top level screen of the mode from where HELP/SETUP was selected.

Self Test

Pressing this key gives access to the SELF TEST function of the Service Monitor. Refer to *Self tests and acceptance tests* in Chapter 2, for details.

Diagnostic

The DIAGNOSTIC screen can only be accessed by entering a protection code. When accessed, it allows a low level of software fault diagnosis to be undertaken. Certain areas of memory can also be reset from this screen. Details of access are given in the maintenance manual relating to this instrument.

Calibrate

Access to the CALIBRATION screen is also code-protected. Details relating to access and use are given in the maintenance manual relating to this instrument.

Brightness

Pressing this key will shift the selected brightness level up by one. If the present level is '4' the next press will extinguish the screen, the next will set the level to '1'. Note that with the screen blanked, all keys remain in the same state of activity as before the screen was extinguished.

Contrast

Selecting this key allows the contrast of the display to be varied using the variable control. The contrast may also be adjusted by the entry of a number between 0 & 255 using the data input keys.

Setup

The setup facilities allow selection of options of user preference and system compatibility. There are two setup pages.

Page 1, shown in fold out diagram (1-10), allows option selection of RF generator facilities.

Page 2, shown in fold out diagram (1-10-6), allows selection of AF level measurement units, GPIB address setting, remote control option selection and serial port setup.

The [Setup] key displays setup page 1, and give access to setup page 2.

Setup page 1

This page allows the following optional settings to be selected.

RF Counter Resolution 1 Hz/10 Hz

The RF counter resolution can be set to 1 Hz or 10 Hz. Selecting 1 Hz will slow the screen update rate by a factor of 10:1. The choice is made by toggling between the two options using the soft key adjacent to the text.

RF Level Measured in Watts/Volts/dBm

The RF level from the transmitter being tested can be displayed in terms of Watts into a 50 ohm load, voltage across the 50 ohm load or dBm into 50 ohms. The choice would normally be made so as to match the specification parameter of the transmitter under test. The selection is made by pressing the soft key adjacent to the text. This will toggle through the three options.

AF Distn/SINAD Averages

When distortion or SINAD tests are made to receivers using the Rx TEST mode or AF TEST mode, the results displayed are obtained by averaging the results of a number of measurements. This allows the user to balance the speed of testing against greater repeatability of measurement. The number of measurements made can be set within the range 1 to 20 by entering the required figure using the data input keys.

RF Level In: EMF/PD

With the EMF option selected, the displayed RF output level shows the open circuit voltage available at the RF output connector.

With the PD option selected the displayed RF output level shows the voltage that would be present across a 50 Ω load.

The selection is made by toggle action of the soft key.

RF Power Ext Atten: dB

The value of any attenuator entered here is considered as part of the instrument and all power measurements will be as from the input to the attenuator, not to the instrument input. Similarly power output levels will be adjusted to take account of the external attenuator value entered.

To enter a value of attenuation, which must be in dB, press the adjacent soft key, key in the digits of the value using the data entry keys and then press the dB terminator key.

The entered value will be applicable to all RF connectors into and out of the monitor. When changing test setups or test modes this must be taken into account to prevent erroneous readings.

The indicator **A** is shown against any signal level which has been calculated to include the external attenuator.

Rx=Tx Offset Freq: Hz

A setup option within the Tx TEST mode (Rx=Tx) will set the signal generator used for receiver testing to the measured frequency of a transmitter being tested. An Rx=Tx offset frequency entered here will cause the signal generator frequency to differ from the measured transmitter frequency by the offset frequency. To enter an offset frequency, press the adjacent soft key, key in the appropriate digits, using the minus key and the decimal point key if necessary, then use the relevant terminator key, (MHz, kHz or Hz). A positive figure will set the signal generator frequency above the measured transmitter frequency, while a negative figure will set the signal generator to a lower frequency than the transmitter.

Return

Returns to the Help/Setup Menu.

Setup page 2

This page allows the following optional settings to be selected.

Audio Level Measured in:

Repeated presses of the adjacent soft key will toggle through Volts, dBm, dBV or Watts and highlight the selection in inverse video.

The level of a signal applied to the AF input socket is measured in terms of the selected option. This will then apply to all subsequent measurements.

The indicated output level from the AF generators is not affected by this selection.

Audio Input Impedance:

This key is only active if the 600 Ω interface option is fitted. Pressing it will toggle between the 600 Ω balanced input impedance or the standard high impedance. The AF input connector on the front panel is used in either case.

Audio Output Impedance:

This key is also only active if the 600 Ω interface option is fitted. Pressing it will toggle between the 600 Ω balanced output impedance or the standard low impedance. The AF generator output connector on the front panel is used in either case.

20 dB audio attenuator:

This key is also only active if the 600 Ω interface option is fitted. Repeated presses of it will insert or remove a 20 dB attenuator from the output circuit of the audio amplifiers. With the attenuator in circuit the maximum output is limited to 400 mV. The adjustment resolution is increased to 0.01 mV below 40 mV and to 0.1 mV from 40 mV to 400 mV.

GPIB Address

Pressing the *[GPIB Addr]* key allows a new GPIB address to be entered by using the data input keys to enter the digits, followed by the ENTER terminator key. It may have a value between 1 and 30.

Remote Control

The Service Monitor can be operated by remote control using either the RS232 (serial) port or the optional GPIB (IEEE 488) interface. The *[Remote Control]* key toggles between the two options. The active function is highlighted in inverse video.

Serial Setup

The *[Serial Setup]* key gives access to the serial port setup menu. The parameters that must be set for compatibility with other equipment connected to the port are:-

Baud Rate; Parity Bit; Character Length; Stop Bit; and Handshaking.

Setting up of the serial port is described in the Chapter 4 of the Programming manual (46882-318B) under *Preparing the Service Monitor for remote operation*.

Printer Setup

A menu of printer type options and printer port selection is accessed through this key. The options are:-

Epson FX80 or FX100.

Laser Printer 75 dpi, 100 dpi, 150 dpi.

RS232 serial port or 'Centronics' parallel port. The selected port is highlighted in inverse video. If the parallel port option is not fitted, it is not shown on the menu, and the *[Printer Port]* key enables or disables the RS232 serial port as a printer port.

Power Up From

Successive presses of this key will toggle through the options available for configuration of the Service Monitor at 'Power Up'.

Last Used Store 0

Store 0 is loaded with the current settings each time power is removed from the instrument. With this selection made, the instrument will power up to the same settings as when power was removed, whether this was by user action or through power failure.

Preset Store 1

Store 1 contains the factory preset settings. With this selection made, the instrument will power up to the Rx TEST mode with all settings, for every mode, to the factory preset settings and options.

User Store 2

Store 2 is the first user accessible store, which is loaded through the user memory function. With this selection made, the instrument will power up to the settings stored in user memory store 2 without having to access the memory as a separate function.

Access to the user memory is by pressing the orange [MEM] key. See Stores, settings/results, later in this chapter, starting on page 3- 82.

Return

Returns to the last screen displayed prior to the pressing of the Help/Setup mode key.

Card Setup

A section giving a detailed explanation of memory cards and their use will be found later in this chapter starting on page 3-84. This key displays the MEMORY CARD FORMAT screen and menu. The real time clock is also set from this screen.

Return (on the HELP/SETUP screen)

Returns to the last used main mode.

Bar charts

The bar charts used to indicate signal levels can be set to autorange or to user selected ranges. The current state of each bar chart is shown by either an **A** (for Autoranging) or **H** (for Held range) at the left of it. The top level screen of Tx TEST, Rx TEST, Dx TEST and AF TEST, all have a [Scope/Bar] key.

Pressing this key will change the soft keys to those shown below. The function of each key is explained.

[Barchart Select]	This key will select each visible bar chart in turn. The selected bar chart is indicated by a highlighted A or H at the left of it.
[Auto range]	This key will set the selected bar chart to autorange. If it is currently set to autorange, the key will have no effect.
[▶◀]	Each press will change the bar chart to the next <i>highest</i> range. If the selected bar chart is set to autorange, the first press will remove autoranging and hold the current range. The next press will change the range. When the highest range is set, subsequent presses will have no effect.
[◀▶]	Each press will change the bar chart to the next <i>lowest</i> range. If the selected bar chart is set to autorange, the first press will remove autoranging and hold the current range. The next press will change the range. When the lowest range is set, subsequent presses will have no effect.
[Scope/Bar]	Pressing this key once, will remove the bar charts from the display and cause the normal oscilloscope to be displayed. Subsequent presses will display the expanded oscilloscope, then the bar charts again.
[Return]	This key will display the top level screen of the selected test mode.

Spectrum analyzer

The spectrum analyzer (SPEC ANA) mode presents a graphical display of Radio Frequency against RF level over a selected sweep of the RF spectrum.

Data relating to the setup and to measurements of the signals being analyzed is presented on the periphery of the display.

As well as the basic spectrum analyzer function, the monitor has a 'Look and Listen' function which allows the operator to listen to the demodulated signal extracted from the RF signal being examined.

Oscilloscope

The digital oscilloscope function, available from the Tx, Rx and AF test modes, displays signal waveforms on part of the display screen. The operation of the oscilloscope function is described in detail later in this chapter under *Oscilloscope*, starting on page 3-80.

When reference to the oscilloscope facility is necessary when describing other functions, this is indicated by heading the reference, ***OSCILLOSCOPE***, ***STANDARD OSCILLOSCOPE*** or ***EXPANDED OSCILLOSCOPE*** as appropriate.

Using the test modes

Brief descriptions

As the Service Monitor 2945A is a duplex instrument, the RF signal generator and the receiver circuits are able to operate simultaneously. This allows mobile transceivers to be tested under their normal operating conditions, with both their receiver section and transmitter section functioning. By selecting a particular test mode on the Service Monitor, one or both sections of the transceiver can be studied. A brief description of the function of each test mode is given below. Detailed user instructions follow under the relevant headings.

Tx TEST

With Tx TEST selected, the **TRANSMITTER TEST** screen is displayed and access to all Tx TEST mode features is available. See fold out diagram (2-0) at the end of this chapter.

The AF voltmeter makes measurements to the signals from the Service Monitor demodulator and displays the results.

The RF signal generator is active, producing an RF signal at the frequency and level set in the Rx TEST mode. This signal will be modulated at the level and frequency set, if the modulation generator selection does not conflict with the requirements of the Rx TEST mode.

Rx TEST

With Rx TEST mode selected, the **RECEIVER TEST** screen is displayed and access to all Rx TEST mode features is available. See fold out diagram (3-0) at the end of this chapter.

The AF voltmeter makes measurements to the signal obtained from the demodulated output of the mobile transceiver and fed into the AF input socket on the front panel of the Service Monitor.

The AF generators are active at the frequencies and levels set in the Tx TEST mode and their output routed to the AF GEN OUT socket, if the AF generator selection does not conflict with the requirements of the Tx TEST mode.

Dx TEST

With Dx TEST selected, the **DUPLEX TEST** screen is displayed and access to transmitter and receiver test features is available. See fold out diagram (4-0) at the end of this chapter. These features are not as comprehensive as those available from the **TRANSMITTER TEST** or **RECEIVER TEST** screens, but do allow measurements to be made to the major parameters. The Service Monitor has two AF generators, either or both of which can be used to modulate the transmitter being tested or the RF generator. However, each generator can only serve one function at the same time. There is only one AF measurement path, which is switched by the software between receiver test and transmitter test functions.

SPEC ANA

With SPEC ANA selected, the SPECTRUM ANALYZER screen is displayed and access to the spectrum analyzer features is available. See fold out diagram (6-0) at the end of this chapter. The RF signal generator is active, producing an RF signal at the frequency and level set in the Rx TEST mode, if the tracking generator feature is not selected. The spectrum analyzer tracking generator signal is provided by the RF generator.

The modulation generators will modulate the RF signal generator, with the same provisos as in Rx TEST mode. If the **LOOK AND LISTEN** screen is displayed, AF Gen 2 is used to provide the sweep signal, therefore it is not available to provide modulation.

AF TEST

With AF TEST selected, the **AUDIO TEST** screen is displayed and access to the AF TEST features is available. See fold out diagram (7-0) at the end of this chapter. The RF generator is disabled.

SYSTEMS

The SYSTEM key gives access to the SYSTEM TEST mode. If any of the system test options have been provided on the particular Service Monitor, the user is able to carry out automatic and/or manual tests to pertinent equipment. The use of the SYSTEM TEST mode is described in the supplementary operating manuals, supplied when any of these options are fitted. Fold out diagram (5-0) at the end of this chapter shows typical SYSTEM TEST mode displays. The displays from all keys are not shown, as there are many similarities to the various systems.

Press To Talk facility

A mode switching capability is provided by the 'Microphone with PTT switch' optional accessory. See *Performance data, optional accessories*, in Chapter 1.

With 'microphone' selected as the external modulation source and the instrument operating in the Tx TEST mode, pressing the PTT switch will cause the instrument to switch to the Rx TEST mode.

With the instrument set to the Rx TEST mode or Dx TEST mode, pressing the PTT switch will allow voice modulation of the RF signal from the Service Monitor, but mode switching will not happen.

Tones

A soft key designated [*Tones*] is included in the top level menus of the Tx TEST mode, Rx TEST mode, Dx TEST mode, and AF TEST mode.

Pressing this key will display the menu shown in fold out diagram (2-5), (3-5), (4-5) or (7-5), and give access to the 'TONES' test facility. This facility is used to provide modulation generators and demodulation decoders to simulate the various coded calling signals used on mobile radio systems for automatic selective calling of mobile transceivers.

General

The instructions for transmitter testing assumes that the Tx TEST mode has been selected, and for receiver testing assumes that the Rx TEST mode has been selected. However, these instructions apply equally to the Dx TEST mode. References are made to Dx TEST mode to clarify this, or to identify a difference in presentation. These references are headed *DUPLEX*.

The Dx TEST mode, the Oscilloscope function, and the TONES facility, each have a section of this chapter dedicated to their operation.

Tx test (transmitter testing)

Overview

The Communications Service Monitor 2945A has been designed to test the performance of mobile communication equipment. This section explains the use of the Tx TEST mode. Typical uses are:-

- Performance checking following manufacture
- Routine quality assurance testing
- Workshop or field fault diagnosis etc.

The tests which need to be carried out will depend on the specification of the transmitter and the reason for testing, however a generalised list would be:-

Transmitter power Transmitter frequency RF distortion Spurious outputs Modulation characteristics Modulation frequency response Companding/limiting Modulation distortion
--

This Service Monitor will perform all of the above tests.

With the Tx TEST mode selected, the screen and menu shown in fold out diagram (2 -0) is displayed.

Using this screen and menu, the Service Monitor is set up for transmitter testing, and the test results displayed.

The sections of the monitor available for transmitter testing are: -

The AF generators, used to provide a modulating signal for the transmitter.

The audio tones generator. Used to provide sequential tones for POCSAG and DCS systems.

The RF power meter.

The RF counter.

The modulation meter, to measure the depth of amplitude modulation or the deviation of frequency modulation and to recover the modulating signal for other tests. The demodulated output is fed to the audio amplifier, and can therefore be monitored on the loudspeaker or on a headset connected to the accessory socket. The SSB option allows Single Side Band modulation to be demodulated.

The oscilloscope, to examine the wave form of the demodulated signal.

As well as setting up the major sections of the Service Monitor, the following parameters are selected from the TRANSMITTER TEST screen:-

The TRANSMITTER TEST screen allows setting of the following;

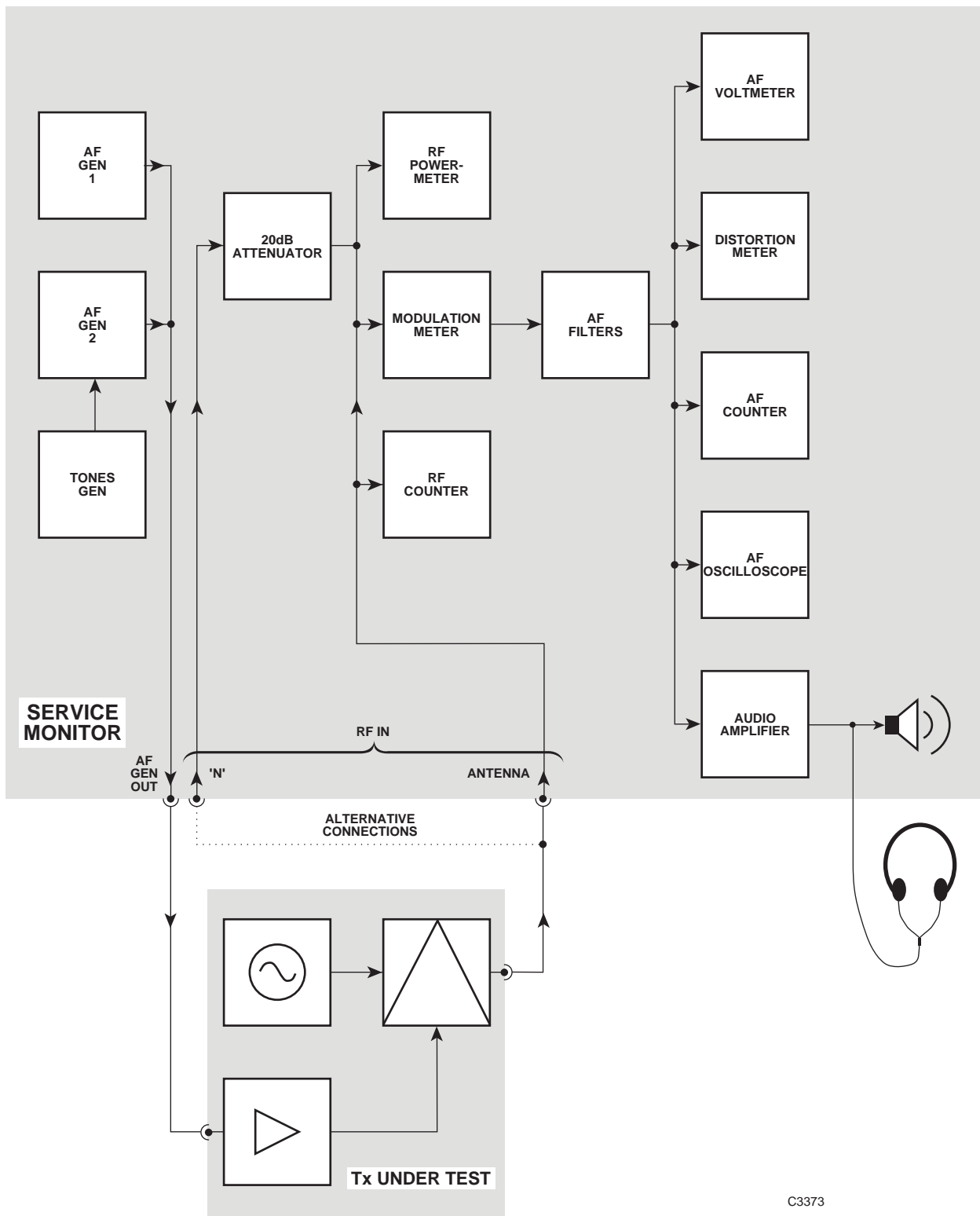
IF filter bandwidth.

AF filter pass-band.

De-emphasis filtering.

Distortion measurement methods.

Connections



C3373

Fig. 3-4 Transmitter test connections

The transmitter and the Service Monitor are connected as shown in Fig. 3- 4, *Transmitter test connections*. The block diagram of the Service Monitor shows the signal routing within it.

The Audio frequency input connection to the transmitter must be to the audio input, in place of the usual microphone input. This connection will vary for differing types of equipment. Points to note are:-

- The microphone must be disconnected, as any input from it would affect the performance of the test.
- The microphone and its cable may complete the 'keying' circuit of the transmitter using a 'press to talk' switch, in which case an alternative arrangement must be provided.
- The RF output connection from the transmitter should be made using good quality RF cable with correctly fitted connectors. Worn connectors and damaged or kinked cable can give rise to high levels of reflected power. This can cause misleading results and possible damage to the transmitter.
- Consider the power output of the transmitter and connect to the appropriate input connector on the monitor. The maximum power to the BNC (Antenna) socket is 1 W and to the 'N-Type' connector 150 W. If the transmitter output power exceeds this level then a suitable power attenuator should be connected between the transmitter and the monitor or a calibrated 'sniffer' used to take a sample of the output, using a dummy load if necessary.
- The power source for the transmitter should be reliable and stable. The battery of a vehicle may discharge if supplying a transmitter during prolonged testing or the 'earth' common return connection may become open circuit if the transmitter is removed from its normal location.

The procedure for making each of the tests listed above follows. Some of the tests may require separate operations and others will only require a reading to be made.

WARNING

Hot surfaces

Take care when touching the RF Input Type N connector after the application of high levels of continuous power. If 50 W is exceeded for a prolonged period, the temperature of the connector can become excessive.

Setting up

When all the required connections have been made, select the Tx TEST mode to display the screen and menu show in fold out diagram (2-0).

Set the parameters or options to suit the test requirements, from the TRANSMITTER TEST menus.

The complete setup can be stored by making use of the internal setup/results memories or the optional memory card facility. Both of these features are described under *Stores, settings/results*, later in this chapter, starting on page 3- 82.

RF generator state

This Service Monitor is a duplex instrument as mentioned earlier. (See *Using the test modes*, on page 3-15.) The state of the RF generator is shown on the TX TEST display by the legend **RF GEN ON** or **RF GEN OFF**. The state of the RF generator can be switched by pressing the top left soft key.

Tx frequency

Press the *[Tx Freq]* key.

The soft key options change to those shown in fold out diagram (2-1)

The receiver circuits of the Service Monitor must be set to the RF output frequency of the transmitter under test. This can be set manually using the data input keys, or automatically by pressing the *[Auto Tune]* key.

Manual frequency setting

Range; 100 kHz to 1.05 GHz

With the **[FREQ]** legend highlighted, data can be entered from the keyboard to the Tx FREQ parameter. As the entry can only be a frequency setting, it is not necessary to select the orange [FREQ] key. Enter the required frequency by using the digit keys and the decimal point key if relevant. The resolution of the RF FREQ entry is 1 Hz, but it is not necessary to enter every digit down to the least significant place if a ‘multiplier’ terminator key is used.

The entry is completed by pressing a terminator key. Using the [MHz], [kHz] or [Hz] key causes the entered frequency to be displayed according to normal convention. The following examples explain further.

Pressing:-

[1] [2] [5] [MHz]	will display	125.000000 MHz
[1] [2] [5] [kHz]	" "	125.000 kHz
[1] [2] [5] [0] [kHz]	" "	1.250000 MHz
[1] [.] [2] [5] [MHz]	" "	1.250000 MHz
[1] [2] [5] [0] [0] [0] [1] [Hz]	" "	1.250001 MHz

Variable control

With the **[FREQ]** legend highlighted, the Tx FREQ parameter can be adjusted by using the variable control.

Frequency increment

The FREQ [\uparrow] and [\downarrow] keys can be assigned to transmitter frequency adjustment. Refer to the section on incremental adjustments which starts on page 3-62.

Automatic frequency setting

Pressing the [Auto Tune] key causes the Service Monitor to sweep over the RF input range and lock onto the strongest signal present on the selected RF input socket. The mean frequency of the signal is displayed against the Tx FREQ legend, with Auto tune replacing OFFSET.

Note

SSB (if fitted). The autotune function may not operate when attempting to tune to an SSB transmitter unless a steady tone is being used as a modulation source. The frequency to which the Service Monitor will tune will be the true RF frequency of the sideband and not that of the channel frequency.

Pressing the [Rx=Tx] key causes the RF generator used for the Rx TEST mode to be set to the same frequency as the measured RF from the transmitter under test. A frequency offset facility can be set up which gives a set difference between the frequency of the measured transmitter RF and the set frequency of the receiver test generator. (Rx=Tx \pm offset). See the option selections within setup page 1, for more information.

After setting the Tx FREQ and any associated adjustments, use the [Return] key to revert to the original TX TEST menu.

Tx power

The [Tx Power] key gives access to RF power measurement functions or associated functions.

Broad Band or Narrow Band power

The [Broad/Narrow] key selects which of the RF power measurement methods is operative. The selected method is indicated on the display by the letters BB or NB to the right of the digital power reading. The use of this facility is explained under *Making measurements* later in this chapter, starting on page 3-25.

Directional Power

The [*Dir Power*] key displays the screen required for using the optional directional power and VSWR accessories. The use of the Directional Power Head accessory is described in Appendix A of this manual, and of the Light-weight Directional Power Head accessory, in Appendix B.

To leave this screen, press any of the blue MODE keys. The top level screen of that mode will be displayed.

RF harmonic Analysis

The [*Harmonic Analys*] key activates the RF harmonic Analysis function. The right-hand side of the screen shows five horizontal bar charts. The upper bar chart shows the power meter reading and is the same as that shown on the other Tx TEST screens.

The four HARMONICS bar charts display the level of the 2nd, 3rd, 4th and 5th harmonics of the carrier. The frequency range of the instrument governs the number of harmonics of which readings can be made.

The use of this facility is explained under *Making measurements* later in this chapter, starting on page 3-25. Pressing the [*Return*] key will display the previously used Tx TEST screen with the Tx power menu.

RF transient power Analysis

The [*Trans Analys*] key selects the RF Power TRANSIENT ANALYSIS mode.

This mode displays a captured RF power profile of a transmitter against time. Triggering is activated by the RF level passing a preset value. The signal is captured using a continually updated, first in/first out, storage device. This allows the Service Monitor to show the power profile both before and after the trigger point.

The use of this facility is explained under *Making measurements* later in this chapter, starting on page 3-25.

Pressing the [*Return*] key will display the previously used Tx TEST screen with the top level Tx TEST menu.

Modulation meter, demodulation options setup

Set up the demodulation options to be compatible with the transmission from the unit under test.

Press the [*Mod Meter*] key. The soft keys change to the demod soft keys shown in fold out diagram (2-3).

Modulation Type

The Service Monitor can demodulate AM and FM signals. The demodulated signal is made available at the 'DEMODO OUT' connector on the rear of the instrument. SSB signals can be demodulated if the SSB option is fitted.

The [*AM/FM*] key, or [*AM/FM/SSB*] key, is used to select the appropriate modulation type by sequential key presses. The MOD LEVEL indication within the main display becomes suffixed by % for AM; and by MHz or kHz for FM. When SSB has been selected, no modulation level is shown, either digitally or as a bar chart.

Selecting the modulation type for Tx TEST does not change the current modulation type set on the Service Monitor RF generator.

SSB Input sensitivity

No RF carrier signal is produced by SSB transmitters. Therefore the automatic gain control circuits of the Service Monitor cannot respond to these signals.

When 'SSB' demodulation has been selected, the RF sensitivity of the Service Monitor can be controlled manually. Three sensitivity settings are given as soft key choices; high, medium and low. The approximate sensitivities of these are shown in the following table:-

<i>[High Sens]</i>	-90 dBm to -30 dBm at 'N type' -110 dBm to -50 dBm at 'Antenna'
<i>[Med Sens]</i>	-30 dBm to +20 dBm at 'N Type' -50 dBm to 0 dBm at 'Antenna'
<i>[Low Sens]</i>	+20 dBm to +50 dBm at 'N Type' 0 dBm to +30 dBm at 'Antenna'

WARNING

Hot surfaces

Take care when touching the RF Input Type N connector after the application of high levels of continuous power. If 50 W is applied for a prolonged period, the temperature of the connector can become excessive.

IF bandwidth

The IF bandwidth of the Service Monitor receiver circuits can be selected from the following options:-

300 Hz	3.0 kHz	30 kHz	300 kHz
--------	---------	--------	---------

Press the *[IF Filter]* key. The right hand soft keys change, to allow selection of IF bandwidth filters as shown above.

The selected filter is shown on the display. Press the *[Return]* key after selecting the required filter.

Audio frequency filtering

The demodulated signal can be filtered using the following audio filters:-

0.3 - 3.4 kHz band pass	50 kHz low pass	15 kHz low pass	300 Hz low pass	CCITT [†] or C-MESS [‡]
----------------------------	--------------------	--------------------	--------------------	--

[†] Only if option 23 (CCITT filter) is fitted.

[‡] Only if option 24 (C-MESS filter) is fitted.

Press the *[AF Filter]* key. The right hand soft keys change, to allow selection of AF filters as shown above. Press the *[Return]* key after selecting the required filter.

OSCILLOSCOPE

The input to the oscilloscope is taken from the demodulators through any selected AF filters. Therefore modulation measurements made using the oscilloscope will include the characteristics of the selected AF filter.

Audio distortion measurement

The Service Monitor is able to measure signal noise and distortion against the following parameters:-

Signal to noise ratio	SINAD level	Percentage distortion
-----------------------	-------------	-----------------------

Press the *[Dist S/N]* key. The right hand soft keys change, to allow selection of S/N, SINAD and distortion measurements.

Off

Disables any active distortion measuring function.

Hint.

By disabling this function, the time taken to measure the remainder of the measurement functions is shortened thereby reducing the update time.

S/N

Selects signal to noise ratio as the measurement method. The Signal to Noise bar chart ranges available are 0 to 30 dB and 0 to 100 dB. The signal to noise ratio is displayed as a digital read-out above the bar chart. The TX TEST mode menu is recalled automatically after pressing this key.

SINAD

Selects SINAD as the measurement method.

The AF1 generator will be set to 1 kHz by this action, regardless of any previous setting.

The distortion bar chart ranges available are 0 to 18 dB and 0 to 50 dB. The SINAD level is displayed as a digital readout above the bar chart. The TX TEST mode menu is recalled automatically after pressing this key.

Dist'n

Selects distortion percentage as the measurement method.

The AF1 generator will be set to 1 kHz by this action, regardless of any previous setting.

The distortion bar chart ranges available are 0 to 10%, 0 to 30% and 0 to 100%. The distortion percentage level is displayed as a digital readout above the bar chart. The TX TEST mode menu is recalled automatically after pressing this key.

With all the required parameters set, power up the transmitter.

The power output of the transmitter is shown on the POWER LEVEL bar chart, with the power level given in digital form above it.

The level of modulation is displayed on the modulation level bar chart, with the FM DEVN or the AM DEPTH shown digitally. When the SSB demodulation function has been selected, no modulation bar chart is displayed. The legend 'SSB Trans' and the selected sensitivity is shown.

The FREQ OFFSET will indicate the difference between the mean (measured) frequency of the transmission and that entered as transmitter frequency.

More (de-emphasis, FM deviation pk/rms, modulation dBr)

Press the *[More]* key. The right hand soft keys change, to allow selection of de-emphasis mode, and FM deviation and modulation measurement modes.

De-emph

De-emphasis filtering, ON/OFF, is toggled by alternate presses of the *[Deemph]* key. The de-emphasis filtering uses a 750 μs time constant to give a 6 dB/octave roll-off.

De-emph ON appears on the main display when appropriate. No indication is given to show that de-emphasis is not on.

Press *[More]* to return to the previous menu or *[Return]* to display the main Tx TEST menu.

FM Dev Pk/rms

Toggles between measuring FM modulation with RMS or with peak detectors. The measurement mode – Pk or rms – appears to the left of the FM deviation bar chart.

Press *[More]* to return to the previous menu or *[Return]* to display the main Tx TEST menu.

Mod dBr

Toggles between measuring the absolute AM or FM modulation or the AM or FM modulation relative to the value registered at the moment the key is pressed. The modulation level is shown in units of dBr when appropriate.

Press *[More]* to return to the previous menu or *[Return]* to display the main Tx TEST menu.

Audio generator setup

Freq. range	10 Hz to 20 kHz
Level range	0.1 mV to 4 V rms
Shape option	Sine or square

To set up the audio generators in order to modulate the transmitter, press the *[Audio Gen]* key. This will display the audio setup menu shown in fold out diagram (2-4).

Set up the audio generator(s) for the required frequency and output level by using the soft keys and data input keys:-

[Gen 1/Gen 2] to select AF1, then, [FREQ][n]...[n][kHz/Hz]

[LEVEL][n]...[n][V/mV/dBm]

then *[Gen 1/Gen 2]* to select AF2 if required,[.../dBm]

The FREQ [↑] and [↓] and the LEVEL [↑] and [↓] keys can be assigned to AF generator frequency and level. See *Incremental adjustments* which starts on page 3-62.

Either or both generators can be switched off to suit the test requirement. To disable a generator select it using the *[Gen 1/Gen 2]* key to toggle between them. When the title of the generator is highlighted on the display, press the orange[ON/OFF] function key. Repeated presses of this key will toggle the ON/OFF action.

The shape of each audio generator output waveform can be either sine or square wave. This is controlled by first selecting the audio generator as for [ON/OFF] control above, then pressing the *[Shape]* key to toggle between the options.

Note that the audio generators are also used as modulation generators for the receiver test signal generator. If both generators are set up as a modulation source in the Tx test mode, switching to Rx TEST mode will show both modulation generators in the OFF condition. Either or both generators can be set up and turned on within the Rx TEST mode. The frequency, level and

shape settings of their last use in the Rx TEST mode will be retained within the Rx TEST mode setup. These settings will be effective when the generators are switched to the 'ON' condition in receiver test mode. Their use as audio generators in the Tx TEST mode will then be disabled.

Pressing the *[Lock]* key locks the output level of the two audio generators to the same level. The unselected generator locks to the level of the selected generator.

When the audio generators are set to the required settings press the *[Return]* key to restore the Tx TEST menu.

Making measurements

This section describes the actions needed to make measurements of each parameter associated with transmitter testing. All tests are described individually as 'one off' tests, but in practice, once set up, all active parameters will be measured simultaneously with continuous updating and the results displayed using the selected measurement units.

The results obtained from tests can be stored for later analysis or transfer to hard copy by making use of the internal setup/results memories or the optional memory card facility. Test mode screen settings can similarly be stored for future use.

All of these features are described under *Stores*, *Settings/results*, or *Printer*, later in the chapter.

Transmitter power

Broad Band and Narrow Band power measurements

The monitor has both Broad Band and Narrow Band power measurement facilities. The Broad Band power meter measures the total average power of all signals present at either RF input, while the Narrow Band power meter measures only the average power of the signal contained within the IF pass band selected for the Tx TEST mode.

The facilities of the Service Monitor allow the RF signal generator to remain active in the Tx TEST mode. Therefore the signal from this will be present at common points within the RF input/output circuits of the instrument and will contribute to measurements made by the power meters. When making measurements where this will make any significant difference to the measurement, disable the RF generator by selecting the RF Gen OFF condition from the Rx TEST mode or the Dx TEST mode.

Narrow band power measurements cannot be made when the frequency of a transmitter has been set using the *[Auto Tune]* key.

The maximum continuous power rating of the 'N-Type' connector is 50 W with a minimum indication of 5 mW. Lower levels of input signal are indicated as voltage levels, the first bar chart graduation being at 20 μ V. The maximum continuous power rating of the antenna BNC connector is 5 W.

CAUTION

A power overload condition is indicated by an audible and visual warning. Should this condition be indicated, immediately reduce the level of RF power from the transmitter into the Service Monitor.

Do not stop the warning by switching off the Service Monitor, as this will silence the warning but will leave the excessive RF power connected to the internal load.

Do not attempt to stop the warning by disconnecting the RF connector, as this can damage the transmitter and may cause electric shock or skin burns.

WARNING

Hot surfaces

Take care when touching the RF Input Type N connector after the application of high levels of continuous power. If 50 W is applied for a prolonged period, the temperature of the connector can become excessive.

With the monitor in the Tx TEST mode, and the transmitter connected to the monitor as described above, key up the transmitter.

The RF power bar chart gives an analogue representation of the active power meter reading. A digital read-out of the power is displayed above the bar chart.

The options available for the digital read-out from the power meter are dBm, Watts or Volts.

The bar chart can be auto-ranging or manually selected. See Bar charts on page 3-13.

External attenuators can be included in the input path to the Service Monitor. The value of any such attenuators can be entered into Setup Page 1 of the Service Monitor, which will cause the power measurement software to calculate the power at the attenuator input. The result of this calculation is shown on the RF power bar chart and as the digital power reading.

Power readings which include an attenuation factor have an inverse video 'A' adjacent to them.

The full-scale ranges of the RF power bar chart, are:-

10 mW to 100 kW in 15 steps of 1-3-10 sequence.

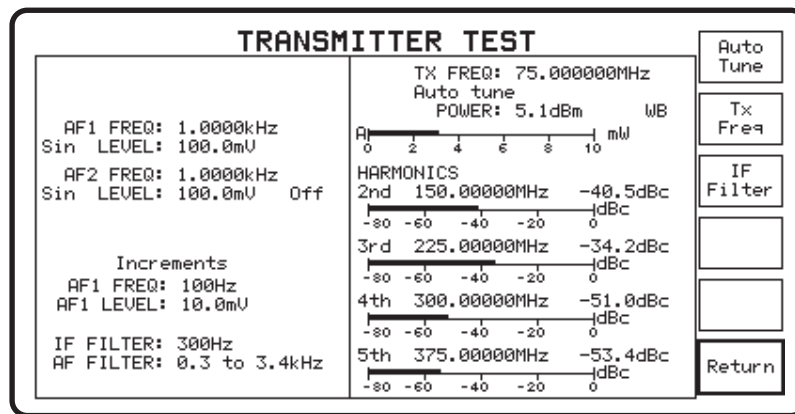
100 mV to 3 kV in 16 steps of 1-3-10 sequence.

Directional power measurements

Directional power and VSWR measurements can be made using the optional Directional Power Head accessory or Light-weight Directional Power Head accessory. The DIRECTIONAL POWER METER screen, accessed by pressing the [Dir Power] key, is used with these accessories. To leave the DIRECTIONAL POWER METER display and return to the Tx test mode display, press the [Tx TEST] key. See Appendices A and B.

RF harmonic analysis

The harmonic content of a transmitter output can be analysed using the harmonic analyzer function.



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Fig. 3-5 Tx power, harmonic analysis screen

To obtain an analysis of a signal, proceed as for making a power level reading. With the power level of the signal to be analysed displayed, press the [Harmonic Analys] key. The screen shown in Fig. 3-5, Tx power, harmonic analysis screen, is displayed. The power level bar chart shows the power output of the transmitter as before. The harmonic content of the signal is shown on the HARMONICS bar charts. These four bar charts are each given to progressive harmonics of the fundamental frequency of the signal. They are graduated in dB relative to the carrier level (dBc), from 0 to -80 dBc.

The harmonic number and frequency is shown over each active bar chart, with the level, in dBc, given as a digital read-out.

The level of a harmonic which has a frequency above the RF range of the monitor cannot be measured and bar charts which would be given to these frequencies remain inactive.

IF passband filters

When making harmonic analysis readings, the IF passband of the Service Monitor can be set independently to that set in the main Tx TEST mode. Pressing the [IF Filter] key when the harmonic analysis function is displayed, allows selection of the following IF passband filters.

300 Hz	3 kHz	30 kHz	300 kHz
--------	-------	--------	---------

The filter selection is retained within the harmonic analysis setup. The IF filter selected in the main Tx TEST mode will be unchanged.

For accurate results, the noise floor over the measurement range should be as low as possible, but the passband should not clip the sidebands of the fundamental signal. Select the filter that will best suit these requirements.

As the Spectrum Analyzer uses the same IF filters, the optimum filtering can be selected by examining the signal using the Spectrum Analyzer.

Pressing the [Return] key will display the top level Tx TEST mode screen.

If the operating mode of the Service Monitor is changed from Tx TEST mode with the harmonic analysis function selected, the harmonic analysis screen will be displayed again when Tx TEST mode is next selected.

RF transient power analysis

This facility is used to capture, display and record changes to power levels of RF signals. The TRANSIENT ANALYSIS screen, used to control and display this function, is accessed from the Tx TEST mode by the key sequence [Tx Power], [Trans Analys]. See Fig. 3-6, Power Transient Analysis screen.

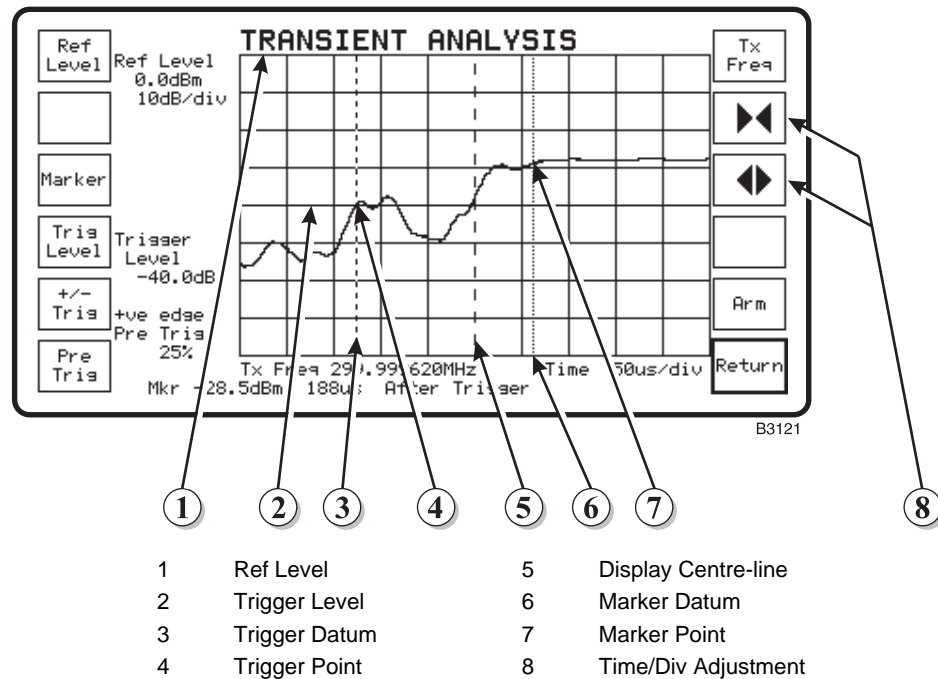


Fig. 3-6 Power Transient Analysis screen

To observe the power level profile of an RF signal during a level transition, the signal is applied to the RF input of the monitor and the instrument armed to trigger when a specific RF level is passed through.

The instrument then displays an RF Power Level vs Time graph, showing the transition.

Bandwidth

The IF filter selected on the Tx TEST screen remains selected when the TRANSIENT ANALYSIS function is selected.

Ref level

The graticule of the transient analysis screen is calibrated in 10 dB/division vertically with the top of the display as the reference level.

To set the reference level, press the *[Ref Level]* key to highlight the Ref Level legend. The required reference level can then be set, either by entering a new value using the data entry keys, or by adjusting the variable control. The reference level should be set so that the expected maximum and minimum levels will be visible on the display.

Note

The reference level setting is common with the SPEC ANA mode reference level; a value set on one, will be found set on the other, when next accessed.

Marker

A variable marker can be displayed, indicated by a fine dotted vertical line, with a read-out of the marker values displayed at the bottom of the screen. The marker reading provides two values.

The absolute RF power level at the marker position. (Not the level relative to the Ref Level).

A time difference of the position of the marker relative to the trigger point.

If the marker, the Mkr legend and the relevant readings are not displayed, press the *[Marker]* key. They will appear at the bottom of the screen with the Mkr legend highlighted. The position of the marker along the time axis of the display can be adjusted using the variable control.

When the marker is displayed and the Mkr legend highlighted, pressing either the *[Ref Level]* key or the *[Trig Level]* key will highlight the appropriate legend and transfer the variable control operation from the marker to the highlighted function.

When the marker is displayed and the Mkr legend highlighted, pressing the *[Marker]* key will remove the marker and its readings from the display.

When the marker is displayed but the Mkr legend is not highlighted, pressing the *[Marker]* key will transfer the variable control operation to the marker, and highlight the Mkr legend.

Trigger level

The transient capture operation is started by the signal level passing through the set Trigger Level. The set Trigger Level is relative to the Ref Level (top of display). This is set by pressing the *[Trig Level]* key to highlight the Trigger Level legend, then either entering a new value using the data input keys or by using the variable control. The Trigger Level can be set to any point within the dynamic range of the current display.

Positive or negative triggering

The transient capture operation can be initiated by either a rising or falling signal. Repeated presses of the *[+/- Trig]* key alternates the selection. The state of the current setting is shown as either +ve edge or -ve edge.

Pre-trigger display

The user can select the proportion of the display given to pre-trigger activity. Repeated presses of the *[Pre Trig]* key will step through 0 %, 25 %, 50 %, 75 % and 100 % values. 0 % will cause the display to commence (on the left of the screen) at the time of trigger, 50 % will place the

trigger point centre screen with pre-trigger levels shown to the left and post-trigger levels shown to the right while 100 % will cause the display to finish (on the right of the screen) at the time of trigger. 25 % and 75 % will produce displays with these proportions of pre-trigger visible. The trigger point is indicated on the display by a medium pecked line.

Transmitter frequency

The frequency of the transmission to be analysed can either be set manually or transferred from the previous test mode used.

When the transient analysis function is accessed, the transmitter frequency set in the Tx TEST mode is taken as the transmitter frequency for analysis.

If the SPEC ANA mode is accessed and the span changed to use a new centre frequency, this will become the new transmitter frequency for the Tx TEST mode and therefore the transmitter frequency for the transient analysis function.

Time scale

The time scale of the display is adjustable from 50 μ s/division (500 μ s full scale), to 5 s/division (50 s full scale). Repeated presses of the [\blacktriangleright] key will progressively increase the time/division in a 1, 2, 5 sequence. Using the [\blacktriangleleft] key will similarly cause the time/division to decrease.

Arming, triggering and storing

The transient capture operation has three phases. The current phase is shown in inverse video at the bottom right of the display.

The **Armed** phase is active when the transient analysis function is accessed. The level of any signal entering the selected RF input connector at the set transmitter frequency is displayed on the screen, if it is within the dynamic range currently being displayed.

Samples of the level of the signal displayed are stored in a circular buffer, configured to be filled within the time of one display scan.

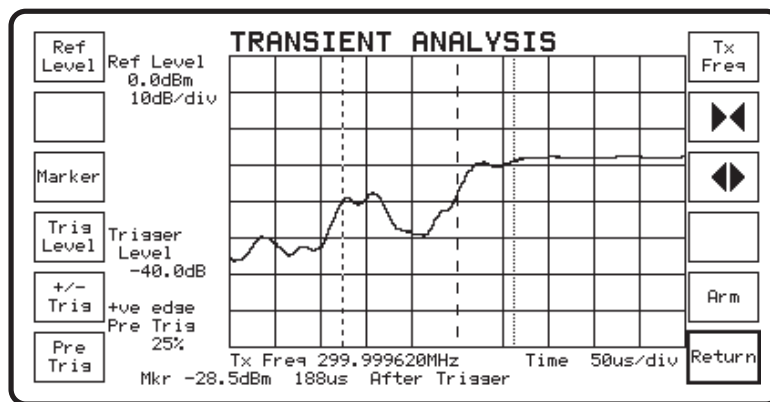
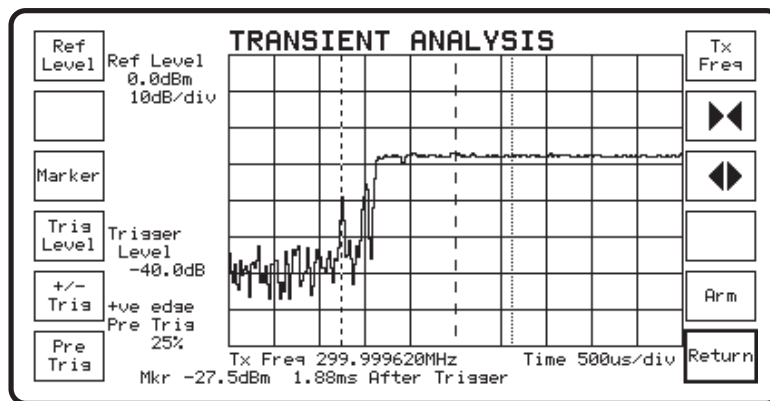
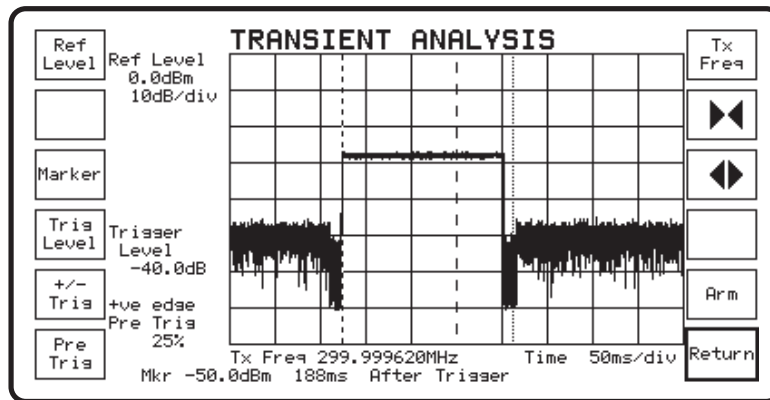
While in the **Armed** phase, the display is re-initialised if a setting is changed which could otherwise result in an erroneous display being produced. The settings which cause re-initialising when changed are:-

- Reference level
- Transmitter frequency
- Display time scale
- Pre-trigger.

The **Triggered** phase is activated by the RF level passing through the trigger level in the selected direction.

Writing to the circular buffer is stopped after the elapse of the post-trigger time to be displayed.

When the display is complete, it will show the profile of the transmitter level transient. This starts the **Stored** phase. Fig. 3-7, shows transient records of the same signal transient at Time/div settings of 50 ms, 500 μ s and 50 μ s.



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Fig. 3-7 Transient Analysis displays

From this condition a permanent record can be made on a suitable printer by using the [DISPLAY HOLD], [Print], key sequence or stored to a memory card using the [DISPLAY HOLD], [Store], [Store Screen], key sequence.

When the current display is no longer required, the **Armed** phase can be reset by pressing the [arm] key.

External attenuators

Compensation for an external attenuator or test fixture included in the RF input path of the monitor can be programmed. The value, in dBs, of the attenuator should be entered in the RF Power Ext Atten: field of setup page 1. The value of the attenuator will then be included in power calculations and the power indicated by the power meter will be that at the input to the external attenuator.

This feature makes use of the extended ranges of the power meter.

The value of the attenuator will also be included in RF level calculations and readouts when in the Rx TEST mode and in Dx TEST mode.

'A' is shown against any signal level which has been calculated to include the external attenuator.

OSCILLOSCOPE

With the oscilloscope facility selected, the POWER bar chart is removed from the display but the digital read-out of the power level is retained.

DUPLEX

With the monitor in the Dx TEST mode the POWER bar chart and digital display remain in the same location and the indications are identical to those given in the Tx TEST mode.

Transmitter frequency

The digits adjacent to the Tx Freq legend on the Tx TEST display refer to the frequency to which the Service Monitor receiver circuits are tuned.

If the frequency of the transmitter is known, this figure can be entered manually. This is done by firstly pressing the [Tx Freq] key in the Tx TEST mode menu and then entering the figure using the data input keys. Complete the entry by use of the appropriate terminator key.

The receiver circuits of the monitor will then be tuned to that frequency and any signal within the IF pass band will be examined. The frequency difference between the set frequency and the true frequency will be displayed as 'offset'.

Hint

When testing a transmitter using sequential tones, it may be necessary to pre-tune the Service Monitor receiver circuits in this way in order to successfully decode the initial tones.

If the transmitter frequency is unknown, or it is to be measured, key up the transmitter and use the key sequence [Tx Freq], [Autotune].

The receiver circuits of the monitor will then carry out a sweep to locate the signal and tune to it. The frequency of the signal is displayed against the Tx FREQ legend.

DUPLEX

The same frequency measurement procedures are applicable when in the Dx TEST mode.

RF distortion, and

Spurious outputs

Distortion of the transmission RF output may be deliberate (modulation is a form of deliberate distortion), it may be due to a fault or because of design limitations. Whatever the reason the distortion produces harmonics or other spurious outputs.

These can be located using the SPEC ANA mode of operation.

By viewing the output signals from the transmitter on a voltage vs frequency plot, any transmissions outside the transmitter's specified bandwidth can be identified.

The use of the SPEC ANA mode is explained fully under that heading.

Modulation characteristics

Modulation frequency response and

Companding/limiting

The requirements of individual users will vary but the principle of the tests will be the same.

A signal having a known level and frequency is applied to the AF input of the transmitter and the level of modulation produced is measured.

To test the modulation characteristics of a transmitter with any degree of accuracy requires that the signal used to provide the modulation is accurately defined.

The Service Monitor has two AF generators for this purpose. The setting up instructions for frequency, level and shape options of these is given under 'Setting Up, AF Generators' above.

The output from the AF generators is available at the AF output connector on the front panel. This signal should be used to modulate the transmitter, by direct connection to the AF input of the transmitter under test.

With the modulation meter options set to correspond with the modulation characteristics of the transmitter, the signal can be examined.

Modulation measurement with the Service Monitor is made using a method which evaluates the positive value and negative value as separate readings. This allows the results of both to be given on the display. The bar chart is a dual display indicating the positive value on the top bar and the negative value on the lower bar. The digital read-out is given in three parts. The normal size legend displays the P-P/2 modulation level, while the individual levels are given in half size numerals.

By making changes to the level of the applied AF signal, the linearity of the modulating circuits can be checked, limiting circuits, companders and voice activated switching circuits can be tested and adjusted.

The dual - positive and negative - readings are particularly useful when checking and adjusting the symmetry of transmitters.

Similarly, by repeating the tests at differing frequencies, the frequency response of the modulating circuits and filters can be plotted and adjusted.

By using both AF generators at different frequencies, or by using squarewave output, intermodulation distortion levels can be explored and transient response examined.

STANDARD OSCILLOSCOPE

The digital oscilloscope facility can be used for modulation testing. When this facility is active within the Tx TEST mode, the Service Monitor demodulator output is applied to the input of the oscilloscope.

The input to the oscilloscope is taken from the demodulators through any selected AF filters. Therefore modulation measurements made using the oscilloscope will include the characteristics of the selected AF filter.

The Y ranges of the oscilloscope are directly calibrated in deviation frequency when FM demodulation is selected and in percent modulation when AM demodulation is selected. The ranges are from 200 Hz/ Div. to 10 kHz/Div. in a 1, 2, 5, sequence and 25 kHz/ Div. FM and 5%, 10% and 20%/ Div. AM.

The X ranges are from 50 μ s/Div to 5 s/Div. in a 1, 2, 5, sequence.

When the oscilloscope facility is selected, the modulation level bar chart is removed from the display. The digital read-out of modulation level, including the positive and negative readings, is retained. The Modulation frequency digital readout is also retained.

EXPANDED OSCILLOSCOPE

When the expanded oscilloscope is selected, all of the above relating to the standard oscilloscope apply *except* that the positive and negative modulation readings are not displayed.

DUPLEX

All of the above information relating to modulation characteristics and frequency response testing also applies to tests made using the Dx TEST mode. The oscilloscope facility is not available when in Dx TEST mode.

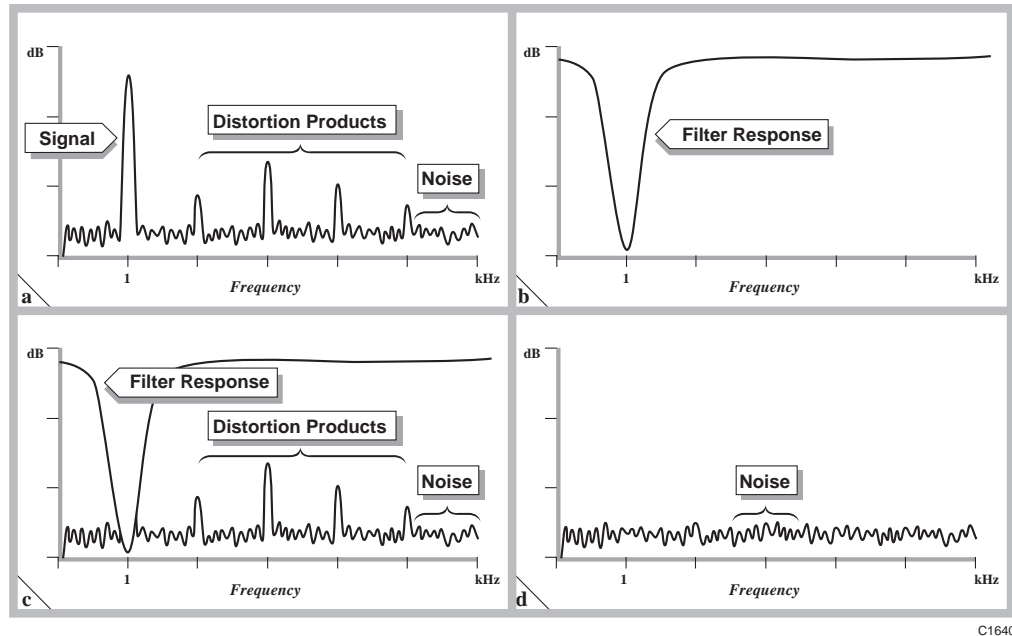
Modulation distortion

Fig. 3-8 Distortion level and signal to noise level measurements.

The signal containing the information being communicated will become distorted during its progress through the system. This distortion may be very slight and almost unnoticeable to the ear or it may be so severe as to cause the information to become unintelligible.

The reasons for this distortion to the signal are the non-linearity of the amplifiers and modulators in the system, and noise within the circuits becoming attached to the signal.

By applying a sinewave signal of known purity to the input of the system and measuring the distortion and noise levels of the demodulated signal obtained at the output of the system, evaluation of the quality of the transmitter is possible.

The three measurements used for this evaluation are SINAD level; distortion percentage; and signal to noise ratio.

The procedures described below are carried out repeatedly under the instruction of the instrument software and the displayed results are continually updated.

To obtain the SINAD level of a signal at the output of a transmitter the output level is measured and noted.

The signal measured comprises the value of the fundamental signal, the values of any distortion products generated and the value of any noise present.

A notch filter tuned to the frequency of the input signal is then placed in the output signal path and the level again measured and noted. The second measurement comprises only the values of any distortion products generated and the value of any noise present. See page 3-33, Fig. 3-8 a, b, & c, *Distortion level and signal to noise level measurements*.

The SINAD level is then calculated according to the formula:-

$$\begin{aligned}\text{SINAD} &= 20 \log \frac{V_1}{V_2} \text{ dB} \\ &= 20 \log \frac{(S + N + D)}{(N + D)} \text{ dB}\end{aligned}$$

To obtain the distortion factor of a signal at the output of a transmitter the output level is measured and noted as for SINAD level measurement.

A notch filter as used for SINAD measurement is used to make a second reading which comprises the same values as for the second SINAD measurement.

The distortion factor is then calculated according to the formula:-

$$\begin{aligned}\text{Distortion} &= 100 \frac{V_2}{V_1} \% \\ &= 100 \frac{(N + D)}{(S + N + D)} \%\end{aligned}$$

For signal to noise level measurements a reading is taken of the output level as for SINAD level and distortion factor measurements. The AF input signal is then disabled and a second level reading taken. A notch filter is not included in the signal output path. The second measurement only comprises the value of any noise present on the demodulated signal. See page 3-33, Fig. 3-8 a, & d, *Distortion level and signal to noise level measurements*.

The signal to noise level is then calculated according to the formula:-

$$\begin{aligned}\text{S/N} &= 20 \log \frac{V_1}{V_2} \text{ dB} \\ &= 20 \log \frac{(S + N + D)}{N} \text{ dB}\end{aligned}$$

The distortion measuring system within the Service Monitor has the capability to make all three measurements. Pressing the *[Mod Dist]* key accesses the distortion measurement menu shown in fold out diagram (3-4).

The action of selecting a measurement system returns the TRANSMITTER TEST main (top level) menu to the display.

The result of the selected measurement will be displayed on a bar chart within the transmitter test screen and a digital read-out given above it. When no distortion measurement system is selected, by pressing the *[Off]* key within the distortion measuring menu, the distortion bar chart and digital read-out are removed from the screen.

Hint

By disabling this function, the time taken to measure the remainder of the measurement functions is shortened thereby reducing the update time.

Measurements of SINAD and distortion percentage carried out by the monitor use a frequency of 1 kHz for the tests. When either of these test methods is selected, the system software sets the frequency of the modulation generator to this frequency to avoid erroneous results.

The input signal level influences the readings obtained by the distortion measuring system and is usually specified as part of the test specification.

OSCILLOSCOPE

With the oscilloscope facility selected, the distortion level bar chart is removed from the display but the digital read-out is retained.

DUPLEX

When in the Dx TEST mode, modulation distortion tests are not displayed.

Rx test (receiver testing)

Overview

The Communications Service Monitor 2945A has been designed to test the performance of mobile communication equipment. This section explains the use of the Rx TEST mode. Typical uses are:-

- Performance checking following manufacture
- Routine quality assurance testing
- Workshop or field fault diagnosis etc.

The tests which need to be carried out will depend on the specification of the receiver and the reason for testing, however a generalised list would be:-

Sensitivity
AF Bandwidth
AF Distortion
Selectivity
Blocking (or desensitisation)
Spurious response
AGC response

With the Rx TEST mode selected, the screen and menu shown in fold out diagram (3 -0) is displayed.

From this screen and menu, the setting up of the inbuilt devices for receiver testing, and the read out of results is carried out.

The sections of the monitor available for receiver testing are:-

RF signal generator.

Audio modulation generators. Used to provide modulation of the RF generator.

Audio tone generator. Provides tones for CTCSS, Sequential, DTMF systems.

Audio distortion meter

Digital oscilloscope

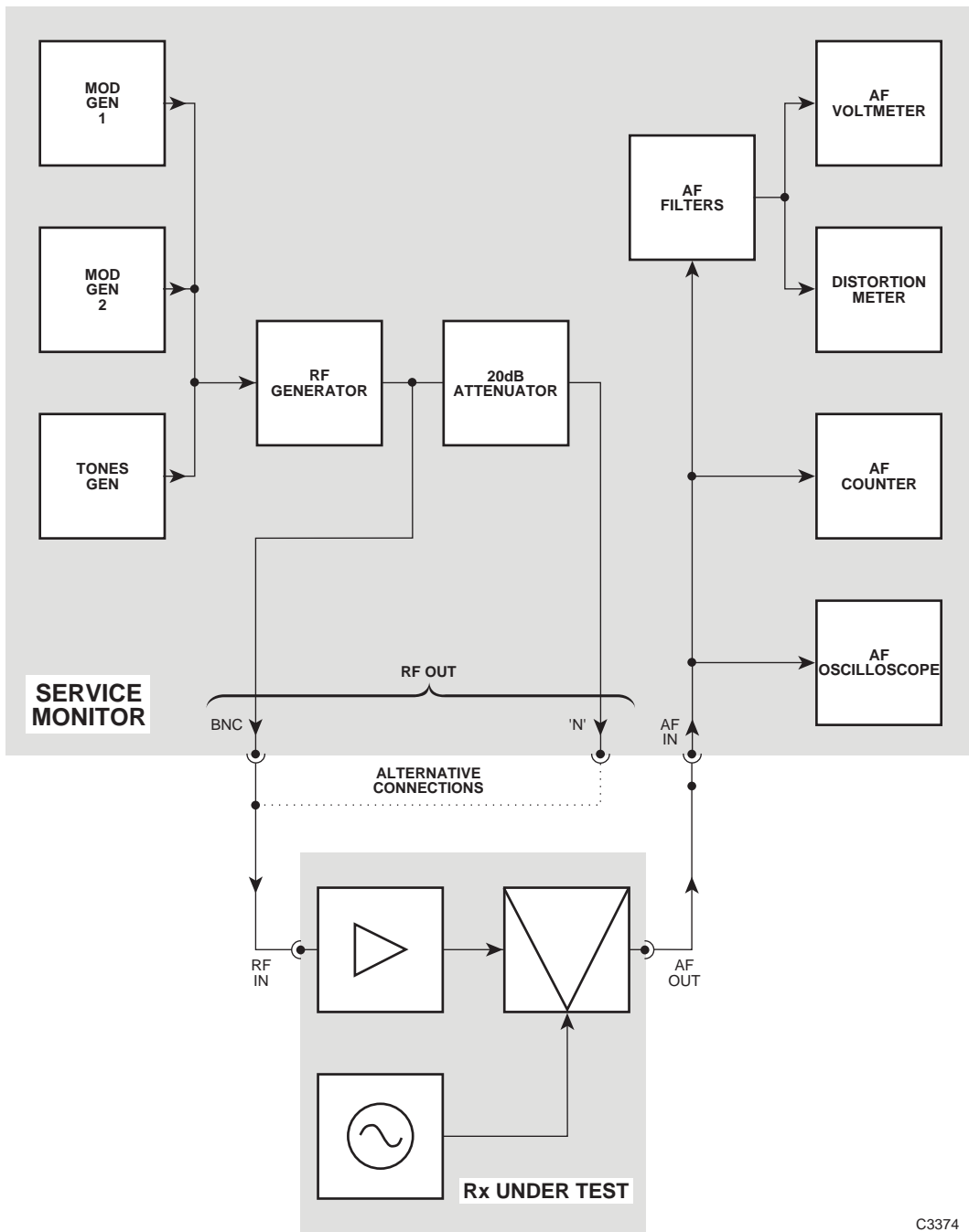
As well as setting up the major sections of the Service Monitor, the selection of the following parameters are selected from the RECEIVER TEST screen:-

Audio filters

Pre-emphasis filtering

Selection of distortion measuring methods.

Connections



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Fig. 3-9 Receiver test connections

Before making any connections between the Service Monitor and the receiver ensure that the RF generator of the Service Monitor is OFF. With the Rx TEST mode selected, press [RF Gen] key to highlight the GEN FREQ legend. Pressing the orange [ON/OFF] function key will change the state of the RF generator. OFF is shown adjacent to the indicated generator frequency when the RF generator is disabled.

The RF generator settings can be changed with the generator ON or OFF.

When testing the receiver section of a transceiver, ensure that the power output of the transmitter section will not exceed the power handling capability of the connector on the Service Monitor. Also ensure that the transceiver cannot be switched to 'TRANSMIT' inadvertently.

The receiver and the Service Monitor should be connected as shown in Fig. 3-9 *Receiver test connections*. The block diagram of the Service Monitor shows the signal routing within it.

Points to note are:-

The power source for the receiver should be reliable and stable. The battery of a vehicle may discharge if supplying a mobile transceiver during prolonged testing or the earth connection may become open circuit if the transceiver is removed from its normal location.

When testing the receiver section of transceivers take precautions to prevent the inadvertent ‘keying’ of the transmitter.

The RF input connection to the receiver should be made using good quality RF cable with correctly fitted connectors. Worn connectors and damaged or kinked cable can produce reflections and losses in the system which will give misleading results.

Setting up

When all the required connections have been made, select the Rx TEST mode to display the screen shown in fold out diagram (3-0).

Set the parameters or options to suit the test requirements from the RECEIVER TEST menus.

Rx frequency

Range	400 kHz to 1.05 GHz
-------	---------------------

Press the [RF Gen] key.

The GEN FREQ legend is highlighted as shown in fold out diagram (3 -1).

If the Rx=Tx function has been set from the Tx TEST mode, the GEN FREQ will be set to the receiver frequency relevant to that test. If this is correct for the receiver under test, there is no need to re-enter the frequency.

Manual frequency setting

With GEN FREQ legend highlighted, data may be entered from the keyboard to the GEN FREQ parameter. Enter the required frequency by using the digit keys and the decimal point key if relevant. The resolution of the RF generator frequency entry is 1 Hz, but it is not necessary to enter every digit down to the least significant place.

The entry is completed by pressing a terminator key. Using the [MHz], [kHz] or [Hz] key causes the entered frequency to be displayed according to normal convention. The following examples explain further.

Pressing:-

[1] [2] [5] [MHz]	will display	125.00000 MHz
[1] [2] [5] [kHz]	” “	125.000 kHz
[1] [2] [5] [0] [kHz]	” “	1.250000 MHz
[1] [.] [2] [5] [MHz]	” “	1.250000 MHz
[1] [2] [5] [0] [0] [0] [1] [Hz]	” “	1.250001 MHz

Variable control

With the GEN FREQ legend highlighted, the GEN FREQ parameter can be adjusted by using the variable control.

Frequency increment

The FREQ [↑] and [↓] keys can be assigned to RF generator frequency adjustment. See *Incremental adjustments* which starts on page 3-62.

Output level setting

Range	
N-Type connector,	-135 dBm to -15 dBm; 0.04 mV to 40 mV pd
BNC connector,	-115 dBm to +5 dBm; 0.4 mV to 400 mV pd (with uncalibrated overrange to +7 dBm)

WARNING

Hot surfaces

Take care when touching the RF Input Type N connector after the application of high levels of continuous power. If 50 W is applied for a prolonged period, the temperature of the connector can become excessive.

The signal generator output level is set using the data keys. It can be defined in dBm with the [dBm] terminator key or by voltage level with the [V], [mV] or [μ V] terminator key.

Voltage levels will be shown as PD or EMF, depending on the selection made on setup page 1. The output range from each connector is given in the *Performance data* section of chapter 1.

The signal generator output level from the BNC connector is calibrated up to +5 dBm. The output level can be increased to approximately +7 dBm, uncalibrated.

Note that any external attenuator values entered on setup page 1 will reflect in the level of indicated output. If an external attenuator value is currently set, output levels which have been modified to take account of the additional attenuation will be indicated on the display by Δ against them. See *RF Power Ext Atten : dB*, on page 3-11.

To enter an output value press the [RF Gen] key, followed by the orange [LEVEL] function key. The GEN and LEVEL legends will be highlighted.

Enter the required value using the data entry numeric keys and the relevant terminator key. The level will be displayed in correct engineering convention.

Variable control

With the GEN and LEVEL legends highlighted, the GEN LEVEL parameter can be adjusted by using the variable control.

Level increment

The LEVEL [\uparrow] and [\downarrow] keys can be assigned to RF generator level adjustment. See *Incremental adjustments* which starts on page 3-62.

Modulation

The RF signal generated for receiver testing can be modulated using either or both of the AF generators or by an external source.

Modulation type

The modulation type is automatically set, to be appropriate to the level terminator key used (FM for Hz, kHz or MHz; AM for %).

Modulation generators

Set up one or both of the modulation generators for the required frequency, level and shape by using the soft keys and data input keys. When these and the de-emphasis filter are set to the required settings press the [Return] key to restore the RECEIVER TEST menu.

Modulation frequency and level

The frequency range and level must not exceed the following limits:-

Modulating freq. range	20 Hz to 20 kHz.
AM depth range	0 to 99% total sum of active modulation sources.
FM deviation range	0 to 75 kHz total sum of active modulation sources.

To enable or set up the modulation generators press the *[Mod Gen]* key. The screen and menu shown in fold out diagram (4-2) will be displayed.

Set up the modulation generator(s) for the required frequency and output level by using the soft keys and data input keys:-

[Gen 1/Gen 2] to select MOD1, then, [FREQ][n]...[n][kHz/Hz]
 [LEVEL][n]...[n][kHz/Hz]
 then *[Gen 1/Gen 2]* to select MOD2 if required,....[.../Hz]

Frequency and level increment

The FREQ [\uparrow] and [\downarrow] and the LEVEL [\uparrow] and [\downarrow] keys can be assigned to the modulation generator frequency and level. See *Incremental adjustments* which starts on page 3-62.

Modulation generator state

Either or both generators can be switched off to suit the test requirement. To disable a generator, first select it using the *[Gen 1/Gen 2]* key. Repeated presses of the orange [ON/OFF] function key will disable or enable the selected generator.

Note that the modulation generators are also used as AF generators to provide a modulation source in the Tx TEST mode.

If both AF generators are set to ON in the Tx TEST mode, switching to Rx TEST mode will show both modulation generators to be OFF.

Either or both generators can be set up and turned on within the Rx TEST mode.

The frequency, level and shape settings of their last use in the Rx TEST mode will be retained within the Rx TEST mode setup. These settings will be effective when the generators are switched to ON in the Rx TEST mode. Their use as audio generators in the Tx TEST mode will then be disabled.

Modulation generator shape

The shape of the output waveform from each modulation generator can be set to either sine or square wave. To change the output waveform from a generator, first select it using the *[Gen 1/Gen 2]* key. Repeated presses of the *[Shape]* key will toggle between sine or square wave.

Modulation generator level locking

Pressing the *[Lock]* key locks the output level of the two modulation generators to the same level. The unselected generator locks to the level of the selected generator.

Pre-emphasis filter

The pre-emphasis filter can be switched in or out of circuit after pressing the *[Mod Gen]* key.

Pressing the *[Pre-emph]* key will toggle the pre-emphasis filter into and out of circuit. The time constant of the filter is 750 μ s, giving an increase with frequency of 6 dB/octave.

The legend Pre-emph ON is displayed when the filtering is in circuit. No indication is given when the filtering is out of circuit.

External Modulation

An external modulation source may be used to modulate the RF generator signal. Pressing the [Ext Mod] key will display the external modulation input selection menu.

The options available are:-

[DC Ext]	Selects the 'EXT MOD IN' connector on the rear of the instrument, with DC coupling.
[AC Ext]	Selects the 'EXT MOD IN' connector on the rear of the instrument, with AC coupling .
[Mic]	Selects Microphone (connected to the ACCESSORY socket on the front panel) as the external modulation source.

The selection is shown on the display next to the Ext Level Source legend. The frequency range for each input option is specified in the *Performance data* section of Chapter 1.

The level of the external modulation signal should be 1.0 V rms. This retains correlation of the modulation level indicated on the display with that applied to the RF signal.

Setting external modulation level

Press the [Ext Mod] key, which as well as displaying the menu mentioned above, will highlight the **EXT LEVEL** legend. Use the data input keys to set the required level, followed by the appropriate [Hz], [kHz] or [%] key.

Hint

The modulation source level can be measured using the AF INPUT connector on the front panel and AF LEVEL bar chart, or by monitoring the modulation level of the RF generator using the Dx TEST mode.

Microphone input

A microphone suitable for connecting to the accessory socket, is available as an optional accessory. See *Options and accessories*, in the *Performance data* section of Chapter 1.

The microphone input circuit contains a limiter to prevent over-modulation, and the external modulation level setting remains effective when the microphone option is selected. This gives versatility of test options to suit the user's requirements.

The microphone input must be selected to make use of the PTT switching facility available in the Tx TEST mode.

The level of the modulation from the external source will add to the level of any internal modulation and will therefore be included in the total sum of modulation sources.

The state of the external modulation source can be changed by pressing the orange [ON/OFF] function key when the **EXT LEVEL** legend is highlighted. Off is displayed next to the external modulation parameters when the external modulation is disabled.

Note that only one type of modulation can be applied to the RF signal. For example:-

If the [%] terminator key is used to complete a modulation setting when an FM deviation level is already set from another source, the latest selection will cause the previous setting to be cancelled.

AF input level measurement

The measured level of signals applied to the AF INPUT connector can be displayed in volts, dBm, dBV or mW. The selection is made from setup page 2, as described under *Audio Level Measured in:* on page 3-12. When the input level is displayed in dBm or mW, the signal is assumed to be measured across 600 Ω .

The 600 Ω interface unit allows the Service Monitor to provide a 600 Ω termination. (See *Audio Input Impedance* on page 3-12.) With the input impedance set at 600 Ω , the indicated level is

that of the input to the Service Monitor. With the input impedance set at High, the indicated level is that of the input to the Service Monitor with an assumed 600 Ω load.

AF filters

The AF signal to the AF INPUT connector on the front panel can be filtered using the following audio filters:-

0.3 - 3.4 kHz band pass	50 kHz low pass	15 kHz low pass	300 Hz low pass	CCITT [†] or C-MESS [‡]
----------------------------	--------------------	--------------------	--------------------	--

- † Only if option 23 (CCITT filter) is fitted.
- ‡ Only if option 24 (C-MESS filter) is fitted.

Press the [AF Filter] key. The left hand soft keys change, to allow selection of AF filters shown above. Press the [Return] key after selecting the required filter.

OSCILLOSCOPE

The input to the oscilloscope is taken directly from the AF input connector on the front panel, not through any of the AF filters. Therefore measurements obtained on the AF voltmeter will show the effects of filtering, whereas those made using the oscilloscope will not.

Audio distortion

The Service Monitor is able to measure signal noise and distortion against the following parameters:-

Signal to noise ratio	SINAD level	Percentage distortion.
--------------------------	----------------	---------------------------

Distortion levels introduced into the audio signal path can be measured using the distortion measuring module.

Pressing the [Dist/S-N] key will display the screen and menu shown in fold out diagram (3-4). The function of each soft key on this menu is as follows:-

Off

Disables any active distortion measuring function and removes the distortion bar chart from the display.

Hint

By disabling this function, the time taken to measure the remainder of the measurement functions is shortened thereby reducing the update time.

S/N

Selects Signal to noise ratio as the measurement method. Compares the level of the demodulated signal together with the system noise, against the level of the system noise only, using the formula:-

$$\begin{aligned}
 S/N &= 20 \log \frac{V_1}{V_2} \text{ dB} \\
 &= 20 \log \frac{(S + N + D)}{N} \text{ dB}
 \end{aligned}$$

See Fig. 3-8 a, & d, *Distortion level and signal to noise level measurements*, on page 3-33. The distortion bar chart is graduated in dB and is also displayed as a digital read-out above the bar chart. The Rx test menu is recalled automatically after pressing this key.

SINAD

Selects SINAD as the measurement method. The modulation generator is set to 1 kHz. By filtering the demodulated signal with a 1 kHz notch filter and comparing the result with the unfiltered signal, the SINAD level is established using the formula:-

$$\begin{aligned}\text{SINAD} &= 20 \log \frac{V_1}{V_2} \text{ dB} \\ &= 20 \log \frac{(S + N + D)}{(N + D)} \text{ dB}\end{aligned}$$

See Fig. 3-8 a, b, & c. *Distortion level and signal to noise level measurements*, on page 3-33. The distortion bar chart is graduated in dB and the SINAD level is displayed as a digital readout above the bar chart. The Rx test menu is recalled automatically after pressing this key.

Dist'n

Selects distortion percentage as the measurement method. The modulation generator is set to 1 kHz. By filtering the demodulated signal with a 1 kHz notch filter and comparing the result with the unfiltered signal, the distortion percentage level is established by the formula:-

$$\begin{aligned}\text{Distortion} &= 100 \frac{V_2}{V_1} \% \\ &= 100 \frac{(N + D)}{(S + N + D)} \%\end{aligned}$$

See Fig. 3-8 a, b, & c. *Distortion level and signal to noise level measurements*, on page 3-33. The distortion bar chart is graduated in % and the distortion percentage level is displayed as a digital readout above the bar chart. The RX TEST menu is recalled automatically after pressing this key.

Making measurements

(Examples of receiver tests).

The procedure for making each of the tests listed in the receiver testing overview, above, follows. Some of the tests may require separate operations and others will only require a reading to be made.

Sensitivity

Receiver sensitivity is defined as the minimum RF level required at the antenna to produce an intelligible output of the modulated information.

The problem with the above definition is that of defining 'intelligible output'. As this is a subjective decision, sensitivity specifications require certain parameters to be set down. The nature of FM and phase transmissions makes sensitivity measurements less straightforward than with AM transmissions. A sensitivity test on an AM receiver can be stated as 'X watts audio output from Y μ V RF input at Z% modulation'.

As there is no direct/linear relationship between RF signal level and audio output with FM receivers, most manufacturers normally quote receiver sensitivity in one of the following four ways:-

12 dB SINAD sensitivity.

20 dB weighted SINAD sensitivity.

20 dB signal to noise sensitivity.

20 dB quieting sensitivity.

When defined as part of a specification, the sensitivity will be given in the form:-

‘Sensitivity (12 dB SINAD) 0.25 μ V’

or

‘Sensitivity (20 dB SINAD) 1.0 μ V EMF’

or

‘12 dB (minimum) SINAD for 0.31 μ V (pd) signal input (at 60% deviation and 1 kHz modulation).’

The test method for each of the above sensitivity specifications varies, but the common features are that each requires a signal of accurately defined level, modulation frequency and modulation level to be injected into the receiver, the AF output level referenced, the modulation or a portion of it, to be removed and the audio level re-referenced.

To carry out each of these tests using Service Monitor proceed as follows:-

12 dB SINAD sensitivity

This test determines the level of the modulated RF signal at which the SINAD measurement is 12 dB. The level of modulation is given as part of the test specification. The standard modulation frequency is 1 kHz.

As the RF signal level is reduced, the ‘noise’ component of the AF output will become proportionally greater. This will result in the SINAD dB reading becoming closer to zero.

To use this Service Monitor to make a 12 dB SINAD sensitivity test, the Service Monitor is set up to make a SINAD distortion measurement and the RF level progressively reduced until the SINAD level reads 12 dB. The RF level of the signal generator will equal the 12 dB SINAD sensitivity level of the receiver.

For a GO/NO GO test the monitor is set up in the same manner as above. The RF level is set to the specified sensitivity level and the SINAD distortion level observed. A reading higher than 12 dB would indicate GO, while a reading of less than 12 dB (i.e. closer to zero) would indicate NO GO.

20 dB weighted SINAD sensitivity

This test is very similar to the 12 dB SINAD sensitivity test

The differences are firstly that the SINAD level specified is 20 dB and secondly that a psophometric weighting filter is included in the test path. This filter imposes a frequency response characteristic to the signal similar to that of the human ear response.

There are two specifications of filter in common use. One is the European standard CCITT and the other is the American C-MESS. The specification of the receiver will state the correct filter to select.

The Service Monitor can have a filter meeting one of these specifications fitted as an option.

The test procedure is identical to that for 12 dB SINAD sensitivity except that the SINAD distortion pass level is 20 dB.

20 dB signal to noise sensitivity

This test determines the level of RF carrier which, when unmodulated will produce an AF output level due only to receiver noise, 20 dB below the AF level produced when modulated at the specified level and at the specified frequency.

As the RF signal level is reduced, the 'noise' component of the AF signal will become proportionally greater. This will result in the Signal to Noise dB reading becoming closer to zero.

To use this Service Monitor to make a 20 dB S/N sensitivity test, it is set up to make signal to noise measurements through the distortion meter menu of the Rx TEST mode. The modulation frequency and level are set according to the receivers test specification requirements.

The RF level is adjusted until the S/N level indicated on the Service Monitor reads 20 dB. The RF level will then equal the 20 dB S/N sensitivity level.

For a GO/NO GO test the monitor is set up in the same manner as above. The RF level is set to the specified sensitivity setting and the S/N level observed. A reading higher than 20 dB would indicate GO, while a reading of less than 20 dB (i.e. closer to zero) would indicate NO GO.

20 dB quieting sensitivity

This test determines the level of unmodulated RF signal that will produce an AF output from the receiver that is 20 dB lower than the noise level from the receiver when no carrier is being received.

The reduction in AF output when a carrier is being received is due to the action of the automatic gain control circuits in the RF amplifiers of the receiver.

The gain of the receiver will reduce as the level of the RF signal increases. Therefore the noise level will decrease with an increase in RF signal level.

To use this Service Monitor to make a 20 dB quieting sensitivity test the unmodulated RF signal is applied to the receiver at the frequency called for in the test specification. If no frequency is specified, a convenient mid band frequency is selected.

Select [*RF Gen*] from the soft key options. Turn the RF signal off by use of the orange [ON/OFF] function key and note the indicated AF level.

Turn the RF signal ON and adjust the RF level until the indicated AF level is 20 dB less than the previously noted level. The indicated RF level is the 20 dB quieting sensitivity level of the receiver.

For a GO/NO GO test proceed as above until the AF level with no RF input is noted. Then turn the RF signal on and adjust the RF level to the figure specified as the 20 dB quieting sensitivity level. Now observe the AF level indication. A reading greater than 20 dB will indicate GO. A reading lower than 20 dB, (i.e. closer to zero), will indicate NO GO.

Basic sensitivity test

To carry out a basic sensitivity test on an AM receiver:

Set the RF generator frequency to that required by the test program. This setting can be entered using the data input keys or set using the Rx=Tx facility discussed under Tx mode. The RF generator can be switched off during the setup operation if required, by pressing the orange [ON/OFF] function key.

Select the 'Mod Gen' menu from the RECEIVER TEST screen.

Set the modulation frequency and level. It is usual to use a single sinewave tone when carrying out sensitivity tests and essential for SINAD tests.

Select the 'pre-emphasis' facility if required, by pressing the [*Pre-emph*] key.

Return to the RECEIVER TEST screen and select the 'AF filter' menu. Select the required AF filtering.

Return to the RECEIVER TEST screen and adjust the RF output level to that required by the test specification.

Switch the RF generator output ON by pressing the orange [ON OFF] function key.

The audio output from the receiver is measured and the level and frequency displayed.

For measuring sensitivity levels, rather than checking against settings, the various parameters on the monitor can be adjusted in steps using the LEVEL [\uparrow] and [\downarrow] keys, or by precision adjustment using the variable control.

AF bandwidth

The audio bandwidth of a receiver should be complementary to that of the transmitter or transmitters associated with it.

The test for audio bandwidth is made by establishing a reference frequency, usually 1 kHz, and reference level, then varying the modulating frequency until the measured audio output level reduces by 3 dB. The 3 dB points above and below the reference frequency will be the limits of the AF bandwidth.

When carrying out audio bandwidth tests the monitor audio filtering should be set to the widest possible, i.e. 50 kHz.

Note that most FM transceivers apply pre-emphasis filtering to the transmitter modulation and de-emphasis filtering to the demodulated signal.

AF distortion

The two methods used for quoting distortion within radio receivers are Distortion Factor and SINAD.

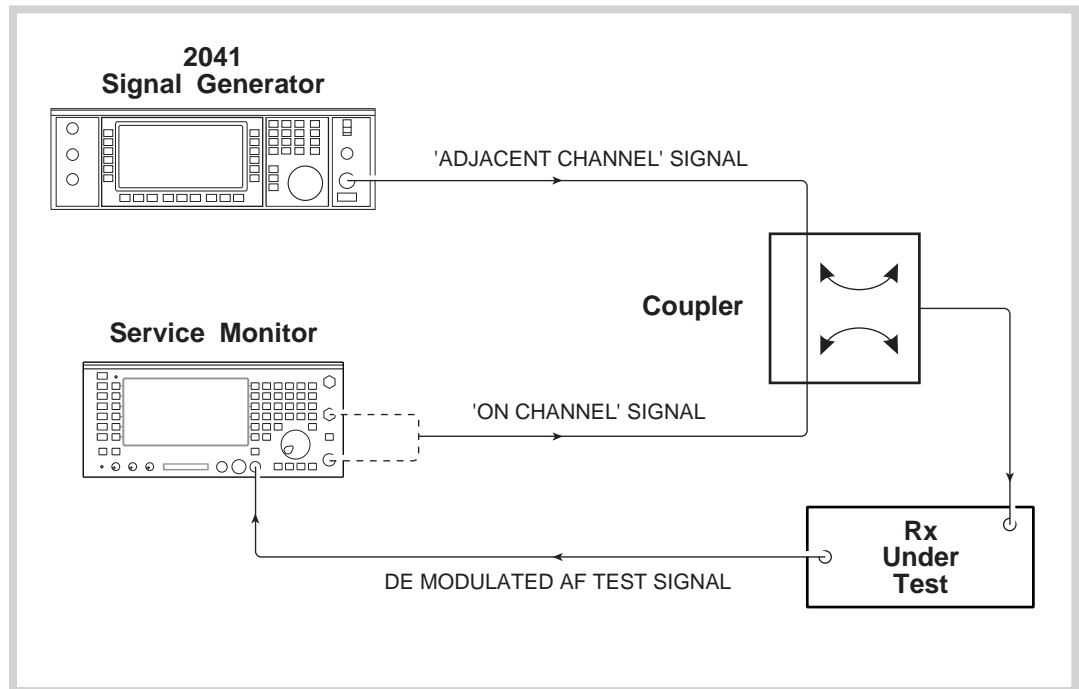
SINAD tests are usually made in conjunction with sensitivity testing (see above), while distortion test results are often quoted within the power output parameter. For example '3 Watts output with better than 10% THD' (total harmonic distortion).

The signal to noise level is also quoted but is a measure of receiver quality, not a true measure of distortion.

The AF distortion measuring facility performs continuous reading and display metering using the selected function, (SINAD or distortion factor). Therefore a distortion test can be carried out by ensuring that the RF generator is tuned to the correct frequency, select the distortion measuring function required and set the levels of the RF and AF generators. The distortion factor or SINAD level is then read from the screen.

To obtain sets of readings relating to differing levels of RF or AF, the levels are reset and the new reading made.

Selectivity



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Fig. 3-10 Selectivity test setup

Selectivity tests are measurements of the capability of a receiver to differentiate between a wanted signal and an unwanted signal, usually that transmitted on an adjacent channel.

This test is carried using the Service Monitor as for previous tests but with a second RF signal generator simulating the adjacent channel transmitter. See Fig. 3- 10, *Selectivity test setup*, on page 3-47.

A specification for receiver selectivity requires parameters to be set down to measure against. Within the specification of a typical mobile radio a typical adjacent channel selectivity figure might read:- '12 dB adjacent channel selectivity; better than 80 dB', and the 20 dB weighted SINAD sensitivity is quoted as 'better than 1 μ V'.

To confirm this selectivity figure proceed as follows:-

The equipment is connected as in Fig. 3- 10, *Selectivity test setup*. The level of modulation for the 'wanted' signal is set to 60% of the maximum deviation for FM receivers or 30% modulation for AM receivers. The modulation frequency is 1 kHz unless specified differently.

The generator being used to provide the adjacent channel signal is set to the frequency of the adjacent channel with a modulation frequency of 400 Hz unless specified differently. The modulation level is set to 60% of the maximum deviation for FM receivers or 30% modulation for AM receivers. The carrier is switched off at the commencement of the test.

The level of the Service Monitor providing the 'wanted' signal is adjusted until a SINAD reading of 20 dB is obtained as for sensitivity testing. The RF output level of the generator should be noted. This should be the same level as that established in the 20 dB sensitivity test (above).

The carrier from the signal generator providing the 'adjacent channel' signal is switched on and the level of its output increased until the SINAD level is reduced to 12 dB. The RF output level should be noted.

The difference in output level of the two RF generators, expressed in dB, is the '12 dB Adjacent Channel Selectivity' level.

In the example above, with a ‘wanted’ signal level of –90 dB and a ‘adjacent’ signal level of –7 dB, the performance of the receiver would be satisfactory. If the ‘adjacent’ signal level was found to read –13 dB the performance of the receiver would be below specification.

Blocking (or desensitisation)

Blocking (or desensitisation) is an undesirable response by a receiver to a signal whose frequency is spaced from the wanted signal by a frequency difference greater than the adjacent channel spacing. The interfering signal will enter the IF pass band of the receiver with sufficient strength to cause the automatic gain control to operate. This will reduce the gain of the receiver and ‘block out’ weak signals.

The test setup is the same as for selectivity testing.

The generator being used to provide the ‘wanted’ signal is set as for selectivity testing and the level adjusted to produce a SINAD level of 20 dB.

The generator providing the ‘interfering’ signal should be unmodulated and set to an RF level of between 80 and 90 dB above the level of the ‘wanted’ signal

The frequency of the ‘Interfering’ signal should be slowly swept over a range of 1 to 10 MHz either side of the ‘wanted’ signal frequency and the SINAD level observed for any significant variation. If any interaction is found, adjust the frequency of the ‘interfering’ signal for maximum reaction. Vary the level of the ‘interfering’ signal until the SINAD level is 14 dB and note the RF level. This is the blocking level of the receiver for the frequency concerned.

Spurious response

The two types of spurious response measurements normally carried out on a receiver are image frequency rejection and IF rejection.

For a specific receiver type, the frequency of the image signal of a ‘wanted’ signal is twice the receiver intermediate frequency above the wanted frequency if the receiver local oscillator runs at a frequency above the wanted signal, or twice the receiver intermediate frequency below the wanted frequency if the receiver local oscillator runs at a frequency below the wanted signal. See Fig. 3-11, *Spurious response ‘Image Frequency’ location*.

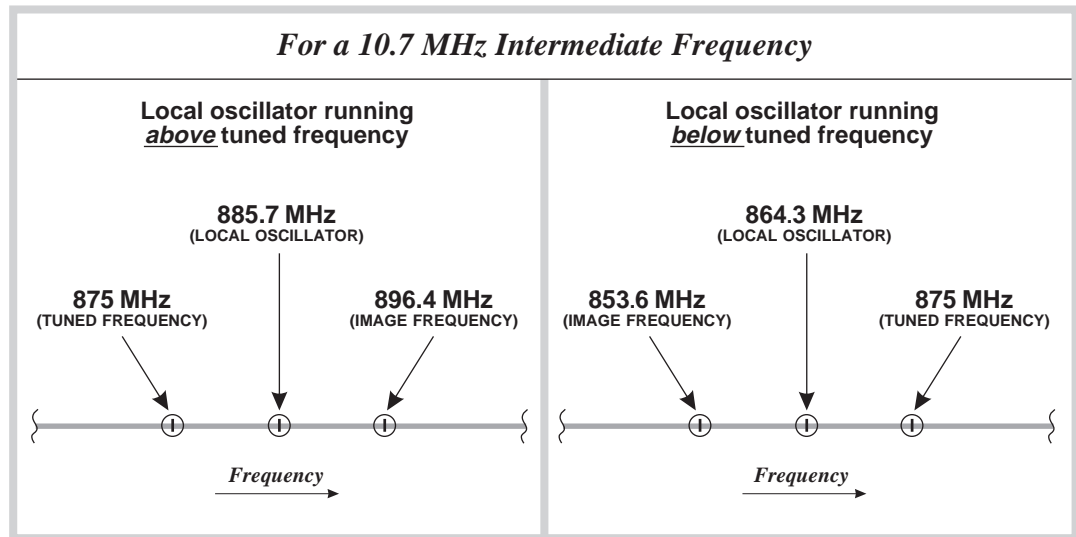


Fig. 3-11 Spurious response ‘Image Frequency’ location

With the receiver and Service Monitor set up as for sensitivity testing, establish a reference RF input level. Change the RF output frequency of the Service Monitor to the image frequency of receiver tuning point, without altering the receiver tuning. Increase the RF output level of the Service Monitor RF generator until the SINAD level reads 20 dB and note the RF level. The

difference in the level of the RF generator readings for the two frequencies, expressed in dB, is the 'image frequency rejection ratio'.

The procedure for measuring the IF rejection ratio is similar to that used to measure image frequency rejection and uses the same setup. The RF reference level is found at the RF frequency to which the receiver is tuned, then the RF generator is retuned to the IF frequency of the receiver under test. The RF output level is increased until a 20 dB SINAD level is obtained. The output level of the RF generator is noted. The difference in level of the RF generator readings, expressed in dB, is the 'IF rejection ratio' of the receiver.

AGC response

Automatic Gain Control is used in AM receivers to stabilise the level of the audio output signal against changes in the level of RF input. This is necessary as the output voltage from the detector circuit with a constant % depth of modulation is proportional to the level of the RF signal applied to the detector.

To plot the AGC response of a receiver, set up the instrument and receiver as described for receiver audio frequency response tests. The test can be made at one RF frequency only or at various points throughout the receiver tuning range. This will depend on the reason for making the test and the specification of the receiver.

Set the RF generator frequency of the Service Monitor to the selected tuning point of the receiver with the modulation level set to 30% at 1 kHz. Increase the RF output level until an AF output is registered on the Service Monitor display, either bar chart or oscilloscope.

Reduce the RF output level until the AF output level of the receiver reaches the noise level.

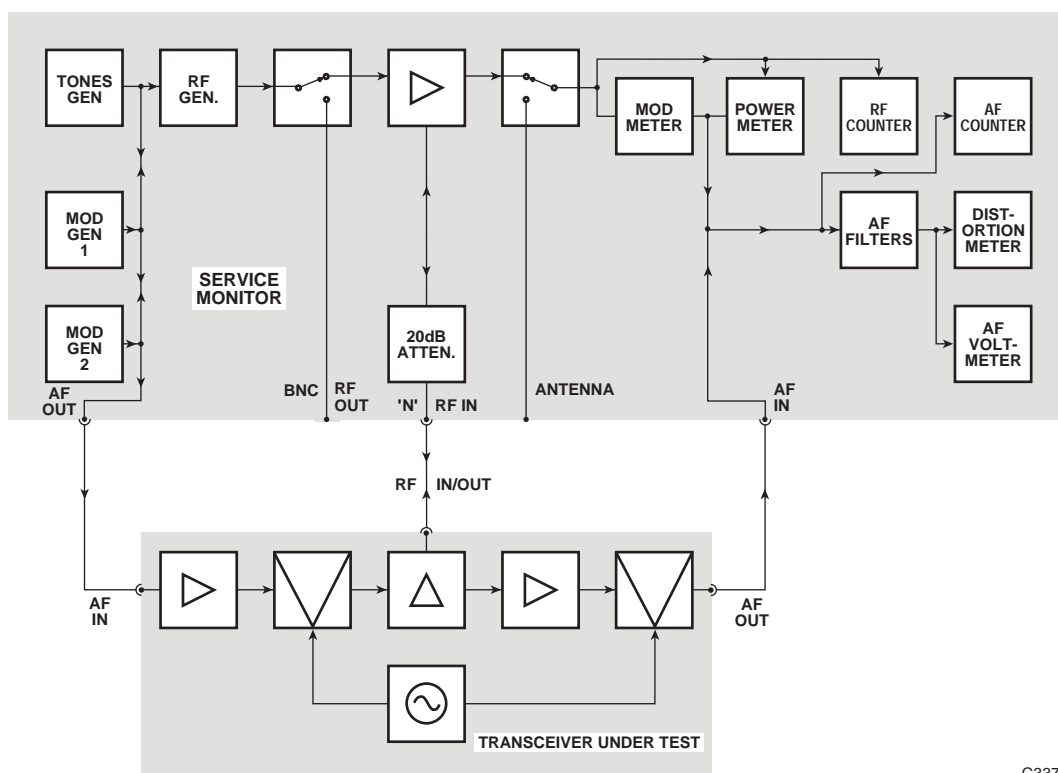
Record the RF signal level and the AF output level.

Increase the RF generator level by suitable increments and record the level of AF output at each point.

Continue until the RF input to the receiver reaches the maximum allowed by the receiver specification or until the AF output level no longer increases, whichever occurs at the lowest RF level.

FM receivers incorporate limiting circuits which reduce the level of the RF signal by clipping the extremities of the signal rather than by compression which is necessary with AGC circuits for AM receivers.

Dx test (duplex testing)



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Fig. 3-12 One port duplex test setup

Overview

With the Dx TEST mode selected, the screen and menu shown in fold out diagram (4 -0) is displayed.

The Dx TEST mode is provided so that transmitter and receiver functions of transceiver operation can be studied simultaneously.

‘One port’ and ‘Two port’ transceivers can be tested. See Fig. 3-12, *One port duplex test setup*, and Fig. 3-13, *Alternative two port duplex setups*.

The Dx TEST mode display does not give all the information that is available from the individual Tx TEST mode and Rx TEST mode displays but these displays are available individually by selecting the appropriate test mode.

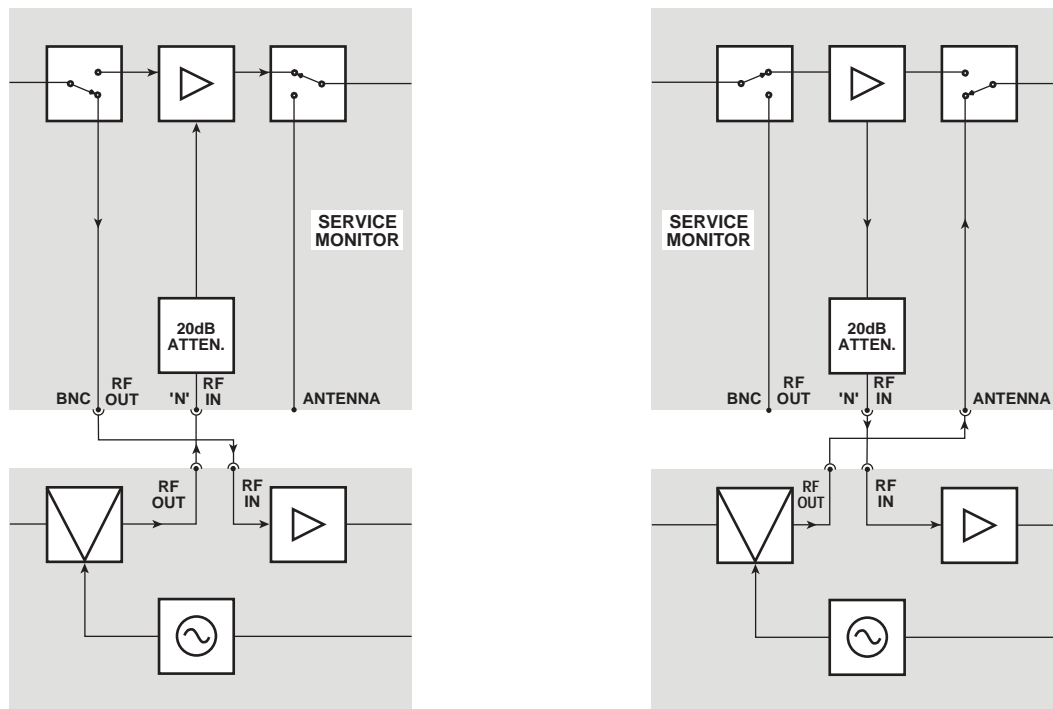
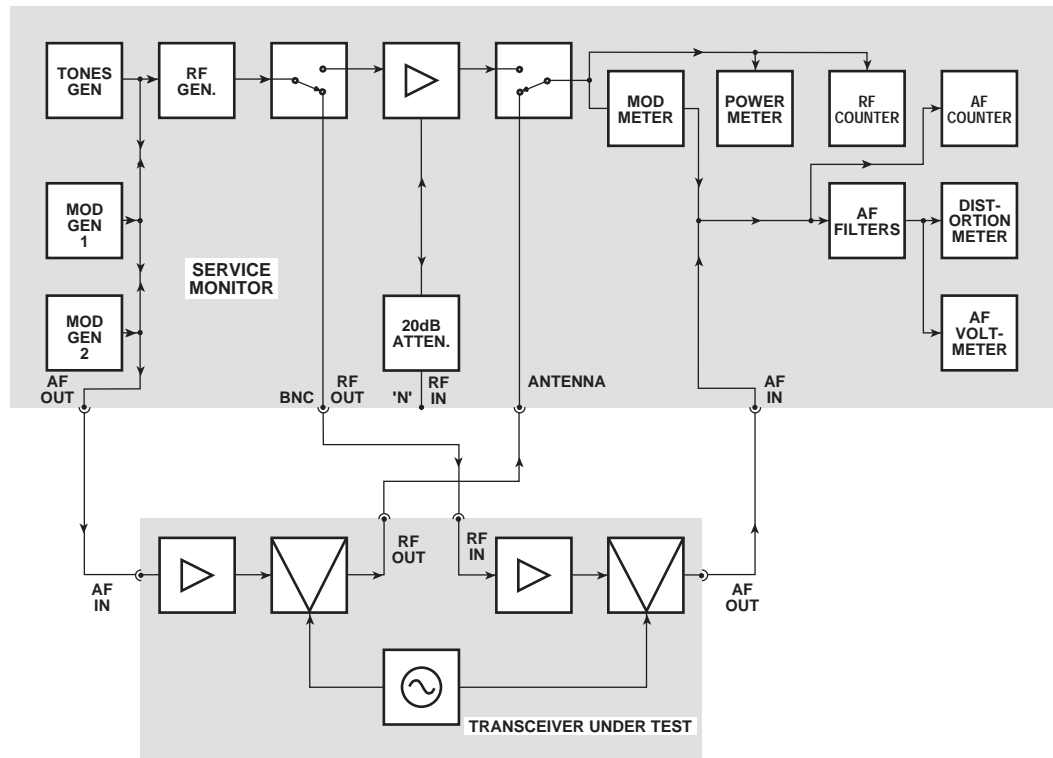
When interchanging between the Tx TEST mode, Rx TEST mode or Dx TEST mode, any active transmitter test and any active receiver test will remain functional.

There are two exceptions to this.

The first is with the modulation generators used for receiver tests and the audio generators used as a modulation source for transmitter tests. The two AF generators in the monitor serve both functions. Therefore, although both can be assigned to either function, if modulation is required on receiver and transmitter simultaneously, only single tones are possible.

The second exception is that the distortion measuring functions can be made only on the AF signal taken from the receiver under test and fed into the AF input connector of the monitor.

The output from the Tx TEST mode demodulator is fed to the AF amplifier as in Tx test mode. However, as the AF measuring circuits are continually switching functions when in Dx TEST mode, the output from the loudspeaker or headset is discontinuous.



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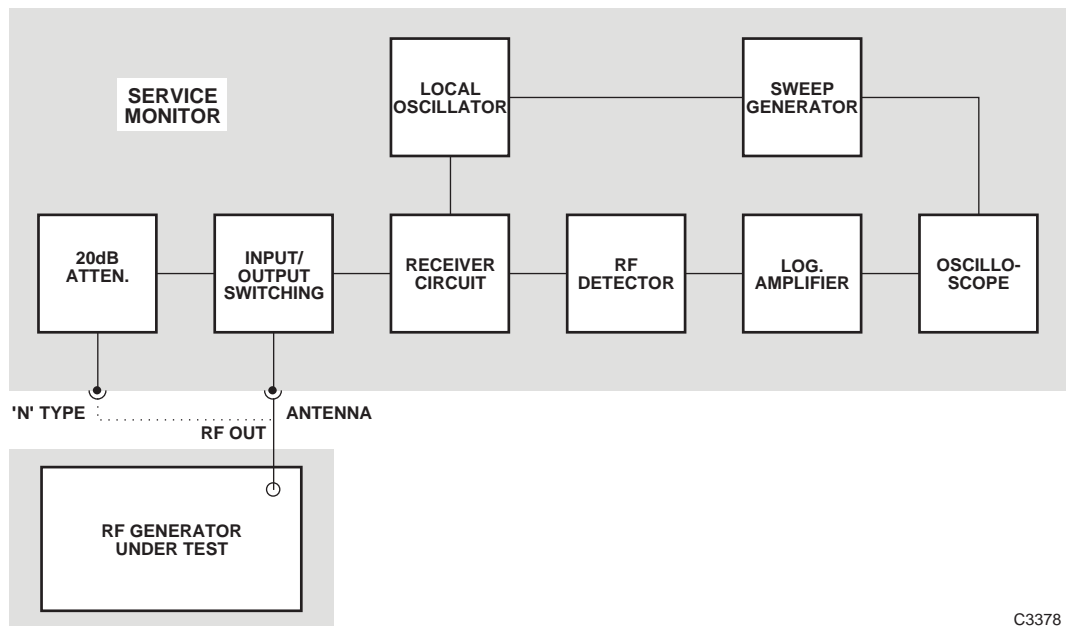
Fig. 3-13 Alternative two port duplex setups

Systems

The [SYSTEM] mode key gives access to dedicated options for testing mobile communications systems such as AMPS and TACS cellular mobile radio telephone systems and MPT 1327 mobile radio trunking systems. Supplementary operating manuals are provided with instruments fitted with these options.

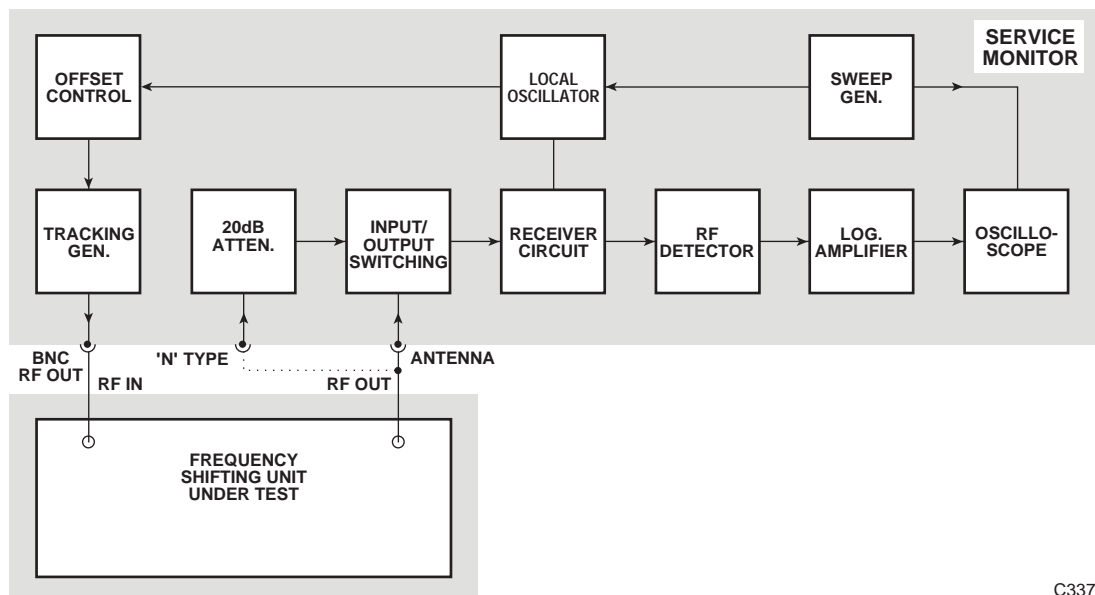
Spectrum analyzer

See Fig. 3-14, *Spectrum analyzer test setup*, and Fig. 3-15, *Spectrum analyzer test setup using the tracking generator*.



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Fig. 3-14 *Spectrum analyzer test setup*



C3379

Fig. 3-15 *Spectrum analyzer test setup using the tracking generator*.

Overview

With the SPEC ANA mode selected, the screen and menu shown in fold out diagram (6-0) is displayed.

In the SPEC ANA mode, the sweep generator causes the acceptance frequency of the analyzer input circuits to repeatedly sweep over the selected frequency range.

The level of RF signal present at the active RF input connector is measured at regular points along the sweep and plotted progressively across the display, thus building up a graph of RF level against frequency.

The uses to which this facility can be put are varied. Within the radio communication field these can include examining the output of a transmitter for spurious radiations, for sideband response or noise levels.

The activity of nearby transmitters can be monitored as an aid to locating interference.

Using the tracking generator facility, the frequency response of filters can be checked and their pass bands plotted.

Setting up

Sweep range

The sweep range can be defined in two ways: either as a centre frequency and a frequency span, or as a start frequency and a stop frequency.

The sweep range will depend on the signal or signals being examined and the harmonics and other spurious frequencies that are to be located.

The datum points are defined using the data input keys in the same manner as other frequency entries such as RF generator frequency or Tx frequency.

The datum point being defined is selected by pressing the relevant soft key, which will cause the datum to be highlighted under the spectrum analyzer graticule on the display. The corresponding datum will also be displayed. Thus START FREQ and STOP FREQ will appear together and SPAN and CENTRE FREQ will appear together.

Centre frequency

Pressing the [*Centre Freq*] key highlights the legend **Centre** under the graticule and allows the entry of any frequency within the spectrum analyzer RF range. This frequency will then be the centre frequency on the graticule. If a figure is entered which would result in the lowest frequency of the span becoming a negative value, the span is reduced so as to set the span start to zero.

The variable control is active when the **Centre** legend is highlighted. It will not adjust the centre frequency to a figure below half of the set span frequency range.

The FREQ [\uparrow] and FREQ [\downarrow] keys can be used to change the centre frequency when the **Centre** legend is highlighted. Each press of one of these keys will increment the centre frequency by the value last set up in the TxTEST mode.

Span

Pressing the [*Span*] key highlights the legend **Span** under the graticule and allows the entry of any frequency within the spectrum analyzer RF range. This frequency will then be the frequency range covered by the frequency sweep. If the frequency entered conflicts with the centre frequency, by requiring a bottom frequency below zero or a upper frequency which is outside the spectrum analyzer RF range, the span will be restricted.

The variable control is active when the **Span** legend is highlighted.

The FREQ [\uparrow] and FREQ [\downarrow] keys can be used to change the span setting when the **Span** legend is highlighted.

Each press of one of these keys will increase or decrease the span setting to the next point in the range 1 kHz, 2 kHz, 5 kHz,.....200 MHz, 500 MHz, 1.0 GHz. The span setting is restricted by the Centre Frequency setting, as explained above.

Start frequency

Pressing the *[Start Freq]* key allows the required start point to be entered using the data entry keys.

The variable control is active when the **Start** legend is highlighted.

Note that when using the variable control the span of the display remains constant. Therefore the stop frequency will follow any change to the start frequency. This is not the case when entering a start frequency by using the data keys.

Stop frequency

The *[Stop Freq]* key highlights the **Stop** legend under the graticule and allows a frequency value to be entered from the data keys.

The variable control is active when the **Stop** legend is highlighted.

Note that when using the variable control, the span of the display remains constant. Therefore the start frequency will follow any change to the stop frequency. This is not the case when entering a stop frequency from the data keys.

Peak find

Press the *[Peak Find]* key to set the marker to the highest level on the trace.

Resolution bandwidth

The bandwidth of the spectrum analyzer acceptance circuits is selectable by the user.

The spectrum analyzer detector circuits will give an output corresponding to the mean level of signal within the acceptance passband. Therefore the choice of pass band, or resolution bandwidth, will depend upon the characteristics of the signal being examined.

The sweep speed is dependent on the resolution bandwidth. A high resolution analysis will take longer to process than a low resolution analysis.

The resolution bandwidth can be selected manually or set automatically.

To set the resolution bandwidth, first press the *[Res BW]* key. The menu shown in fold out diagram (6-12) will be displayed. The options then available are:-

- Press the *[Auto Res BW]* key to set the resolution bandwidth to the optimum setting as determined by the Service Monitor software. The setting is then shown on the display. Use the return key as appropriate to resume setting up or testing.
- Press the *[Manual Res BW]* key to set the required resolution bandwidth by manual selection. The passbands available for selection are:-

300 Hz	3 kHz	30 kHz	300 kHz	3 MHz
--------	-------	--------	---------	-------

The setting is then shown on the display. Use the return key as appropriate to resume setting up or testing.

- Press the *[Return]* key to exit the resolution bandwidth selection menu.

Reference level

The top of the graticule represents the reference level which can be set between -50 dBm and +52 dBm

Pressing the *[REF LEVEL]* key will highlight the **Ref Level** legend and allow a level within the above range to be entered using the data entry keys. The entry must be terminated with the [dBm] terminator key.

Vertical scale

The vertical scale can be displayed with a range of 10 dB/division or 2 dB/division. To select the vertical range, press the *[Vert Scale]* key which will cause the menu shown in fold out diagram

(6-2) to be displayed. Repeated presses of the [10 dB/2 dB] key will toggle the options, with the current choice being shown in the display.

The LEVEL [↑] and [↓] keys adjust the reference level in either 2 dB or 10 dB steps, depending on the setting of the reference level vertical range.

Video filter

A video bandwidth filter can be switched into the display path to reduce the visible noise. To set the state of this, first press the [Vert Scale] key. Alternate presses of the [Video Filter] key will set the Video filter ON or OFF.

The filter frequency is selected automatically to provide optimum performance for the selected resolution bandwidth.

Peak hold

The spectrum analyzer mode has a peak hold facility. When set ON, this facility displays the highest received signal level at each frequency point of the display. Signals of a lower level will not over-write the display, signals of a higher level will over-write previously recorded signals. To set the state of the peak hold facility, first press the [Vert Scale] key. Alternate presses of the [Peak Hold] key will set the facility ON or OFF.

Markers

Marker and δ Marker

The Marker and δ Marker facility allows frequency and level measurements to be made to the signal displayed on the spectrum analyzer screen. The Marker or δ Marker readout is shown at the lower left of the display. The RF level is given in dBm and the RF frequency in MHz, kHz or Hz.

Pressing the [Mkr/ δ mkr] key toggles through the following actions:-

- Displays marker line and marker readout.
- Selects Marker function and allows adjustment using the variable control.
- Selects δ Marker function and allows adjustment using the variable control.
- Removes marker line and marker readout from the display.

With Marker selected and the **Mkr** legend highlighted, adjusting the variable control will move the marker line across the display. The RF level and frequency of the signal at the intersection of the marker line and the displayed signal is shown by the marker readout.

With δ Marker selected and the **δ Mkr** legend highlighted, adjusting the variable control will move the marker line across the display. The marker readout shows *the difference* in RF level and frequency between the intersection of the *marker line* and the displayed signal *and* the intersection of the *display centre line* and the displayed signal. A negative frequency value indicates that the marker line is at a frequency lower than the frequency of the display centre line.

Marker to reference

Pressing the [Marker to Ref] key moves the marker line to the display centre line.

- With the Marker function active, the marker readout will display the RF level and frequency of the signal at the intersection of the display centre line and the displayed signal
- With the δ Marker function active, the marker readout will display 0 dBm and 0 Hz until the marker line is repositioned.

Tracking generator facility

The tracking generator facility uses the RF generator of the Service Monitor to provide a tracking signal source.

This allows the spectrum analyzer to show the frequency response of frequency dependent circuits such as filters.

The frequency response of any circuit connected between the tracking generator output and the spectrum analyzer input will be displayed.

Note

When making calculations relating to frequency response results, take into account the impedance matching between the circuit and the Service Monitor. (See performance specification.)

The frequency offset facility adds to the above capability by allowing tests to be made to frequency shifting circuits. The tracking generator's sweep may be positively or negatively offset with respect to the spectrum analyzer's output. The sum of the offset and the frequency analyzer span cannot produce a figure beyond the frequency range of the RF generator (see performance specification). Under these circumstances, the 2945A selects an appropriate span.

Because the RF generator is used as the tracking generator, control is required over both modes of its operation. The RF generator On/Off menu allows this to be enabled or disabled from the SPEC ANA mode.

Setting the tracking generator

Control of the tracking generator parameters is carried out from the menu accessed by pressing the *[Track/RF Gen]* key. This key will either give direct access to the tracking generator parameters or to the RF generator On/Off menu, whichever was used last. If the RF generator On/Off menu is reached, pressing the *[Track Gen]* key will display the tracking generator parameter control menu shown in fold out diagram (6-5). This menu gives the following options:-

Tracking generator ON or OFF.

Alternate presses of the *[T/Gen On/Off]* key will toggle the tracking generator output ON and OFF. When in the ON condition, the RF level and frequency offset will be shown on the display.

Tracking generator level.

Pressing the *[Level]* key will highlight the **Track Gen Level** legend and allow the level to be altered, either by the variable control or by entering a new value using the data entry keys.

Locking tracking generator frequency to sweep frequency.

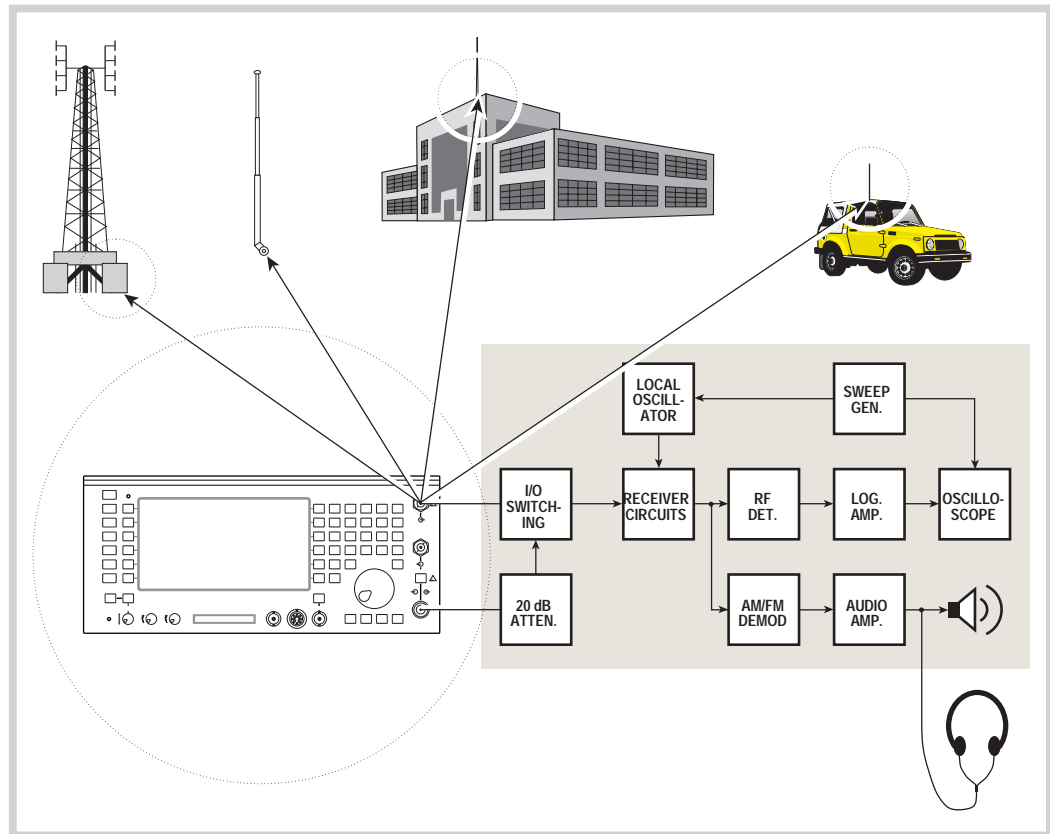
Pressing the *[Freq Locked]* key will lock the Frequency of the tracking generator to the sweep oscillator of the spectrum analyzer. When locked, the legend **Locked** is shown under the **Offset** legend on the display. Repeated presses of this key will toggle between **Locked**, (zero offset), and the offset previously set (see below).

Setting the value of the tracking generator frequency offset.

A new value is entered by first pressing the *[Freq Offset]* key and then using the data entry keys.

Additionally, the RF generator may be disabled from the spectrum analyzer tracking generator menu. Pressing the *[RF Gen]* key will display the RF Generator On/Off menu. Repeated presses of the *[RF Gen On/Off]* key will display the **RF Gen Off** or the **RF Gen On** legend. This indicates the state of the RF generator when the tracking generator facility is off.

Look and Listen



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Fig. 3-16 Spectrum Analyzer setup, Look and Listen function

The Look and Listen facility allows the instrument to be used for 'OFF-AIR' monitoring of transmissions while examining the area of radio spectrum on which the transmission being monitored is centred. The width of RF spectrum scanned in the Look and Listen mode is adjustable in steps from a minimum of 100 kHz to 1 MHz.

The RF signal from a suitable antenna is coupled to the Service Monitor through either the antenna BNC connector or the 'N type' connector on the front panel. The signal is passed through the spectrum analyzer circuits to be displayed as a conventional spectrum analyzer display. The listen demodulator obtains its signal from a non-sweeping IF circuit and is tuned to the centre frequency of the display. The output from it is routed through an AF amplifier to the internal loudspeaker, to the accessory socket and to the 'demod out' socket. See Fig. 3-16, *Spectrum Analyzer setup, Look and Listen function*.

Setting up

Pressing the *[Look & Listen]* key from the SPECTRUM ANALYZER menu selects this option. The menu shown in fold out diagram (6-6) is displayed.

Centre Freq and Span setting

When operating in the 'Look & Listen' mode, the spectrum display is defined only by the Centre Freq and Span settings.

The centre frequency is set by selecting the *[Centre Freq]* key to highlight the legend **Centre** at the bottom of the display and then entering a value using the data input keys. Fine adjustment can be made using the variable control when the **Centre** legend is displayed as above.

With an input signal displayed, adjusting the centre frequency will allow the listen detector to be tuned to an observed signal.

The Span setting controls the sweep range covered by the spectrum analyzer. When in the Look and Listen mode the sweep span is selected from the Span menu accessible by pressing the *[Span]* key. Four span widths are available as listed below.

1 MHz	500 kHz	200 kHz	100 kHz
-------	---------	---------	---------

Demod settings

The 'listen' demodulator and its associated circuits are set to extract the information from the signal tuned to the centre frequency of the display. The following options are available through the *[Demod]* key.

Modulation type	AM	FM
De-emphasis	ON	OFF
AF filter	300 Hz to 3.4 kHz	15 kHz LP

'Listen' IF bandwidth

Instruments with the 'Demod Filters' option fitted, have additional IF filters included in the 'Listen' IF amplifier. This allows an appropriate filter, matched to the channel spacing and modulation characteristics of the signal of interest, to be selected. This is independent of the spectrum analyzer resolution bandwidth selected.

Pressing the *[Listen IF BW]* key will display the following filter options:-

5 kHz	12.5 kHz	25 kHz	50 kHz	300 kHz
-------	----------	--------	--------	---------

The selected filter is shown on the display, above the 'Demod' type legend.

Instruments not fitted with the 'Demod Filters' option can be set to 15 kHz or 300 kHz. This also is irrespective of the spectrum analyzer resolution bandwidth selected. The current setting is shown to the left of the display. To change the setting, first press the *[Listen IF BW]* key, which will display *[15 kHz]* and *[300 kHz]* keys. Press the appropriate key to select the required setting.

Switching to the Tx TEST mode after a signal has been located will allow the signal to be monitored with the IF bandwidth set to 300 Hz, 3.0 kHz, 30 kHz or 300 kHz.

Resolution bandwidth selection

The resolution bandwidth for the display can be selected from the following through the *[Res BW]* key:-

Auto Res BW	3 kHz	30 kHz	300 kHz
-------------	-------	--------	---------

With automatic resolution bandwidth selected, the resolution bandwidth is dependent on the sweep span, as shown below:-

Span Setting	Resolution Bandwidth
1 MHz	30 kHz
500 kHz	30 kHz
200 kHz	3 kHz.
100 kHz	3 kHz.

When operating in the Look and Listen mode, some functions or options of SPEC ANA mode will be available to the user. Reference to these is made on the display but their condition cannot be changed without returning to the main spectrum analyzer display. These are:-

Reference level dB/div	2 dB	10 dB
Video filter option	OFF	ON
Peak hold option	OFF	ON

Input sensitivity

The input sensitivity of the Service Monitor in the Look and Listen mode is the same as for the normal spectrum analyzer input. The reference level can be set using the data input keys, or adjusted using the variable control. The LEVEL [↑] and [↓] keys adjust the reference level in either 2 dB or 10 dB steps depending on the setting of the reference level vertical range.

Making measurements

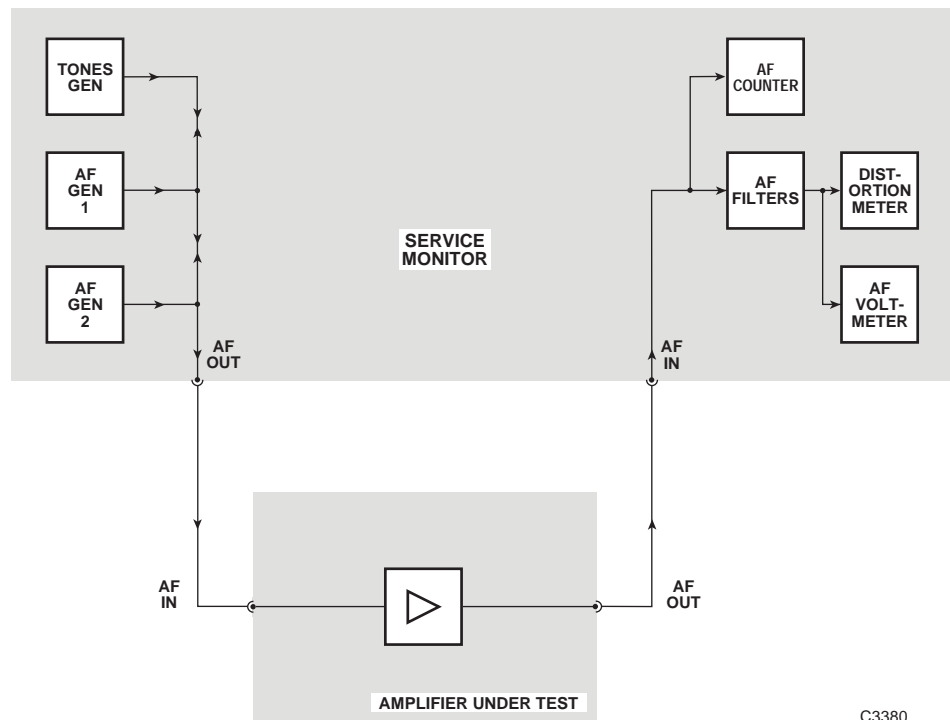
The monitor can be used to determine the frequency of a transmission and to identify the modulation type and content of asymmetric transmissions. When the transmission to be examined is visible on the display, adjust the centre frequency line on the display to coincide with the peak of the signal. This will be the carrier frequency and will be shown as a digital readout. Progressively reduce the span and optimise the filtering and demodulation method while listening to the demodulated output. As the span is reduced the centre frequency may need optimising.

The peak level of the signal can be determined by reference to the RF level scale on the display.

The top of the graticule represents the reference set on the display. Each division of the graticule represents either 10 dB or 2 dB, as set in the vertical scale setup menu of the main SPEC ANA mode.

AF test (audio frequency testing)

Overview



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Fig. 3-17 Audio test setup.

To enter the AF TEST mode press the blue [AF TEST] key. This will cause the screen and menu shown in fold out diagram (7-0) to be displayed.

When the AF TEST mode is selected, the combined output from the AF generators, plus the data generator facility, is available at the AF output connector. Signals fed to the AF input connector are routed to the AF signal analysing circuits. See Fig. 3- 17, *Audio test setup*.

The frequency, level and shape parameters of the audio generators can be set within the following limits:-

Freq. range	10 Hz to 20 kHz
Level range	0.1 mV to 4 V rms
Shape option	Sine or square

By using the AF signal generators and the measuring functions of the Service Monitor, it can be used for performance testing of passive and active AF circuits such as filters and amplifiers.

Frequency, level, distortion level, SINAD level and signal to noise ratio measurements can be made. The oscilloscope facility is available to observe and measure waveforms. The tones receiver facility is available for the performance checking of features such as digitally coded squelch generators.

The AF output signal and the measuring facilities can each be used independently.

Setting up

The audio generators are the signal sources for AF testing. Good practice is to disable the source until tests are set up. This is achieved by selecting each of the generators in turn and pressing the orange [ON/OFF] function key to display Off adjacent to each of the generator's output data on the display. The required generator or generators can be set up in the Off condition and enabled by the above procedure when all connections and setting are complete.

To select and set up the audio generators press the [Audio Gen] key. This will display the audio setup menu shown in fold out diagram (7-2).

Repeated presses of the [Gen1/Gen2] key will highlight the AF1 and AF2 legends in turn to indicate the selected generator.

Set up the audio generator(s) for the required frequency and output level by using the soft keys and data input keys:-

[Gen 1/Gen 2] to select AF1, then, [FREQ][n]...[n][kHz/Hz]
 [LEVEL][n]...[n][V/mV/dBm]
 then [Gen 1/Gen 2] to select GEN2 if required,...[.../dBm]

The FREQ [↑] and [↓] and the LEVEL [↑] and [↓] keys can be assigned to AF generator frequency and level. See *Incremental adjustments* which starts on page 3-62.

The shape of each audio generator output waveform can be either sine or square wave. This is controlled by first selecting the audio generator as for On/Off control above, then pressing the [SHAPE] key to toggle between the options.

Input level measurement

The measured level of signals applied to the AF INPUT connector can be displayed in volts, dBm, dBV or mW. The selection is made from setup page 2, as described under *Audio Level Measured in:* on page 3-12. When the input level is displayed in dBm or mW, the signal is assumed to be measured across 600 Ω.

The 600 Ω interface unit allows the Service Monitor to provide a 600 Ω termination. (See *Audio Input Impedance* on page 3-12.) With the input impedance set at 600 Ω, the indicated level is that of the input to the Service Monitor. With the input impedance set at High, the indicated level is that of the input to the Service Monitor with an assumed 600 Ω load.

Input filtering

The AF signal to the AF INPUT connector on the front panel can be filtered using the following audio filters:-

0.3 - 3.4 kHz band pass	50 kHz low pass	15 kHz low pass	300 Hz low pass	CCITT [†] or C-MESS [‡]
----------------------------	--------------------	--------------------	--------------------	--

[†] Only if option 23 (CCITT filter) is fitted.

[‡] Only if option 24 (C-MESS filter) is fitted.

Press the *[AF Filter]* key. The right hand soft keys change, to allow selection of AF filters as shown above. Press the *[Return]* key after selecting the required filter.

The 50 kHz LP filter can be considered to be the 'unfiltered' selection as this represents the normal full bandwidth of the audio circuits.

Distortion measurement

The distortion measuring facilities of the monitor are available within the AF TEST mode and are implemented by selecting the *[Dist/S-N]* key. This will cause the menu shown in fold out diagram (7-4) to be displayed.

Pressing each of the soft keys will have the following effect:-

Off

Disables any active distortion measuring function.

Hint

By disabling this function, the time taken to measure the remainder of the measurement functions is shortened thereby reducing the update time.

S/N

Selects signal to noise ratio as the measurement method. The AF generator is disabled and enabled alternately by the monitor software and the total output level from the circuit under test is measured by the AF voltmeter at each state. See Fig. 3-8 a, & d *Distortion level and signal to noise level measurements*, on page 3-33.

Calculations are performed by the software to calculate the signal to noise ratio using the formula:-

$$\begin{aligned} \text{S/N} &= 20 \log \frac{V_1}{V_2} \text{ dB} \\ &= 20 \log \frac{(S + N + D)}{N} \text{ dB} \end{aligned}$$

The distortion bar chart ranges available are 0 to 30 dB and 0 to 100 dB. The signal to noise ratio is displayed as a digital read-out above the bar chart. The AF test menu is recalled automatically after pressing this key.

SINAD

Selects SINAD as the measurement method. The AF generator is set to 1 kHz and the 1 kHz distortion notch filter is switched alternatively in and out of circuit, with the signal level being measured by the AF voltmeter in each state. See Fig. 3-8 a, b, & c, *Distortion level and signal to noise level measurements*, on page 3-33.

The monitor software calculates the SINAD level according to the formula:-

$$\begin{aligned} \text{SINAD} &= 20 \log \frac{V_1}{V_2} \text{ dB} \\ &= 20 \log \frac{(S + N + D)}{(N + D)} \text{ dB} \end{aligned}$$

The distortion bar chart ranges available are 0 to 18 dB and 0 to 50 dB. The SINAD level is displayed as a digital readout above the bar chart. The AF test menu is recalled automatically after pressing this key.

Dist'n

Selects distortion percentage as the measurement method. The AF generator is set to 1 kHz and the 1 kHz distortion notch filter is switched alternatively in and out of circuit, with the signal level being measured by the AF voltmeter in each state. See Fig. 3-8 a, b, & c, *Distortion level and signal to noise level measurements*, on page 3-33.

The monitor software calculates the distortion level according to the formula:-

$$\begin{aligned} \text{Distortion} &= 100 \frac{V_2}{V_1} \% \\ &= 100 \frac{(N + D)}{(S + N + D)} \% \end{aligned}$$

The distortion bar chart ranges available are 0 to 10% and 0 to 30%. The distortion percentage level is displayed as a digital readout above the bar chart. The AF test menu is recalled automatically after pressing this key.

Oscilloscope

The oscilloscope facility can be used from within the AF test mode to examine the signal present at the AF input socket. The sensitivity of the Y axis is adjustable from 10 mV/division to 20 V/division in a 1,2,5 sequence.

The input to the oscilloscope is taken directly from the AF input, and not through any of the AF filters. Therefore measurements obtained on the AF voltmeter will show the effects of filtering, whereas those made using the oscilloscope will not.

A section on the use of the oscilloscope facility starts on page 3-80.

Incremental adjustment keys

General

This section provides information on the use of the incremental adjustment keys. Other sections of this chapter have specific references to these keys; this section gives general information.

The incremental adjustment keys are located under the variable control, with one pair designated **FREQ**, [↑] and [↓], the other pair designated **LEVEL**, [↑] and [↓]. Each pair can be assigned to a selected parameter within a test mode, which then allows that parameter to be adjusted in steps.

Note that the **FREQ** [↑] and [↓] keys, and the **LEVEL** [↑] and [↓] keys, do not have to be assigned to the same generator.

The parameters that can be selected are: -

Parameter	Test mode
Tx frequency	Tx test mode
AF generator 1 frequency	Tx test mode
AF generator 2 frequency	Tx test mode
AF generator 1 level	Tx test mode
AF generator 2 level	Tx test mode
RF generator frequency †	Rx test mode
RF generator level	Rx test mode
Modulation generator 1 frequency	Rx test mode
Modulation generator 2 frequency	Rx test mode
Modulation generator 1 level	Rx test mode
Modulation generator 2 level	Rx test mode
AF generator 1 frequency	AF test mode
AF generator 2 frequency	AF test mode
AF generator 1 level	AF test mode
AF generator 2 level	AF test mode
RF centre frequency	Spec ana.
RF frequency span ‡	Spec ana.
RF level ‡ ‡	Spec ana.

† The RF generator can be made to step up or down through each channel of a mobile radio system type, by setting the Δ frequency to the channel spacing frequency.

‡ The SPEC ANA mode SPAN adjustment using the FREQ [↑] and [↓] keys, sets the span to predetermined values. These are not adjustable by the user. See Setting up; SPAN on page 353.

‡ ‡ The SPEC ANA mode RF LEVEL adjustment using the LEVEL [↑] and [↓] keys, changes the RF reference level in steps of 1 display division. This can be either 2dB/div or 10 dB/div, dependent on the value of dB/div set in the SPEC ANA mode.

Assigning

The assignment of the incremental keys is shown in the display, along with the step value.

To assign a parameter to a pair of keys, first select the parameter as if to change the value using the data input keys, but rather than entering a new value press the orange [ALT Δ] key. Now enter the value of the step to be incremented at each keypress, followed by the correct terminator key.

For example to assign the FREQ [↑] and [↓] keys to AF generator 1 in the Tx TEST mode and to step up or down by 500 Hz steps, follow this procedure:-

From the Tx TEST display press the [Audio Gen] key.

Use the [Gen 1/Gen 2] key to select **AF1**

Press the orange [LEVEL] key.

The **LEVEL** legend following **AF1** will be highlighted.

Press the orange [Δ INC] key, followed by [5] [0] [0] and the [Hz] terminator key.

The display will show the legend

Increments
AF1 FREQ: 500 Hz

Now each press of a FREQ [↑] or [↓] key will increase or decrease the output frequency of AF generator 1 by 500 Hz.

Points to note are:-

Each press of a FREQ [↑] or [↓] key will be effective from the current point. Thus if the frequency of the generator in the above example has been incremented to **1,500 Hz** and then

adjusted by use of the variable control (or the data entry keys) to **1,495 Hz**, the next incremental step down will produce a frequency of **995 Hz**.

The assignment and value of a incremental setting will be retained, with the mode setup, when a different mode is selected or the instrument is powered down. This is of particular note when assigned to the AF generators as they are also the modulation generators within the Rx TEST mode and the AF generators within the AF TEST mode.

The incremental keys cannot be used when in the Dx TEST mode.

Use within spectrum analyzer mode

The SPEC ANA mode makes use of the FREQ [↑] and [↓] keys for span adjustment. The span is ranged up or down in a 1, 2, 5 sequence, from 1.0 kHz to 1.0 GHz.

Adjustment to the span by these keys is linear about the centre frequency and will not adjust below zero or above the top frequency limit.

When the **Centre** legend is highlighted the FREQ [↑] and FREQ [↓] keys will increment the centre frequency by the value last set up in the TxTEST mode.

The LEVEL [↑] and [↓] keys adjust the reference level of the spectrum analyzer in either 2 dB or 10 dB steps depending on the setting of the reference level vertical range.

Tones

Tones sub-mode

Audio tones and digital code signals are used for many purposes within radio communication systems. The Service Monitor has a TONES mode accessed from the Tx TEST, Rx TEST, Dx TEST and AF TEST modes.

This gives facilities for testing tone calling and control systems of the following types.

- Sequential Tones. A selective calling system using audio tones.
- CTCSS (Continuous Tone Coded Squelch System).
- DCS (Digitally Coded Squelch).
- DTMF (Dual Tone, Multi-Frequency).
- POCSAG (Post Office Code Standardisation Advisory Group). A paging system using digital signalling.

The tone mode is entered from the top level screen of any main mode, other than SYSTEM or SPEC ANA.

Pressing the [Tones] key will display the screen shown in Fig. 3-18, *Tones selection screen and Tones mode receiver input level setting*.

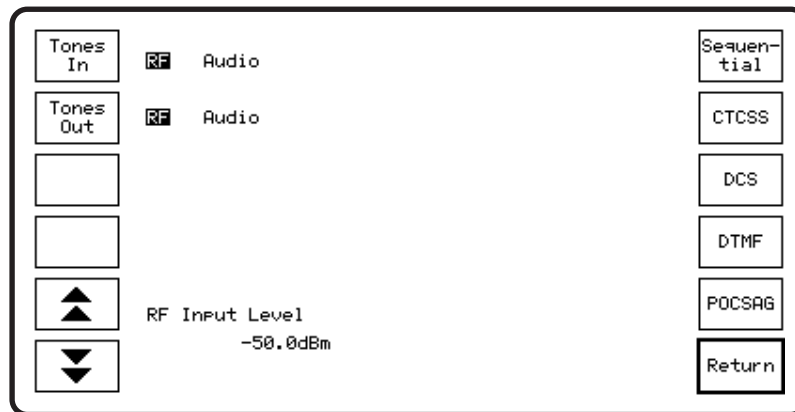


Fig. 3-18 Tones selection screen and Tones mode receiver input level setting

Observing tones signals in other test modes

The effect of any tones signalling on transmitters or receivers under test can be studied using any test mode of the Service Monitor.

When a test mode is selected, (either by pressing the [Tx TEST] key, [Rx TEST] key etc. or by pressing the [Return] key), while any tones signal is running continuously (CTCSS or DCS Tones On; Sequential or DTMF continuous mode Sending), the tones will continue to be generated. See the Tones ON/OFF control section of each specific tones description.

Signal routing

The tones sub-mode can be entered from either Tx TEST, Rx TEST, Dx TEST or AF TEST modes.

The encoded signal produced by the Service Monitor can be routed to the equipment under test in two ways:

- As a modulated RF signal from either of the RF output connectors.
- As an AF signal from the AF GEN OUT connector.

Similarly, an encoded signal produced by the equipment under test can be routed to the Service Monitor in two ways:

- As a modulated RF signal to either of the RF input connectors.
- As an AF signal to the AF INPUT connector.

The input and output routing settings are made from the TONES selection screen. Pressing the [Tones In] or [Tones Out] key alternates the setting between **RF** and **Audio**. The selected settings will be retained until reset, either manually or by recalling instrument settings. Any tone sequence or continuous tone that is running when an input or output routing setting is changed will be stopped.

RF input attenuators

The RF input circuits of the Service Monitor are auto-ranging under most operating conditions. When operating in some of the tones modes this can be a disadvantage as the tones decoders need to receive the leading burst of any transmission. Therefore when TONES mode is selected, the auto-ranging function is disabled and the RF input sensitivity of the service monitor is set manually.

This is done by using the [▲] and [▼] keys on the TONES selection screen. For correct operation of the TONES decoders, the input signal level should *not exceed* the level set.

Each keypress will switch the sensitivity of the service monitor up or down by 10 dBm. If the level of the applied signal is unknown, it can be measured using the Tx TEST mode. The Service Monitor RF Input Level can then be set *above* the measured level.

The following table shows the RF input level settings that are available for either of the RF input connectors.

RF N in		RF Antenna in		Audio
398 W	56.0 dBm	1.00 W	30.0 dBm	<40.0 V
39.8 W	46.0 dBm	100.0 mW	20.0 dBm	<20.0 V
3.98 W	36.0 dBm	10.0 mW	10.0 dBm	<10.0 V
398 mW	26.0 dBm	1.00 mW	00.0 dBm	<4.0 V
39.8 mW	16.0 dBm	100 µW	-10.0 dBm	<2.0 V
3.98 mW	6.0 dBm	10 µW	-20.0 dBm	<1.0 V
398 µW	-4.0 dBm	1 µW	-30.0 dBm	<400 mV
40 µW	-14.0 dBm		-40.0 dBm	<200 mV
4 µW	-24.0 dBm		-50.0 dBm	<100 mV

When using the AF INPUT connector for TONES operation, the [▲] and [▼] keys on the TONES selection screen set the AF input sensitivity. The column headed Audio, in the above table, lists the AF input settings. The AF input signal level should be less than that shown for the current setting.

Sequential tones

Overview

Sequential tones signalling systems use sequences of audio tones to control various functions of a radio system. There are many systems in operation world-wide, all using up to 15 tones labelled with the hexadecimal digits 0 to E with 'No Tone' as F. Some systems make use of extended tones for certain functions.

Each version has its own tone allocation tables for the 15 tones and its own timing for tone duration.

The versions for which tone allocation tables and tone duration values are included in the Service Monitor are:-

CCIR	ZVEI	DZVEI	EEA	EIA	USER 1	USER 2
------	------	-------	-----	-----	--------	--------

The USER 1 and USER 2 tables allow tone frequencies and tone durations to be programmed by the user.

This Service Monitor has encoding facilities with variable parameters which allow signals to be produced for testing systems using precise values and adverse values. The decoding facility will measure the frequency and duration of the received tones, match the results against the appropriate look-up table and list the results with the identification of each tone.

Observe notes relating to signal routing and RF input attenuators at beginning of this section. See page 3-65.

Continuous sequential tones can be produced at the same time as CTCSS or DCS tones.

Using the decoder

The sequential tones decoder will function when the instrument is in the Rx TEST mode.

Press the [Decoder] key and the AF SEQUENTIAL DECODER screen will be displayed. A tone sequence fed into the AF input will be decoded and the results will be displayed.

Testing sequential tone receivers

Using the encoder

To test the operation of receivers using sequential tone signalling, proceed as follows:-

Rx TEST settings

Select the receiver test mode by pressing the [Rx TEST] key.

Set the RF output frequency of the Service Monitor to that set on the receiver.

Ensure that the RF generator within the Service Monitor is in the OFF condition. This should remain OFF until the Service Monitor and the receiver under test are set up and properly interconnected.

Make a suitable RF connection between one of the Service Monitor RF output connectors and the RF input connector of the receiver.

Set the RF output level from the Service Monitor to an appropriate setting.

Select the 'RF SEQUENTIAL TONES' function by using the key sequence, [Tones], [Sequential]. The screen and menu shown in Fig. 3- 19, *RF Sequential tones encoder display, main menu*, will be displayed.

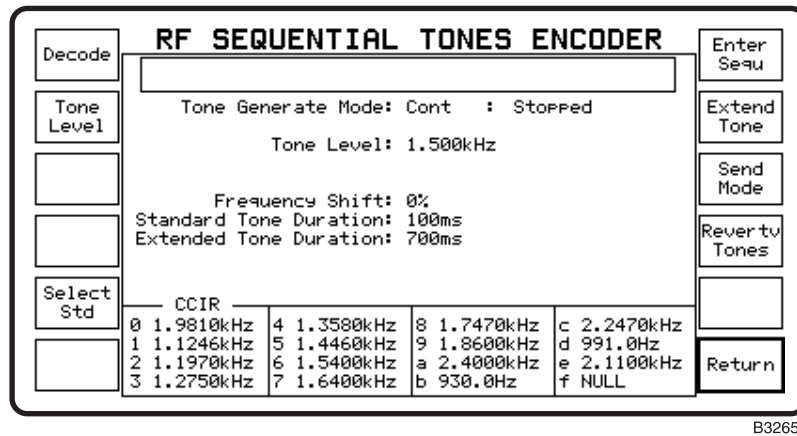


Fig. 3-19 RF Sequential tones encoder display, main menu

Setting the Tones mode

The display is divided into three areas.

- At the bottom of the display is a table listing the frequencies allocated to the 15 tones, 0 to E. Above the table is shown the system type, i.e. CCIR, ZVEI etc.
- At the top of the display is a panel in which the tone sequence to be transmitted is assembled or edited.
- The centre of the display shows information relating to the parameters of the system.

Check that the system type shown above the frequency table is the same as the system type on which the receiver to be tested operates. If this is not correct press the [Select Std] key to display the SELECT TONES STANDARD screen and menu as shown in Fig. 3-20, *Sequential tones standard selection menu*.

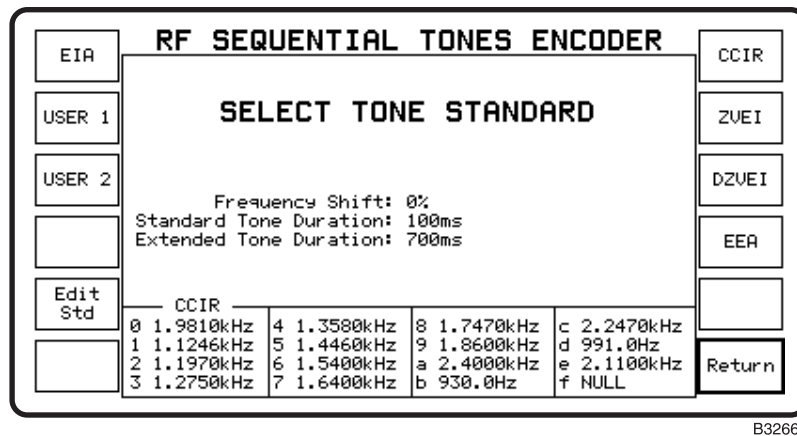


Fig. 3-20 RF Sequential tones standard selection menu

Select the correct system standard by pressing the appropriate key. The frequency allocation table will change to relate to the selected standard and the settings of the tone duration parameters will also change to the correct values for the system.

Return to the main sequential tones menu.

When the frequency allocation table is correct for the system, check that the other parameters are correctly set. The tone modulation level has a default setting of 1.5 kHz but can be set by the user to any level up to the instrument's maximum of 75 kHz.

Creating the tone sequence

To create the required tone sequence, first press the *[Enter Sequ]* key to display the cursor in the tone sequence panel.

Enter the required sequence by using any of the data entry keys 1 to 9, zero and the Hex digits A to E. The *[Extend Tone]* key is used to convert a standard tone to an extended tone or an extended tone to a standard tone. With the cursor positioned over the tone to be changed, each press of the *[Extend Tone]* key will extend it or reduce it to standard. The cursor is moved by using the variable control.

Editing a tone sequence

An existing tone sequence can be edited as required. Using the rotary control, move the cursor over the character to be changed. To delete the unwanted character and insert a new character in its place, press the data key corresponding to the new character. To delete an unwanted character and close up the sequence, press the [DELETE] key.

Editing the tone standard

Tone frequency shifting

The frequency of all the tones in the table can be collectively altered by up to $\pm 10\%$ for tolerance checking.

Tone duration

The duration times for standard and extended tones are set to the system standard when the system is selected. They can be altered by the user from the EDIT TONE STANDARD screen, which is accessed by pressing the *[Edit Std]* key on the SELECT TONE STANDARD screen.

Press the *[Tone Durat'n]* key or the *[Tone Ext Dur]* key as appropriate and enter the required duration using the data entry keys and the [ms] terminator key.

Producing the sequential tone signal

The Service Monitor has four tone modes for producing sequential tone signals. These are selected after pressing the *[Send Mode]* key. This will display the soft keys shown below:-

[Cont Tones] Generates the tone sequence repeatedly.

[Tone Burst] Generates one sequence of the tones then stops.

[Step Tones] Each initiation causes one tone of the sequence to be generated for the stated duration. Subsequent initiations step to the next tone in the sequence.

[Single Tone] Pressing any data entry key will cause the corresponding tone to be generated for the stated duration.

[Return] Returns to the main Sequential Tones menu.

The selected send mode, i.e. Cont, Burst, Step or Single, will be shown on the display against the legend Tone Generate Mode.

Before sending tones using the RF generator ensure that the RF generator is ON.

Tone ON/OFF control

When the RF SEQUENTIAL ENCODER screen or the AF SEQUENTIAL ENCODER screen is displayed, the sequential tones are turned on or off by the orange [ON/OFF] function key.

If the sequential tones are ON and the Tx TEST, Rx TEST, Dx TEST or AF TEST mode selected, the tones will continue to be generated.

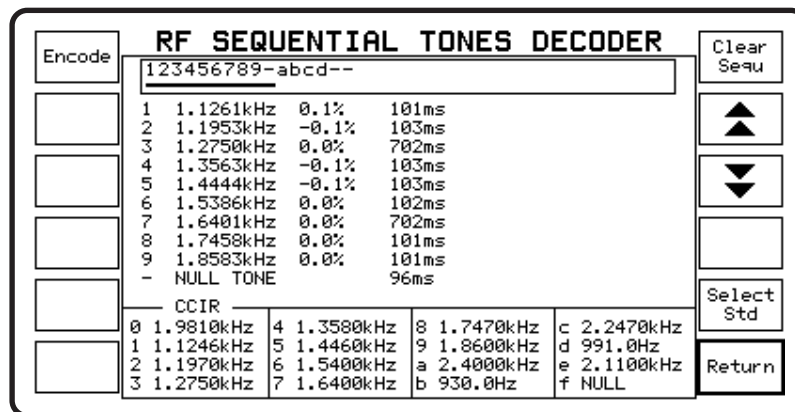
If the tones out routing has been set to give RF tones, this is provided by modulation generator 1. The legend ---Tones --- will be displayed against MOD1 FREQ on the RECEIVER TEST or DUPLEX screens. If **MOD1** is selected, the sequential tones can be controlled by repeated presses

of the orange [ON/OFF] function key. If **MODI** **FREQ** is selected, the tones are still controlled by the orange [ON/OFF] function key, but if a frequency is entered using the data keys or if the variable control is adjusted, the tones will cease. They can then be re-started *only* when the RF SEQUENTIAL ENCODER screen or the AF SEQUENTIAL ENCODER screen is displayed.

If the tones out routing has been set to give AF tones, this is provided by audio generator 1. The legend --Tones-- will be displayed against AF1 FREQ on the TRANSMITTER TEST, DUPLEX or AF TEST screens. If **AF1** is selected, the tones can be controlled by repeated presses of the orange [ON/OFF] function key. If **AF1** **FREQ** is selected, the tones are still controlled by the [ON/OFF] key, but if a frequency is entered using the data keys or if the variable control is adjusted, the tones will cease. It can then be re-started *only* when the RF SEQUENTIAL ENCODER screen or the AF SEQUENTIAL ENCODER screen is displayed.

Testing sequential tone transmitters

To test the operation of transmitters sending sequential tones calling signals, proceed as follows:-
 Select the Tx TEST mode, then make all the required settings and RF connections for conventional transmitter testing. Refer to the Tx TEST section of this manual for the correct procedures. Set the frequency of the Service Monitor input to that of the transmitter output. Key the transmitter and check that the Service Monitor is obtaining a signal from the transmitter. Select TONES mode. The attenuators in the receive path of the Service Monitor will be held at their current setting. Press the [Sequential] key. The RF SEQUENTIAL TONES DECODER screen and menu is displayed. See Fig. 3-21, *Sequential tones decoder screen*. If the encoder screen is displayed, press the [Decode] key.



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Fig. 3-21 RF Sequential tones decoder screen

Check that the tones standard shown above the tone number/frequency list corresponds to the system used by the transmitter. If this is not correct, select the correct standard from the menu accessed through the [New Std] key.

Key the transmitter to transmit a tone sequence. Within the Service Monitor the TONES decoder will decode the tones sequence obtained from the modulation meter.

The decoded sequence will appear in the panel at the top of the display, with the first 10 characters underlined. The sequence decoder store can hold up to 40 decoded characters. Any received in excess of this will be lost.

The underlined tones are listed in the centre of the display with an analysis of the parameters of each tone as below:-

- The measured frequency of each tone.
- The percentage error from the true tone frequency.
- The duration of each tone.

By using the [▲] or [▼] keys, the analysis of all tones in the decoded sequence can be shown.

The stored sequence can be cleared from the store by pressing the [Clear Sequ] key.

Revertive tones

Revertive tones signalling takes various forms. The common factor is that a tone sequence received by a mobile transceiver or other receiver, will trigger a second sequence to be returned. The second sequence may be a duplicate of the first or a different sequence. It can be used to modulate a signal on a reverse channel or on a different channel. For some applications either or both of the tone sequences may be used as an AF signal.

The routing of the original tone signal out of the Service Monitor, and the revertive tone signal into the Service Monitor, is dependent on the settings of the [Tones In] and [Tones Out] keys on the TONES selection screen. This allows the permutations shown in the following table.

Original tones out	Revertive tones in
RF	RF
RF	AF
AF	RF
AF	AF

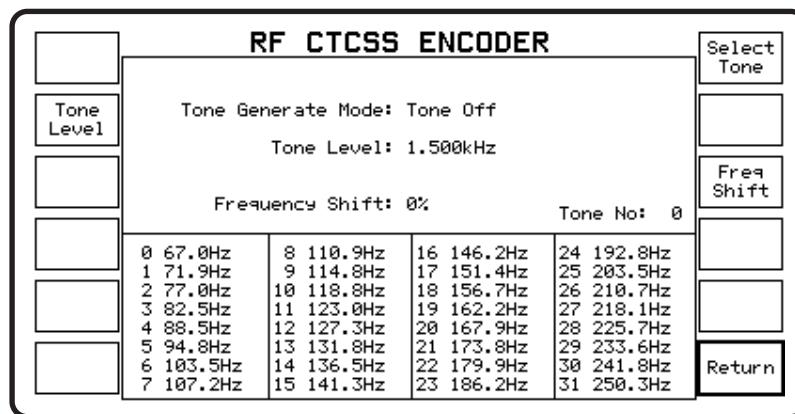
The revertive tones operation is configured by pressing the [Revertv Tones] key. To send a tone burst, do one of the following:-

- If TONE BURST has NOT already been selected as the send mode, press the [Send Mode] key to access the send mode menu, then press the [Tone Burst] key. The tone sequence will be generated, then after the last tone, the Service Monitor will change to decode mode ready to decode the revertive tones.
- If TONE BURST has already been selected as the send mode, press the orange [ON/OFF] function key. The tone sequence will be generated, then after the last tone, the Service Monitor will change to decode mode ready to decode the revertive tones.

The encoder screen can be displayed again by pressing the [Encode] key.

CTCSS

The CTCSS tones system uses a continuous tone at a precise frequency, transmitted below the audio pass band, to un-squelch the receiver.



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Fig. 3-22 RF CTCSS encoder screen and menu

Pressing the [CTCSS] key on the TONES selection screen will display the screen shown in Fig. 3-22, RF CTCSS encoder screen and menu.

The CTCSS function of the Service Monitor will generate a single AF tone, selected from those listed on the display.

Output level

The required output level of the tone signal can be set using the data entry keys, after highlighting the legend **Tone Level** by pressing the *[Tone Level]* key.

The units used to specify the output level will relate to the selected output routing and, when RF output is selected, the modulation method. The modulation type is automatically set, to be appropriate to the level terminator key used (FM for Hz, kHz or MHz; AM for %).

The valid output range for each output option is shown in the following table.

Output type	Output range	Default
RF AM	0 - 99%	30%
RF FM	0 - 75 kHz	1.5 kHz
Audio	100 μ V - 4 V	100 mV

Tone selection

The required tone is selected from the table in the lower part of the display. Press the *[Select Tone]* key to highlight the legend **Tone No.** Use the data keys to enter the number of the required tone, then press the [ENTER] key.

Tone frequency shift

The frequency of the selected tone can be shifted by up to $\pm 10\%$. Press the *[Freq Shift]* key to highlight the legend **Frequency Shift**. Use the data keys to enter the value of frequency shift required. Only whole numbers within the above range are valid. Complete the entry with the [%] key.

Tone ON/OFF control

When the RF CTCSS ENCODER screen or the AF CTCSS ENCODER screen is displayed, the tone is turned on or off by the orange [ON/OFF] function key.

If the CTCSS tone is ON and the Tx TEST, Rx TEST, Dx TEST or AF TEST mode selected, the CTCSS tone will continue to be generated.

If the tones out routing has been set to give RF tones, this is provided by modulation generator 2. The legend --CTCSS-- will be displayed against MOD2 FREQ on the RECEIVER TEST or DUPLEX screens. If **MOD2** is selected, the CTCSS tones can be controlled by repeated presses of the orange [ON/OFF] function key. If **MOD2 FREQ** is selected, the CTCSS tone is still controlled by the [ON/OFF] key, but if a frequency is entered using the data keys or if the variable control is adjusted, the CTCSS tone will cease. It can then be re-started only when the RF CTCSS ENCODER screen or the AF CTCSS ENCODER screen is displayed.

If the tones out routing has been set to give AF tones, this is provided by audio generator 2. The legend --CTCSS-- will be displayed against AF2 FREQ on the TRANSMITTER TEST, DUPLEX or AF TEST screens. If **AF2** is selected, the CTCSS tones can be controlled by repeated presses of the orange [ON/OFF] function key. If **AF2 FREQ** is selected, the CTCSS tone is still controlled by the [ON/OFF] key, but if a frequency is entered using the data keys or if the variable control is adjusted, the CTCSS tone will cease. It can then be re-started only when the RF CTCSS ENCODER screen or the AF CTCSS ENCODER screen is displayed.

DCS

Overview

Digitally Coded Squelch signalling is a system for addressing mobile radio transceivers from their base station by transmitting a code unique to the addressed transceiver for the duration of the transmission. The principles and limitations of the system provide 104 uniquely identifiable codes for use on any one RF channel.

The coded signal consists of a repeating 23 bit word which has error correcting information and timing using 14 bits, leaving nine bits available to carry address code.

The digital signal is formatted as a simple non-return to zero (NRZ) signal which is used to directly modulate the transmitter. On frequency shift modulating systems a '1' is usually made to increase the carrier frequency and a '0' to decrease the carrier frequency. An 'Invert' facility is included to reverse the polarity of the digital signal before it is applied to the modulator.

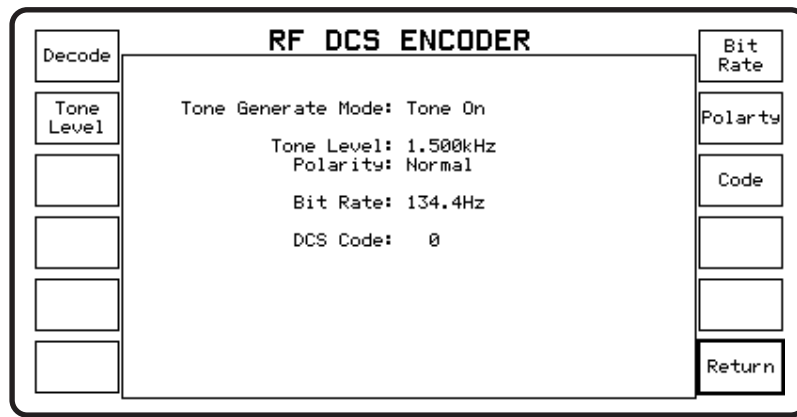
The most often used bit rate for generating the 23 bit code words and that which is specified in most standards is 134 bits/s. This allows the system to operate below the communications audio pass band.

See *Signal routing* and *RF input attenuators* starting on page 3-65.

DCS receiver decoder testing

To test the DCS decoder function of a mobile transceiver, set up and connect the Service Monitor with the mobile as described in the Rx testing section of the operating manual.

Access the DCS facility within the RF tones mode by using the sequence, *[Tones]*, *[DCS]*. The RF DCS Encoder screen and menu is displayed as shown in Fig. 3-23, *RF DCS ENCODER screen and menu*.



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Fig. 3-23 RF DCS ENCODER screen and menu

Check that the bit rate is correct for the unit to be tested. If a different bit rate is required to that which is shown on the display, enter the required value as follows.

Press the *[Bit Rate]* key to highlight the **Bit Rate** legend on the display. Use the data entry keys to enter the correct value and press the Hz terminator key. *Note. The most common bit rate for DCS systems is 134 bits/s.*

Check that the tone (modulation) level is correct for the system specification. If a different level is required to that which is shown on the display, enter the required value as follows:-

Press the *[Tone Level]* key to highlight the **TONE LEVEL** legend on the display. Use the data entry keys to enter the correct value and press the [kHz] or [Hz] terminator key as appropriate. *Note. The level of modulation for DCS signal modulation is usually within the range 10% to 20% of the system maximum level.*

Check the modulation polarity of the transceiver. For positive modulation the polarity should be set to Normal and for negative modulation, set to Inverted.

The *[Polarity]* key toggles between these two options.

To enter or change the DCS code for the transceiver to be tested, first press the *[Code]* key to highlight the legend **DCS Code**. Key in the code using the data entry keys. The Service Monitor will accept any octal sequence in the range 0 to 777.

Complete the entry by pressing the [Enter] key. Leading zeros will be suppressed.

Return to the Rx TEST mode and check that the RF generator is active, then return to the TONES, DCS mode. The DCS coded signal will be produced when the legend Tone On is displayed against Tone Generate Mode:. See *Tone ON/OFF control* below.

Tone ON/OFF control

When the RF DCS ENCODER screen or the AF DCS ENCODER screen is displayed, the tone is turned on or off by the orange [ON/OFF] function key.

If the DCS tone is ON and the Tx TEST, Rx TEST, Dx TEST or AF TEST mode selected, the CTCSS tone will continue to be generated.

If the tones out routing has been set to give RF tones, this is provided by modulation generator 2. The legend ---DCS--- will be displayed against MOD2 FREQ on the RECEIVER TEST or DUPLEX screens. If MOD2 is selected, the DCS tones can be controlled by repeated presses of the orange [ON/OFF] function key. If MOD2 FREQ is selected, the DCS tone is still controlled by the [ON/OFF] key, but if a frequency is entered using the data keys or if the variable control is adjusted, the DCS tone will cease. It can then be re-started only when the RF DCS ENCODER screen or the AF DCS ENCODER screen is displayed.

If the tones out routing has been set to give AF tones, this is provided by audio generator 2. The legend --DCS-- will be displayed against AF2 FREQ on the TRANSMITTER TEST, DUPLEX or AF TEST screens. If AF2 is selected, the DCS tones can be controlled by repeated presses of the orange [ON/OFF] function key. If AF2 FREQ is selected, the DCS tone is still controlled by the [ON/OFF] key, but if a frequency is entered using the data keys or if the variable control is adjusted, the DCS tone will cease. It can then be re-started only when the RF DCS ENCODER screen or the AF DCS ENCODER screen is displayed.

DCS transmitter encoder testing

The decoders within transceivers equipped with DCS signalling are usually programmed to generate their code for inclusion on the reverse channel.

The DCS RF decoder function of this Service Monitor is able to demodulate the DCS signal and display the digital data.

The DCS signal is fed into a comparator register and occurrences of bit patterns corresponding to the three 'fixed bits' 0 0 1, of the coded signal are flagged.

23 bit samples of the coded signal are placed in registers with the occurrences of the 0 0 1 sequence occupying the 12, 11 and 10 bit positions. The value of the data in bit positions 1 to 9 is decoded. This corresponds to the DCS code number.

The binary representations of all the decoded sequences are displayed, along with the DCS code. The oct values are compared with the system permitted codes in a look-up table and the true code indicated.

The user can select the decoder bit rate to match that of the system, within the range 100 bits/s to 200 bits/s. The modulation level of the data signal is shown on the display.

DTMF

Overview

Dual Tone, Multi-Frequency.

The DTMF tones function will generate and decode sequences, of up to 40 characters corresponding to the standard DTMF frequencies.

The encoder allows the user to create characters sequences which are routed to the AF GEN OUTPUT connector or to the RF generator modulators.

The decoder will accept up to 40 tone pairs, either from the modulation meter output or as AF signals from the AF INPUT connector.

Tx test DTMF tones function

In the Tx TEST mode, with *[Tones In]* set to **RF**, DTMF tones generated within the mobile under test, are recovered from the RF signal and routed to the DTMF decoder.

The RF frequency and modulation type of the transmitter under test is set up from the Tx TEST mode.

Pressing the *[Tones]* key will display the screen shown in fold out diagram (2-5). The *[DTMF]* key will then give access to the RF DTMF DECODER screen shown in Fig. 3-24, *RF DTMF DECODER screen and menu*.

The decoder measures the frequencies and duration of each tone pair, identifies the character, and calculates any frequency errors. The results of this are listed on the display as shown.

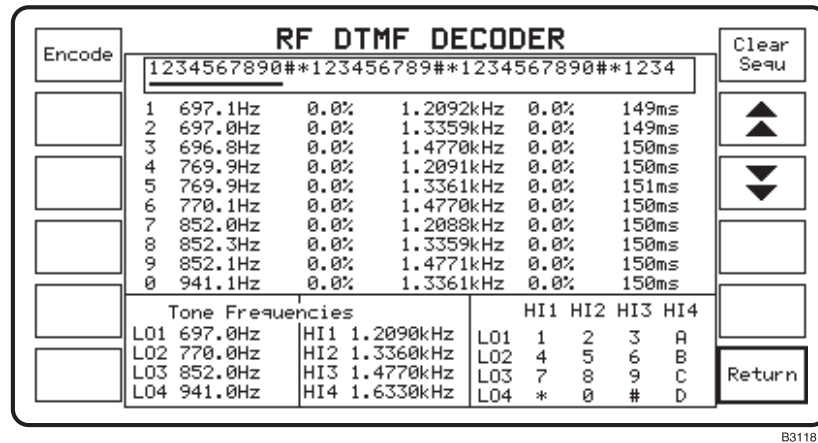


Fig. 3-24 RF DTMF DECODER screen and menu

The bottom of the screen contains two tables. The tone frequencies table on the left lists the eight frequencies, LO1 to LO4 and HI1 to HI4, used for DTMF signalling. The table on the right shows the 16 digit/character/symbol keypad with the LO tones and HI tones matrix.

The panel at the top of the display area shows the contents of the DTMF decoder memory. A maximum of 40 symbols can be stored, any additional symbols will not be accepted.

The central area of the display, which is blank when first accessed, lists the measured frequencies of ten of the received tones. The underscore in the decoded character panel of the display indicates which characters are listed. The left hand column shows the measured frequencies of the 'LO' tones with the percentage error, the centre column the corresponding 'HI' tones with error, while the right hand column shows the duration of each tone.

To display the next 10 decoded results, press the *[▼]* key. To display the previous 10 decoded results, press the *[▲]* key.

The display can be printed and the results stored on a memory card.

To clear the contents of the decoder memory press the *[Clear Sequ]* key. **Once cleared, they cannot be retrieved.**

Rx test DTMF tones function

In the Rx TEST mode, with *[Tones Out]* set to **RF**, the encoder output is fed to the RF generator and the tones used to modulate the RF signal. The DTMF decoder within the receiver under test can then be tested.

When setting up the Service Monitor to test the DTMF decoder of a receiver, commence as for normal Rx tests. When all settings are correct, disable the modulation generators by using the key sequence *[Mod Gen]*, *[Gen 1/Gen 2]*, *[OFF/ON]*, as appropriate, then the RF generator by using the *[RF GEN]*, *[LEVEL]*, *[ON/OFF]* key sequence.

Press the *[Tones]* key to display the screen shown in fold out diagram (3-5). The *[DTMF]* key will then give access to the RF DTMF ENCODER screen.

Formatting a tone sequence

To create the required tone sequence, first press the *[Enter Sequ]* key to display the cursor in the tone sequence panel. If the tone sequence panel is not empty use the *[DELETE]* key to clear the sequence.

Enter the required sequence by using any of the 16 available characters of the DTMF keypad. Pressing the equivalent data key on the front panel will cause the character to be entered in the sequence panel. The cursor then moves to the next position and a second character can be entered.

Any number of Null Tones can be included in a tone sequence. A Null Tone is a silent period, and has a duration of one tone period. It is indicated in the tone sequence panel by a dash (—). To enter a Null Tone in a tone sequence, press the *[Null Tone]* key once.

A maximum of 40 characters can be included in a sequence, any further entries will over-write the existing sequence.

Editing a tone sequence

An existing tone sequence can be edited as required. Using the rotary control, move the cursor over the character to be changed. To delete the unwanted character and insert a new character in its place, press the data key corresponding to the new character. To delete an unwanted character and close up the sequence, press the *[DELETE]* key.

Tones modulation level

The modulation level produced by each tone of the tone pair can be set independently.

Pressing the *[Lo Tone Level]* key will highlight the legend **Lo Tone Level**. The modulation level can then be set using the data entry keys.

The modulation level produced by the tones is set using the *[Lo Tone Level]* or *[Hi tone Level]* key, followed by use of the data input keys. The modulation level limits are 25 Hz to 75 kHz FM or 1% to 99% AM. Attempted entries outside of the values will be ignored. The default level is 1.5 kHz.

The modulation level produced by each tone of the tone pair can be set independently. Levels of the two tones can be locked using the *[Lock Levels]* key. This key toggles between the locked and unlocked condition. When going from unlocked to locked, the latest level set will be taken by both tones.

The tone duration and the pause duration, (time between each tone) can each be set independently, from 20 ms to 1.0 s. The default values are 150 ms duration and 50 ms pause.

A tones frequency shift facility is provided for testing decoder circuits. To shift the frequency of the transmitted tones press the *[Freq Shift]* key to highlight the **Frequency Shift** legend on the display and enter the percentage value of the shift required using the data entry keys. Frequency increases or decreases are possible. Entering a negative value will cause the transmitted frequencies to be decreased from the stated frequency. The maximum frequency shift is 10%.

When the DTMF TONES functions are set, return to the Rx TEST mode and enable the RF generator. Return to the DTMF RF ENCODER function. Press the *[Send Mode]* key to display the Send Mode menu. The options available are:-

[Cont Tones] Generates the tone sequence repeatedly until the orange *[ON/OFF]* function key is pressed.

[Tone Burst] Generates one sequence of the tones then stops.

[Step Tones] The first press causes the first tone of the sequence to be generated for the duration specified. When the *[Step Tones]* key is pressed again, the next tone in the sequence will be generated for the duration specified.

[Single Tone] After pressing this key, pressing any data entry key will cause the corresponding tone to be generated for the duration specified.

Using the appropriate keys to send the selected tones to the receiver, tests can be made to the DTMF decoder.

Dx test DTMF tones function

When in Dx test mode the DTMF tones function can be accessed by pressing the *[Tones]* key. The user can select encode or decode. The encode function will produce tones for mobile receiver testing and decode will interpret tones produced by a mobile transmitter. The encoder and decoder cannot operate simultaneously.

AF test DTMF tones function

The use of the DTMF tones function within the AF test mode allows the Service Monitor to produce DTMF tones for direct injection into the DTMF decode circuits of mobiles or other equipment.

The decoder will analyze DTMF tones produced within mobiles and other equipment.

The DTMF tones are obtained from the AF output connector on the front panel. The output levels and impedances are as for the AF generator output.

The input to the DTMF decoder within the Service Monitor is through the AF input connector. The decoder will respond to signal levels above approximately 150 mV rms.

Tones ON/OFF control

When the RF DTMF ENCODER screen or the AF DTMF ENCODER screen is displayed, the tone is turned ON or OFF by the orange [ON/OFF] function key.

If the DTMF tone is ON and the Tx TEST, Rx TEST, Dx TEST or AF TEST mode selected, the DTMF tone will continue to be generated.

If the tones out routing has been set to give RF tones, these are provided by modulation generators 1 and 2. The legend --Tones-- will be displayed against both MOD1 FREQ and MOD2 FREQ on the RECEIVER TEST or DUPLEX screens. If **MOD1** or **MOD2** is selected, the DTMF tones can be controlled by repeated presses of the orange [ON/OFF] function key. If **MOD1 FREQ** or **MOD2 FREQ** is selected, the DTMF tones are still controlled by the [ON/OFF] key, but if a frequency is entered using the data keys or if the variable control is adjusted, the DTMF tones will cease. They can then be re-started only when the RF DTMF ENCODER screen or the AF DTMF ENCODER screen is displayed.

If the tones out routing has been set to give AF tones, this is provided by audio generators 1 and 2. The legend --Tones-- will be displayed against both AF1 FREQ and AF2 FREQ on the TRANSMITTER TEST, DUPLEX or AF TEST screens. If **AF1** or **AF2** is selected, the DTMF tones can be controlled by repeated presses of the orange [ON/OFF] function key. If **AF1 FREQ** or **AF2 FREQ** is selected, the DTMF tones are still controlled by the [ON/OFF] key, but if a frequency is entered using the data keys or if the variable control is adjusted, the DTMF tones will cease. They can then be re-started only when the RF DTMF ENCODER screen or the AF DTMF ENCODER screen is displayed.

POCSAG

Overview

The POCSAG system is an international standard for radio pager operation. The system operates by broadcasting digital messages on a common frequency, only alerting the addressed radio pager when the transmitted address matches that of the pager. The signal transmitted consists of two main elements, the address and the message.

The POCSAG test facility within the Service Monitor generates a paging signal containing all elements of a 'live' signal. This signal is transmitted using the RF generator output to feed a suitable test rig or TEM cell.

The decoder test facility allows a POCSAG type encoded signal to be decoded and displayed.

To access the POCSAG test facility use the following key sequence:-

[Rx TEST], [Tones], [POCSAG].

The screen and menu shown in Fig. 3- 25, *POCSAG radio pager test screen and menu*, will be displayed.

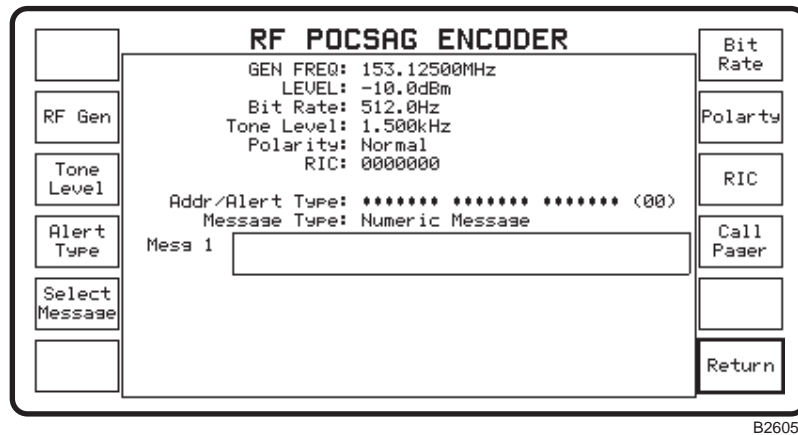


Fig. 3-25 POCSAG radio pager test screen and menu

The facilities offered by this Service Monitor for testing radio pagers are:-

- The RF generator of the Service Monitor can be set to any frequency within the specified range of the Service Monitor. The default frequency is 153.125 MHz.
- The RF level can be set to any level within the normal operating level of the Service Monitor.
- The modulation level of the signal can be to any level within the normal operating level of the Service Monitor. The default level is 1.5 kHz.
- The Address and Alert warning type can be set to any of the four available. The alert message generated by radio pagers can be selected from four formats. The selection is controlled by two function bits within the transmitted address codeword. The Service Monitor displays a representation of the audible alert message, shows the relevant function bit combination, and describes the type of message that is transmitted after the particular alert message. See Fig. 3-26, *Alternative address/warning messages*.

The Service Monitor has 7 different inbuilt messages which can be sent to the radio pager. These messages are selected by repeated presses of the [Select Message] key. The selected message is shown in a panel on the display with the legend MESS 1 (or Mess 2 etc.).

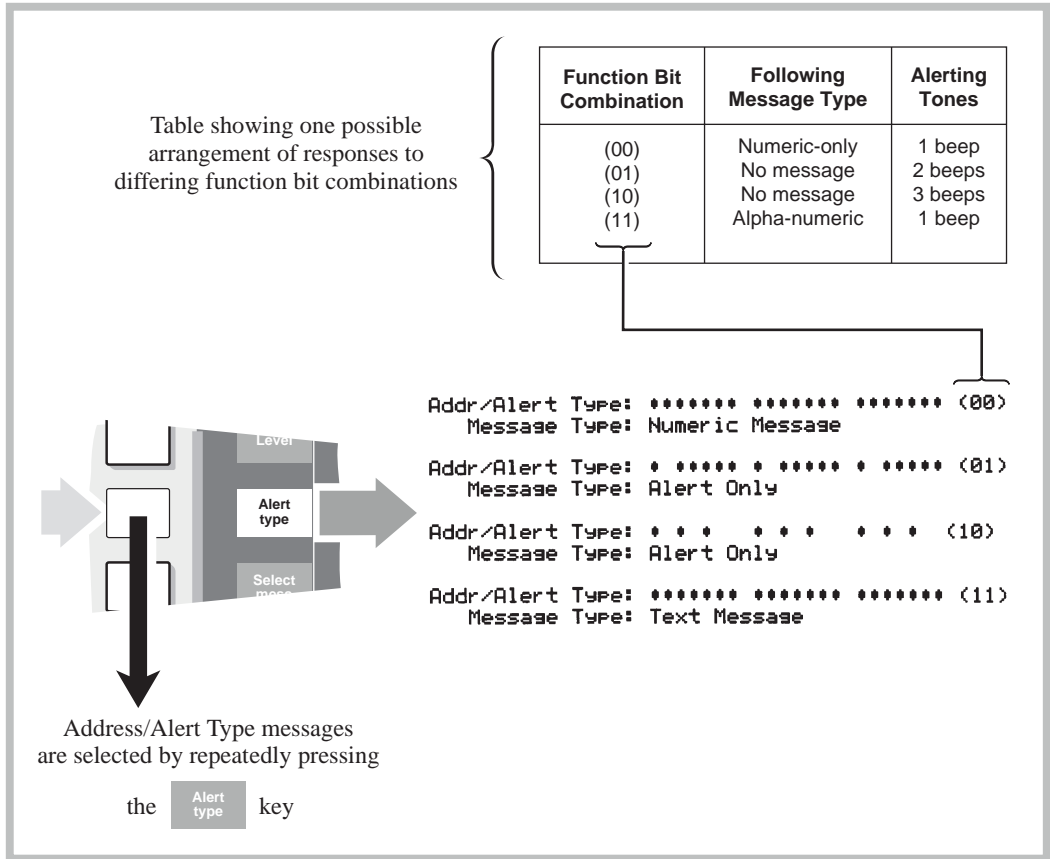
The bit rate of the transmitted test signal can be set by the user within the limits 400 Hz to 4.8 kHz. The default bit rate is the standard system bit rate of 512 Hz.

The generated data can be transmitted with normal or inverted polarity.

The radio identification code (RIC) of the radio pager is set by the user. This is entered into the Service Monitor as a seven digit decimal number corresponding to the 21 bit address code of the radio pager. The number is unique to the radio pager and will have a maximum decimal equivalent of 2097151.

Note

Leading zero can be omitted from the entry of RIC to save time.



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
Fig. 3-26 Alternative address/warning messages

Testing a radio pager

Radio pagers are self-contained units with no external antenna provision, therefore it is not possible to make a direct RF connection between the Service Monitor and the pager. The Service Monitor output can be taken from the BNC RF output connector using the telescopic antenna accessory (IFR part No 54421/001N) or similar, where suitable screening is available. Alternatively, a TEM cell may be preferable.

To configure the Service Monitor to make operational tests to a radio pager proceed as follows:-

- Select the POCSAG option from the Rx TEST mode, TONES function.
- Set the RF generator frequency to match the pager system operating frequency. Press the [RF Gen] key to highlight the GEN FREQ: legend on the display. Enter the required frequency using the data input keys.
- Set the RF output level to a suitable value by pressing the [RF Gen] key followed by the orange [LEVEL] key to highlight the GEN and LEVEL: legends on the display. Use the data input keys to enter the RF level.
- Set the modulation level to match the specification of the system to which the pager is assigned. Press the [Tone Level] key to highlight the Tone Level: legend on the display. Enter the required modulation level using the data input keys.
- Set the bit rate to match the specification of the system to which the pager is assigned. Press the [Bit Rate] key to highlight the Bit Rate legend on the display. Enter the value of the required bit rate as a frequency using the data input keys, terminated by [Hz].
- If the system requires the transmitted data to have an inverted format, press the [Invert] key to make the legend beside the Polarity: legend on the display read Inverted. The [invert] key toggles the legend between Inverted and Normal.

- Set the RIC (Radio Identification Code), to match that of the pager. Press the *[RIC]* key to highlight the legend  on the display and enter the required number using the data entry keys, followed by *[ENTER]*. An attempt to enter a number which exceeds the range of the system maximum will not be accepted and the previously displayed  will be retained.

The Service Monitor is now configured to produce a signal compatible with the radio pager. With the radio pager powered up and located as mentioned above, press the *[Call Pager]* key. The radio pager will respond.

To test the differing response options of the radio pager the user can select the combination of function bits and the contents of the message transmitted.

The Function bits are changed by repeated presses of the *[Alert/Type]* key. See Fig. 3-25, *POCSAG radio pager test screen and menu*, above.

The message content of the signal can be selected from 7 options by repeated presses of the *[Select Message]* key. Message 1 contains no data and thus produces an alert only response from the radio pager.

The parameters of the test signal can be varied within the limits mentioned in *Facilities* above, to test the performance tolerances of the radio pager.

Decoding POCSAG type signals

The POCSAG DECODE option allows signals containing data formatted to the POCSAG specification to be decoded and displayed.

Decoding of either numeric or alpha-numeric messages is selectable.

The decoder can be set to respond to and display:-

Only messages addressed to a specified RIC number.
 Only messages containing the sequence 12345.
 All messages.

To configure the Service Monitor to decode POCSAG signals proceed as follows:-

- If the signal is to be obtained by 'Off air' monitoring, select Tx TEST mode or Dx TEST mode and the BNC (antenna) input. Use a suitable antenna to receive the transmissions. Set the transmitter frequency (Tx FREQ), of the Service Monitor receiver, to the frequency of the transmission to be decoded.
- If the signal is obtained from a receiver output, select AF TEST and connect the receiver output to the AF INPUT socket. Select the POCSAG option from within the TONES function. If the POCSAG decode option is not fitted, the POCSAG ENCODE screen and menu will be displayed, and decoding is not possible. If the POCSAG decode option is fitted the POCSAG DECODE screen and menu will be displayed.
- Set the RIC code, if messages to a specific 'RIC address' only are to be decoded (see response option selection, below).
- Select the required decode format. The *[Decode Format]* key toggles the selection between *Numeric* and *Alpha-numeric*.

Response options

Select the required response option. Repeated presses of the *[Decode On]* key will sequence through the options of:-

- *ALL* to respond to, and display, the first incoming POCSAG format message.
- *On RIC* to respond to, and display, the first incoming POCSAG format message which is addressed to the set RIC.

- *On sequence 12345* to respond to, and display, the first incoming POCSAG format message which contains the numeric sequence '12345'.

Press the [*Clear Sequ*] key to remove any data from the decode register and to re-arm the decode function.

The next message received, if it conforms to the set decode format, will be decoded and the message displayed.

The following parameters of the signal are decoded and shown on the display:-

Bit Rate:	The bit rate of the received signal.
Polarity:	Normal or inverted coding.
RIC:	The Radio Identification Code of the addressed pager.
Addr/Alert Type:	Shows the format of the alerting signal.
Message Type:	Numeric or Alpha-numeric.

If a message is included in the transmission, this is shown in the message panel. Messages of up to 120 characters can be shown.

The decoder detects the codewords of messages with errors and applies error correction. The number of error codewords received in the message and the number of corrections made is shown.

Oscilloscope

The digital oscilloscope option is available from within the Tx TEST, Rx TEST and AF TEST modes. There are two display functions:

The standard display with a viewing area of approximately 38 × 70 mm.

The expanded display with a viewing area of approximately 63 × 96 mm.

The oscilloscope display may or may not be shown when the Tx TEST, Rx TEST or AF TEST modes are selected. This is dependent on the last use of the selected test mode, and the selection made using the [*Power Up From*] key on setup page 2.

To access the oscilloscope function from a bar chart display, press the [*scope/bar*] key: the first press will show the standard display, the second press will show the expanded display, the third press will return to the bar chart display.

Setting up

The Y sensitivity and the timebase ranges of the oscilloscope are set from the right hand soft keys. The current settings are shown above the oscilloscope display.

When in Rx TEST and AF TEST modes, the Y (vertical) input is by the AF input connector . The Y sensitivity is switchable in a 1, 2, 5 sequence, from 10 mV/division to 20 V/division. The [AC/DC] key selects AC or DC coupling into the oscilloscope.

When in Tx TEST mode, the Y input is taken directly from the modulation meter output. The Y axis is calibrated to display modulation level. FM ranges are from 0.5 kHz/division to 25 kHz/division. AM ranges are 5%/division, 10%/division and 20%/division.

The horizontal timebase has ranges of 100 μs/division to 5 s/division in a 1, 2, 5 sequence.

The soft keys have the following functions, (top to bottom):-

[X]	Increases Y Sensitivity by one range per key press.
[◆]	Decreases Y Sensitivity by one range per key press.
[▶▶]	Increases Time/Division by one range per key press.
[◀◀]	Decreases Time/Division by one range per key press.
[Scope/Bar]	Steps to Expanded display or Bar chart display
[Return] (Standard)	Returns display and menu to Tx TEST, Rx TEST or AF Test.
[Persistence] (Expanded)	Steps persistence setting through Off, Low Med High Inf.

The vertical position of the oscilloscope trace can be adjusted using the POSITION rotary control.

The horizontal sweep trigger can be set for repetitive or single sweep, set by the scope mode keys (Item 15 on fig 3-1, Front panel).

With repetitive mode selected, the trace will free-run, re-triggering on the positive-going edge of the signal, at the end of each sweep. In the absence of a signal the trace will auto-trigger.

With single sweep selected, the first positive going signal will trigger a sweep. The [SINGLE] key must be pressed to re-arm the trigger circuit before another sweep can be triggered.

Expanded display

With the expanded display selected, the area of the display available for digital readings is limited. The following table shows the data that can be displayed in each test mode.

Tx Test	Rx Test	AF Test
Tx FREQ OFFSET POWER MOD FREQ FM/AM LEVEL SINAD, S/N, DISTORTION	AUDIO FREQ LEVEL SINAD, S/N, DISTORTION	AUDIO FREQ LEVEL SINAD, S/N, DISTORTION

Persistence

The persistence of the scope trace can be selected to suit the user's requirements. The expanded display has a [Persistence] key, which steps through the available persistence settings. The persistence setting is effective on both the expanded and standard oscilloscope displays but can only be set from the expanded display.

The following table shows the available settings and the approximate decay times.

Setting	Decay time (seconds)
Off	0
Low	1
Med	3
High	8
Inf	Infinite

Stores, settings/results

Overview

A section of the non-volatile RAM in the Service Monitor is designated as a user store for instrument settings and results. 'Power Down' and 'Factory Pre-set' settings are also held in this area of memory.

The memory card option extends the 'User store' facility, by providing additional memory and by allowing screen bitmaps, 'SYSTEM' settings, 'SYSTEM' results and 'SYSTEM User Defined' test programs to be stored. A 'Print Store' function allows most types of data stored on memory cards to be printed without being recalled to the Service Monitor display.

The use of memory cards is described later under 'Memory cards'.

There are two routes through which the user memory can be accessed, depending on the action to be performed.

To recall data from memory or to store settings, press the orange [MEM] key. This will display the STORE/RECALL screen and menu.

To store test results or bit-maps of test screens, first press the [DISPLAY HOLD] key. The soft key menu will change to show a [Print] key and a [Store] key. Pressing the store key will display the DISPLAY HOLD STORE screen and menu.

STORE/RECALL

To store settings or to recall data from memory proceed as follows:-

Press the orange [MEM] key. The STORE/RECALL screen and menu is displayed. A message, 'Recall from Store No.' is shown, flashing in inverse video.

A sub-heading 'INTERNAL STORE' is shown above a list of the store locations, with addresses from 00 to 09. A line of details relating to each store is shown against each address.

Store location 00 is followed by the information;

'P Settings Power Down Store'.

This location holds the settings of the Service Monitor when power was last switched off.

The 'P' shows that the data is protected, it cannot be over-written or deleted.

'Settings' shows that the data is a set of instrument settings.

'Power Down Store' is a title identifying the contents.

Similarly store location 01 contains the factory default settings.

Recalling

To recall the contents of a store location, proceed as follows:-

Press the [Recall] key to display the inverse video message, 'Recall Store No.' if it is not already displayed.

Key in the two digit address of the location, using the data entry keys.

Recalling Settings

Entering '00' or '01' will recall the settings described above.

When 'Settings' are recalled, the Service Monitor will set to the mode which was current when the settings were saved.

Take care after recalling 'settings', as selections such as RF IN/OUT [SELECT], incremental settings and bar chart ranges are included.

Note

The addressing procedure of all memory functions is similar. The flashing, inverse video message describes the action that will happen when a location address is entered, and requests a two digit store address. The first digit entered appears beside the message, but the second digit of the address implements the action.

Recalling Results

When 'Results' are recalled, the RESULTS SCREEN is displayed. The test results are shown against each of the parameter headings. Results of tests made when in the Dx TEST mode are shown with the RECEIVER TEST results in the top half of the display and the TRANSMITTER TEST results in the bottom half.

Storing

Storing settings

To store settings, make sure that all the parameters, selections, bar chart ranges and other settings, relevant to the intended work, are set as required. Then proceed as follows:-

Press the orange [MEM] key and the STORE/RECALL screen will be displayed. Ignore the flashing inverse video message.

Press the [*Store Setting*] key, which will cause the flashing inverse video message to change to, '*Store Settings To Store No*'.

Key in the two digit address of the required empty or unprotected location. Any data already contained in the location will be overwritten.

The location address list will show the contents of the location as 'Settings'.

A unique title can be attached to the store location. See 'Titling store locations' later.

DISPLAY HOLD STORE

Storing results

Results obtained using the Tx, Rx, Dx, and AF test modes can be stored. For this, the memory is accessed using the [DISPLAY HOLD] key.

To store test results, make the required test, and when the display shows the results to be stored, proceed as follows:-

Press the [DISPLAY HOLD] key. The current soft key menu will be replaced to show two keys, [*Print*] and [*Store*].

Press the [*Store*] key which will cause the DISPLAY HOLD STORE screen to be displayed, with a flashing inverse video message '*Store Results To Store No*'.

Key in the two digit address of the required empty or unprotected location. Any data already contained in the location will be overwritten.

The location address list will show the contents of the location as 'Results'.

A unique title can be attached to the store location. See 'Titling store locations' later.

Other memory functions

Other memory functions can be carried out from either the STORE/RECALL or DISPLAY HOLD STORE screen and menu.

Protecting store contents

The contents of any store location can be protected from being over-written or deleted.

To protect a store location, Proceed as follows:-

Press the [*Protect Store*] key. The inverse video message, '*Protect Store No*.' is displayed.

Key in the two digit address of the location to be protected, using the data entry keys. A 'P' will be shown against the location address in the list.

Any attempt to over-write or delete the contents of the location will cause the message '***ERROR Store protected ***' to be displayed momentarily.

To remove the protection from a location, use the same procedure used to protect the location. The 'P' will be removed from the location address.

Deleting store contents

To delete the contents of an unprotected store location, proceed as follows:-

Press the *[Delete]* key. The inverse video message, 'Delete Store No.' will be displayed.

Key in the two digit address of the location to be deleted, using the data entry keys. The contents will be deleted as soon as the second digit is keyed and the location address list will show the location as 'Empty'.

Once deleted, the contents cannot be retrieved.

Note

Store locations 00 and 01 which contain 'Last Power-down' and 'Factory Preset' settings respectively, cannot have their protection removed or be deleted.

Titling store locations

Store locations can be titled from either the STORE/RECALL screen and menu or the DISPLAY HOLD STORE screen and menu. Titles can be up to 20 characters long, including any spaces.

Press the *[Enter Title]* key. The inverse video message, 'Title Store No.' will be displayed. Key in the address of the store location to be titled. The soft key menu will change to show the following keys:-

[▲], *[▼]*, *[Enter Char]*, *[Title Complet]* and *[Return]*.

A line of letters, digits and symbols is shown at the bottom of the display. An inverse video cursor, which can be controlled using the variable control, highlights a selected character on the line. A similar cursor is shown in the title area of the location address.

The selected Character is entered into the title area of the location address list by pressing the *[Enter Char]* key. Subsequent characters are entered in the same way.

Errors can be corrected by using the *[←]* or *[→]* keys to place the cursor over the incorrect character and then inserting the correct character.

When the title is complete, press the *[Title Complet]* key. The normal STORE/RECALL screen or DISPLAY HOLD STORE screen will be displayed.

A title can be changed or corrected at any time using the titling procedure.

Memory card

The optional memory card facility extends the scope of the memory facility by the use of a 'Smart Card' containing non-volatile static RAM with battery back-up. The card should have at least 128 k of memory.

Information loaded onto a card is not unique to the source instrument. The data on memory cards can be read onto other equipment using a suitable card reader.

A memory card is loaded into the memory card port located on the front panel of the Service Monitor. Slide the card, face upwards, into the slot, guided by the channelling on the card and in the slot sides. Firm but not excessive pressure is required over the final 1-2 mm of travel to engage the contacts. The memory card may be inserted or removed from the instrument with the power on or off.

Formatting memory cards

Memory cards must be correctly formatted before data can be stored on them. The MEMORY CARD FORMAT screen and menu has facilities for formatting and checking them.

If a memory card is inserted in the Service Monitor that has been formatted to the required standard, the MEMORY CARD FORMAT screen will show the size of the memory and the title, if any, of the card.

If a memory card is inserted that has not been formatted to the required standard, the message *'Card Not Formatted'* is displayed on the MEMORY CARD FORMAT screen.

To apply formatting, press the *[Format Card]* key. The message *'Writing To Mem Card. Do Not Remove.'* is displayed until the formatting is completed. When the card has been successfully formatted, the memory size will be displayed and the card title will show *'IFR Card'*

Titling cards

To change the card title press the *[Enter Title]* key. A title can then be applied to the card using the same procedure as for titling store locations (see 'Other memory functions, titling store locations) earlier. A card title can have up to 11 characters, including any spaces.

Accessing the memory cards

When a memory card is in place, accessing the user store memory will also give access to the card memory.

The STORE/RECALL screen or the DISPLAY AND HOLD/STORE screen are displayed as described above.

By pressing the *[▼]* key the memory store address list heading changes to 'MEMORY CARD' and a format description. The locations are numbered 10 to 19. Successive operations of this key will increment the numbering by 10 until the list is numbered from 90 to 99. Further operation of the key will have no effect. To return to the lower numbered locations use the *[▲]* key to increment down.

Each memory card has capacity for 90 store locations. Therefore, with a memory card in place, the number of store locations accessible through the STORE/RECALL screen or the DISPLAY AND HOLD/STORE screen is increased to 100; locations 00 to 09 in the normal internal memory, with locations 10 to 99 on the memory card.

Data is stored on the memory cards in files, using a DOS style format. These files can use as much empty card space as they require. Therefore, if large files are stored, such as SYSTEM User Defined test programs, the number of store locations available on that card may be reduced.

All operations relating to internal user stores apply to memory card operation, but with the additional facilities for storing the following:-

Bitmaps of test screens.

Parameter settings for system tests.

Results of system tests.

User defined test programs written in MI-BASIC.

Write-protecting cards

The contents of memory cards can be protected from accidental overwriting or erasure by using the differing methods of protection available on the Service Monitor and the memory cards.

Write protect card switch

Setting the write-protect switch, on the non-contact end of the memory card, offers a physical method of protecting the card contents.

Protect store function

The use of the *[Protect Store]* key described under 'other memory functions' earlier, can be used to protect any selected store location on the card. The protection information is contained on the card and will remain active if the memory card is loaded in other service monitors or equipment.

Lock stores function

A coded lock function, accessible by using the *[HELP/SETUP][Card Setup]* key sequence, allows a portion of the store locations to be protected behind a four figure code. The use of this function is described below.

Coded store protection

Memory cards can have code protected locking applied to a portion of the store locations. This locking prevents the state of write-protection from being changed.

This allows users not in possession of the code, to have access to data held in protected stores, without being able to remove the protection. Only users in possession of the code can unlock the protection and change the contents.

The same code is needed to adjust the portion of memory locations locked.

After formatting, the code number of a card is 0 (single zero).

Locking Stores

The portion of store locations which can have their protection locked is variable from 1 to 90 locations.

Locking is carried out from the MEMORY CARD FORMAT screen. The right-hand soft keys of this screen include [*Change Code*] and [*Lock Stores*] keys.

Any consecutive number of locations can be locked but must start at location 10.

To lock the protection on a portion of the store locations, proceed as follows:-

Store the settings or results into the required locations of the memory card as described earlier.

Protect the store locations, using the [*Protect Store*] key and the relevant address.

Access the MEMORY CARD FORMAT screen, by the key sequence [HELP/SETUP], [*Card Setup*].

The legend '*Locked*' is shown against the [*Change Code*] and [*Lock Stores*] keys.

Press either of these keys and the inverse video message '*Enter Code*' will be displayed.

Newly formatted cards have a code of 0 (single zero). Key this in and press the [ENTER] key. The '*Locked*' legend will no longer be displayed.

If the code is not '0', key in the correct four figure code and press the [ENTER] key.

When the '*Locked*' legend is no longer displayed, press the [*Lock Stores*] key. The inverse video legend *Lock Stores 10 to* is displayed.

Key in the address of the last store of the portion to be locked, using the data keys. The address will appear on the display as it is keyed in. Press the [ENTER] key.

It will not be possible to change the state of protection of store locations in the locked portion of the memory card. The unprotected store locations can be written to or deleted.

Unlocking stores

Insert the card in the Service Monitor and access the MEMORY CARD FORMAT screen as described above. The legend '*Locked*' will be shown against the [*Change Code*] and [*Lock Stores*] keys.

Press the [*Lock Stores*] key, which will cause the message *Enter Code* to be displayed. Key in the four figure code number and press the [ENTER] key. If the correct code number has been entered the '*Locked*' legend will no longer be displayed.

The inverse video legend *Lock Stores 10 to* ('*n*' is displayed. ('*n*' being the number of the highest store location protected).

Key in any store location address lower than 10 and press the [ENTER] key.

Changing the range locking

To change the range of the locked portion, proceed as above but key in the address of the last location of the new portion to be protected and press the [ENTER] key.

Changing the locking code

To change the locking code, use the following procedure:-

Insert the card and access the MEMORY CARD FORMAT screen.

Press the [*Change Code*] key, which will cause the message *Enter Code* to be displayed.

Key in the existing code number and press the [ENTER] key. The '*locked*' and the *ENTER CODE* legends will no longer be shown.

Press the [*Change Code*] key. The inverse video legend '*New Card Code*' is displayed. Key in a new four figure number and press the [ENTER] key.

The new code will apply to the card but it will not be protected in the Service Monitor until the next power-up.

Storing on memory cards

Storing screen bitmaps

The facility to store a screen bitmap allows any active test screen to be held and saved. This includes oscilloscope traces, spectrum analyzer displays and harmonic analysis displays.

Screen bitmaps are stored from the DISPLAY HOLD STORE screen.

To store a screen proceed as follows:-

Press the [DISPLAY HOLD] key, as described under '*DISPLAYHOLD STORE, Storing results*', above, until the DISPLAYHOLD STORE screen is shown.

Press the [*Store Screen*] key. The inverse video message, '*Store Screen To Store No.*' is displayed.

Key in the required two digit address.

The location address list will show the contents of the location as '*Screen*'.

Storing systems data

Settings and results of SYSTEM tests, and user defined test programs, can only be stored on a memory card when the Service Monitor is operating in a system option. The procedures are described in the operating manual supplement applicable to the system. A summary of operation is:

A memory card location which contains SYSTEM data will show '*Syst Set*' or '*Syst Res*' or '*BASIC*' on the location address list.

To store '*SYSTEMS*' data, press the [*MEM*] key. The STORE/RECALL screen will be displayed. A [*Store Sys Par*] key is shown, in addition to those on the non-system screen.

Pressing this key will show a new soft key menu with the three keys [*Store Sys Set*], [*Store sys Res*] and [*Store BASIC*]. Pressing the appropriate key will store the current system parameter settings, the last test results from the current system or the user defined test program if one is present.

Titling, protecting or deleting can be used as for non-system operation.

Storing system MI-BASIC programs

User defined SYSTEM test programs, which are written in MI-BASIC, can be stored on memory cards as explained above. These must be down-loaded into the Service Monitor before they can be transferred onto a memory card.

Printing from memory cards

The contents of memory card store locations, with the exception of SYSTEM test results, can be sent directly to a printer, without recalling into the Service Monitor display.

To print the contents of a store location, proceed as follows:-

Make sure that a suitable printer is connected, and that the Service Monitor is correctly set up to drive it. (See *Printer* on page 3-89).

Access the STORE/RECALL screen.

Press the [*Print Store*] key. The flashing inverse video message, '*Print Store No.*' will be displayed.

Key in the two digit address of the store location to be printed.

The contents of the store will be printed.

When the printout is complete, the Service Monitor can be configured for further tests or operations.

Error messages

There are a number of error messages associated with the store facility, which will be displayed, for approximately 10 seconds, under certain conditions. These are listed below.

- *** ERROR Store Empty **** The recalled store location is empty.
- *** ERROR Card Not Formatted **** The card in the memory card slot is not formatted or the Service Monitor does not recognise the format.
- *** ERROR Store Protected **** The store addressed is protected and therefore cannot be overwritten or deleted. Alternatively, the write protection switch on the memory card is set ON.
- *** ERROR No Card Present **** There is no memory card present, therefore the intended operation cannot be carried out.
- *** ERROR No Card Interface **** An attempt has been made to access a card store when the option is not fitted.
- *** ERROR Card Directory Full **** The internal directory on the card is full, other stores have been put on in a DOS environment (PC).
- *** ERROR Memory Card Full **** The memory card does not have sufficient space to store the intended data.
- *** ERROR Can't Store Internally **** The intended data can only be stored on a memory card.
- *** ERROR DOS File not Found **** The DOS file for the store has been deleted or corrupted on a PC, but the Service Monitor directory file believes it is still there.
- *** ERROR Cannot Print Store **** The contents of the store cannot be printed. Either the addressed store location is an internal store or the location contains SYSTEM settings.

There are also a number of error messages associated with formatting and using memory cards. These are displayed permanently until the condition is remedied or the intended action cancelled.

- No Card Present* An action has been called up which requires a memory card but there is not one present.
- Card Not formatted* The card fitted is not formatted to the requirements of the Service Monitor.
- Option Not Fitted* An action has been called up which requires a memory card but the memory card option is not fitted.
- Unknown Size* The fitted card is not of a recognised memory size.

Real time clock. Date and time stamping

Purpose

The memory card option also contains a real time clock, with date and time stamping facilities.

The date and time is printed on all screen dump printouts.

Data stored on memory cards also has date and time fields. This information is not visible on the Service Monitor, but is included so as to be visible when memory card files are viewed on a DOS style file display.

A clock set locking facility protects the clock setting from unauthorised adjustment.

Access

The real time clock read-out with its setting facility, is on the MEMORY CARD FORMAT screen and menu. This is accessed by the key sequence, [HELP/SETUP], [*Card Setup*].

Setting the clock date and time

The soft keys on the left of the screen are all relevant to the real time clock.

A new date or time can only be set if the clock set locking facility shows 'Enabled'. If it shows 'Locked' the clock four figure access code must be entered. See 'Locking and enabling', below.

To set a new time, proceed as follows:-

Press the [*Set Time*] key once. The 'hours' digits of the digital read-out will be highlighted.

Press the [*▲*] key or the [*▼*] key repeatedly, until the correct hours setting is shown.

Press the [*Set Time*] key again. The 'minutes' digits of the digital read-out will be highlighted.

Press the [*▲*] key or the [*▼*] key repeatedly, until the correct minutes setting is shown.

Press the [*Set Time*] key again. The time display will return to normal and the new time will be set.

To set a new date, proceed as for time setting except for:-

Press the [*Set Date*] key once, to highlight the 'day' digits.

After setting the 'days', 'month' and 'year', press the [*Set Date*] key again to set the new date.

Locking and enabling clock setting

When shipped, the clock set locking code is '0' (single zero). This code ensures that the clock set locking is 'Enabled'. Any other code will re-lock the clock setting whenever the Service Monitor is powered up.

To lock the real time clock proceed as follows:-

Press the [*Clock Setting*] key. The inverse video legend 'New Clock Code' will replace the 'Enabled' legend, with the current code shown beneath it.

If the code shown is '0', key in a four figure code and press the [ENTER] key. The new code will be shown.

The clock setting will remain enabled until the Service Monitor is switched off. The code will be required to enable the clock setting function after the next power up.

If the code shown beneath the 'New Clock Code' legend is not '0', the clock setting will lock when the Service Monitor is next switched off. The code will be required to enable the clock setting function after the next power up.

Printer

An RS232 printer can be driven by the Service Monitor when connected to the SERIAL PORT on the rear panel. Complete screen images and hard copy of stored test results can be printed.

The serial port must be set to the printer option through 'Setup Page 2' and the [*Remote Control*] key. The port must be configured to match the requirements of the printer using the port configuration menu also accessible through 'setup page 2', and the [*serial port*] key.

To print screen images, make the required test, and when the display shows the data to be printed, proceed as follows:-

Press the [DISPLAY HOLD] key. The current soft key menu will be replaced to show two keys, [*Print*] and [*Store*].

Press the [*Print*] key. The display will be reproduced by the printer.

Test results held in the Service Monitor memory stores or on memory cards can also be printed. The procedures for these operations are described earlier in this chapter. See *Stores, settings/results*, on page 3-82 and *Printing from memory cards*, on page 3-87.

Parallel printer port option

Parallel output

The parallel printer port option provides an output suitable for direct connection to a parallel drive printer. Fig. 3-27, *Parallel printer port socket contacts*, shows the pin numbering of the socket and Table 3-1, *Parallel printer port connections*, shows the function of the socket connections.

Pin connections



Fig. 3-27 *Parallel printer port socket contacts* (as seen facing panel)

Table 3-1 Parallel printer port connections

Contact	Function	Contact	Function
1	Strobe	10	ACK
2	Data 0	11	BUSY
3	Data 1	12	PE
4	Data 2	13	SLCT
5	Data 3	14	to +5 V via R
6	Data 4	15	ERROR
7	Data 5	16	to +5 V via R
8	Data 6	17	to 0 V via R
9	Data 7	18 to 25	Ground

Accessory port (rear optional)

As well as the parallel printer output, this option also provides an accessory port which allows the control of external devices by logic control from the instrument. Fig. 3-28, *Rear accessory port socket connections*, shows the pin numbering of the socket and Table 3-2, *Rear accessory port connections*, shows the function of the socket connections. Fig. 3-29, *Simplified diagram of rear accessory port switching* shows the switching associated with the port.

Switches 1(a) to 1(d) are parts of a multi-pole rocker switch, mounted on the printed circuit board within the option assembly. By setting these switches, the user has the option of logic level output on the appropriate pins or of closing contacts between pairs of pins.

Pin Connections

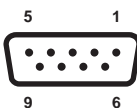


Fig. 3-28 *Rear accessory port socket connections* (as seen facing panel)

Table 3-2 Rear accessory port connections

Contact	Function
1	+5 V
2	Logic line 3 or logic contact 3(a)
3	Logic line 2 or logic contact 2(a)
4	Logic line 1 or logic contact 1(a)
5	Logic line 0 or logic contact 0(a)
6	logic contact 3(b)
7	Logic contact 2(b)
8	Logic contact 1(b)
9	Logic contact 0(b)

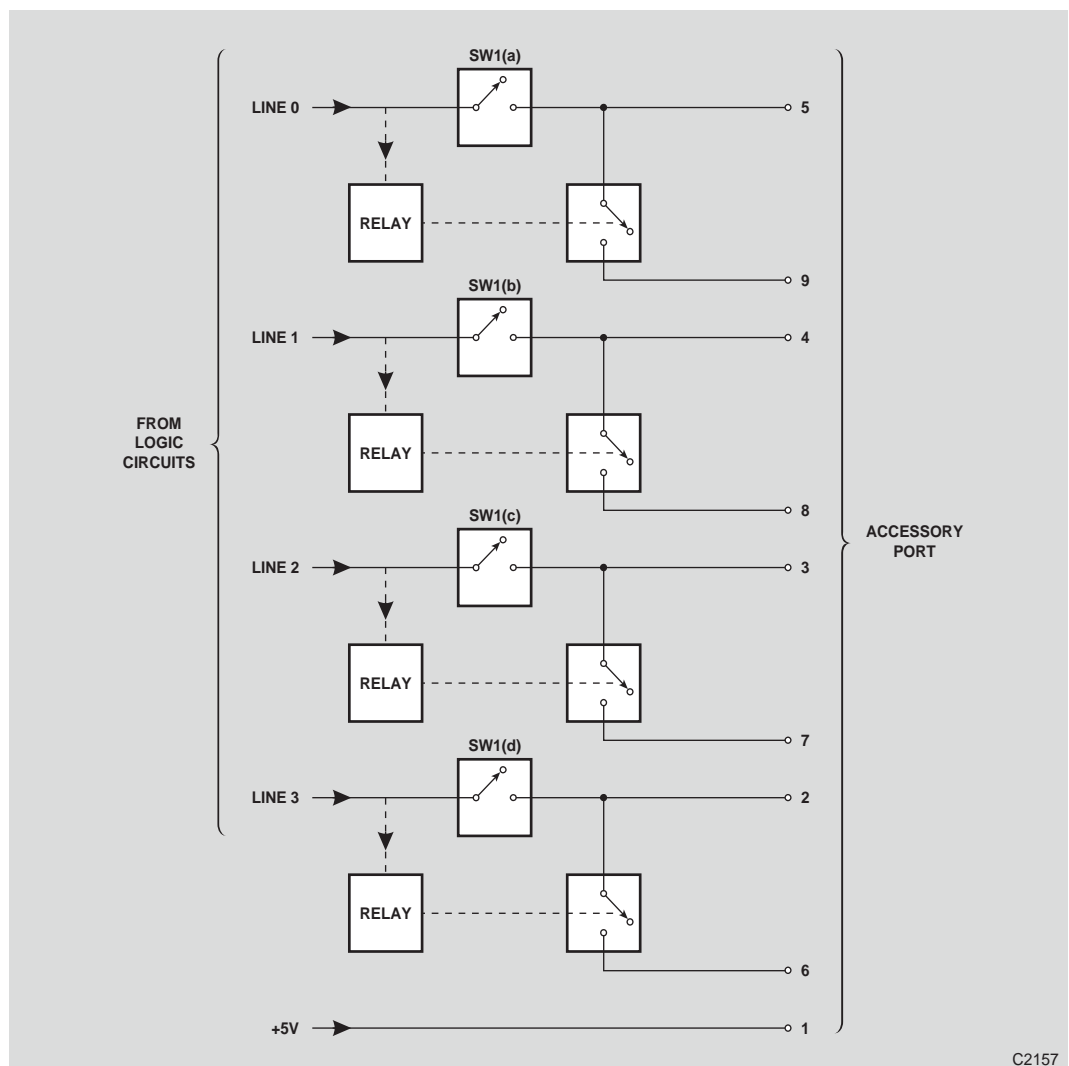


Fig. 3-29 Simplified diagram of rear accessory port switching

Setting up

Logic line state

The state of the logic lines outputs can be set from the logic lines setup menu, accessible by the key sequence, [HELP/SETUP], [Setup], [Setup Page 2], [Logic Lines].

The top four soft keys on the right of the display control the normal state of the logic lines. Pressing these keys will set the options alternately.

If the appropriate section of S1 is closed, the output can be set to either logic high or logic low. If the appropriate section of S1 is open, the contacts between pin pairs can be set to opened or closed. Switch S1 is mounted within the option assembly, on the printed circuit board. The option assembly must be removed from the service monitor to have access to S1. Remove the power connection from the service monitor, and any connections from the option assembly before removing it from the service monitor. After making changes to S1, refit the option assembly to the service monitor before re-connecting the power lead. Each of the four lines can be set individually.

When any section of S1 is closed, and the connector output of that line (pins 2,3,4 or 5) is at a logic state high, the associated pin (6,7,8 or 9) will also be at logic state high.

When any section of S1 is open, and the connector output of that line (pins 2,3,4 or 5) is at a logic state low, the associated pin (6,7,8 or 9) will be open circuit.

Logic line control

Additional control is provided to logic lines 0 and 1, from the two top soft keys on the left of the logic line setup menu.

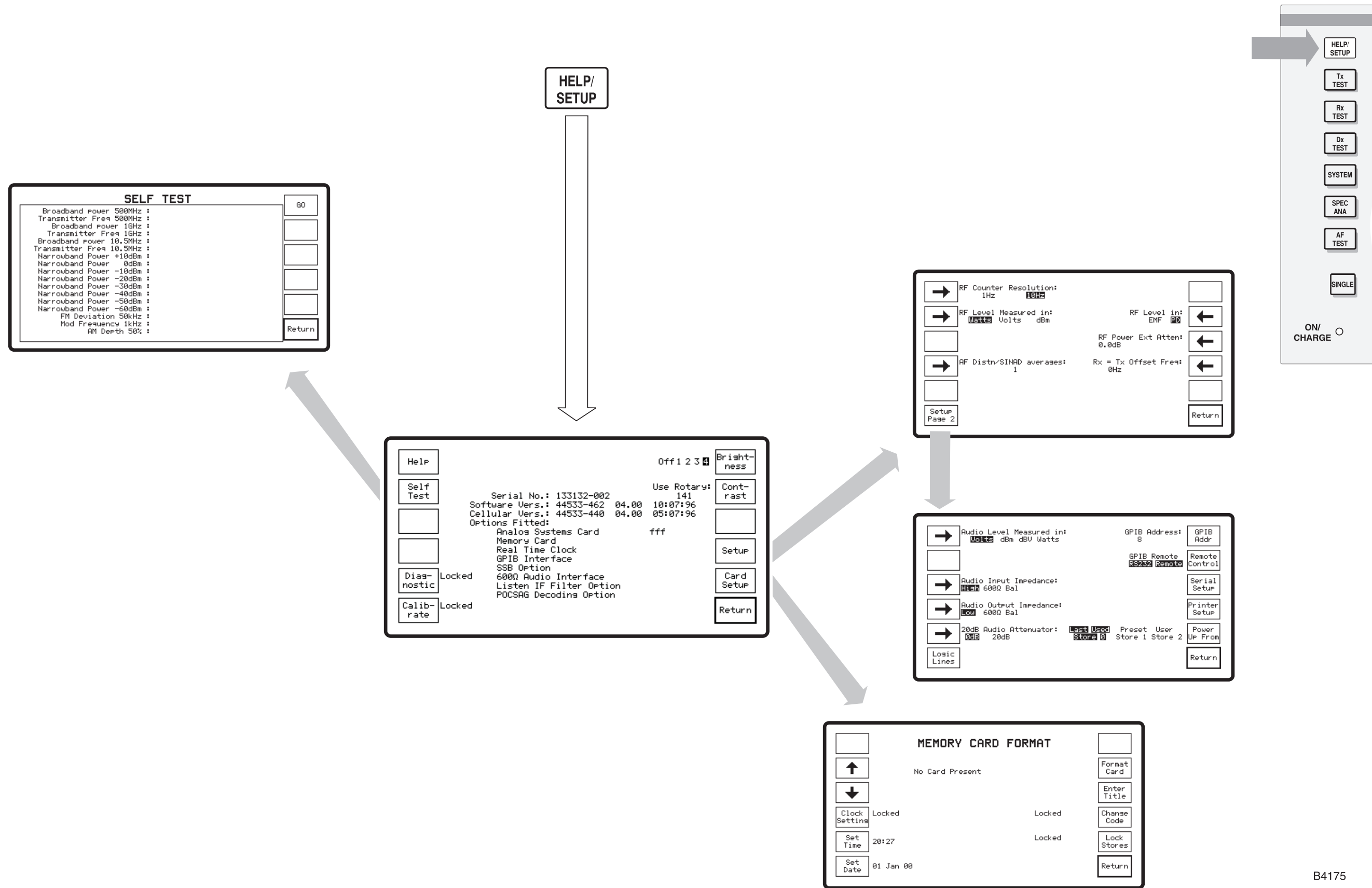
When set to 'As setting', the output will be as set by the right-hand soft keys.

When the 'Line 0 Mode' is set to 'Close for Transmit', the state of this line will depend upon which operating mode the instrument is set to.

When the instrument is in the Rx TEST mode, line 0 will take up the 'Closed/Logic High' state, and the 'Open/Logic Low' state for all other test modes.

The 'Press To Talk' switch on the accessory microphone, if this accessory is fitted, will switch the instrument from Rx TEST mode to Tx TEST mode. Therefore line 0 will also change state when the 'Press To Talk' switch is operated.

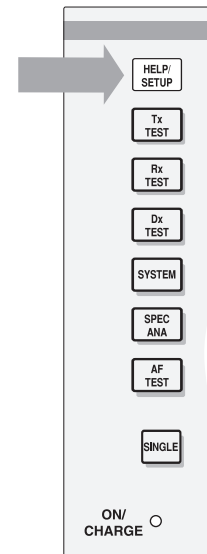
When the 'Line 1 Mode' is set to 'Close on Squelch', line 1 will take up the 'Closed/Logic High' state when the instrument is in a squelched condition, and the 'Open/Logic Low' state when the instrument is not squelched.



Test mode screen and menu (1.0). HELP/SETUP with lower levels.

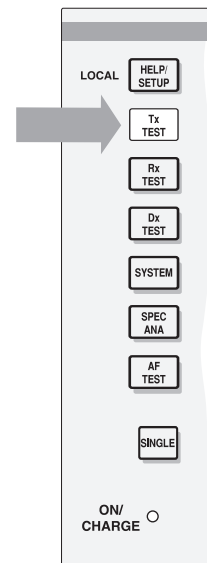
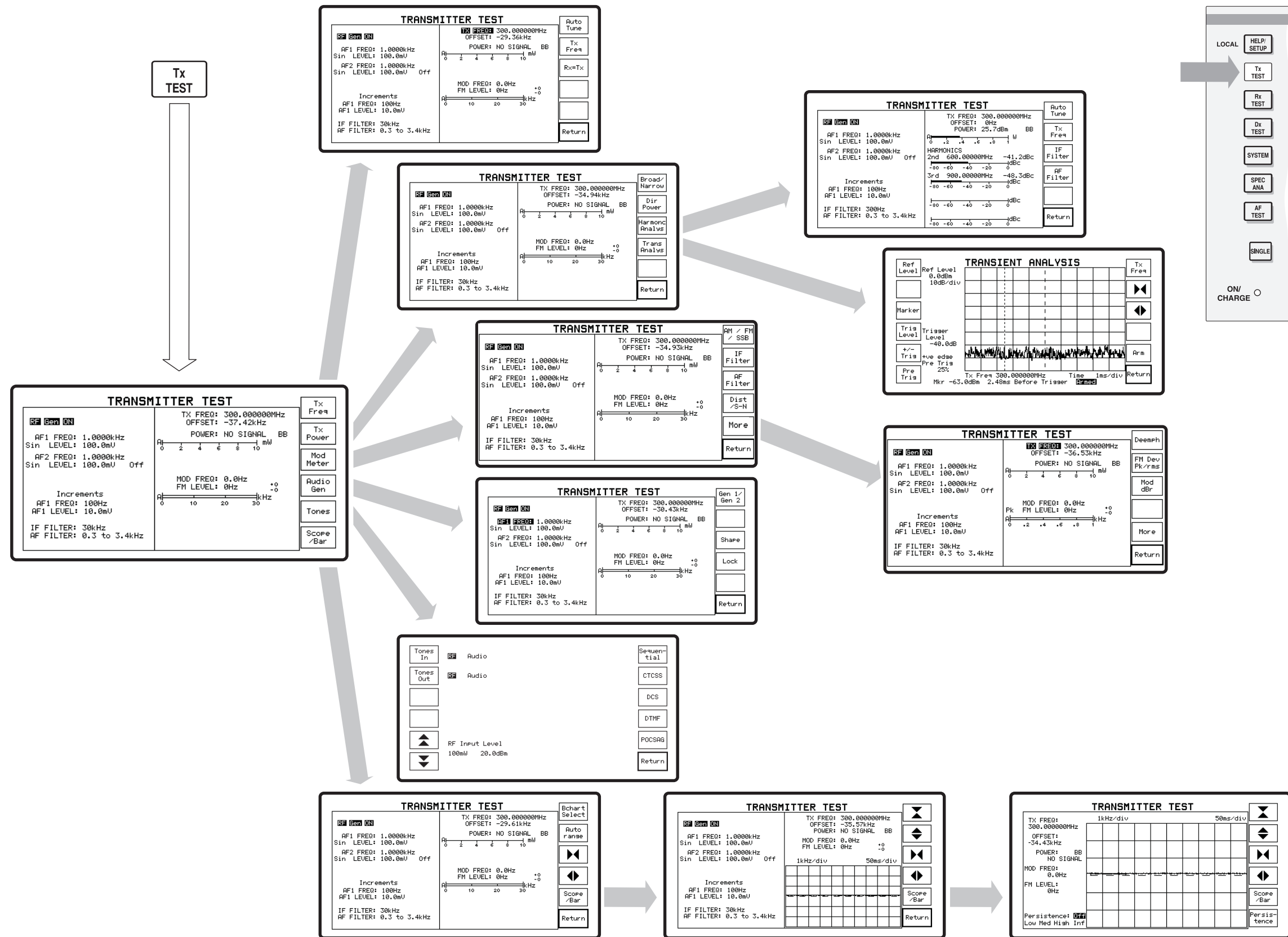
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B4175



C4176

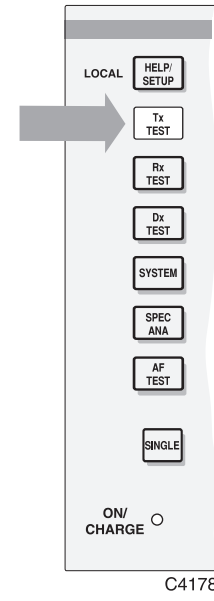
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Test mode screen and menu (2.0). Tx TEST with next levels.

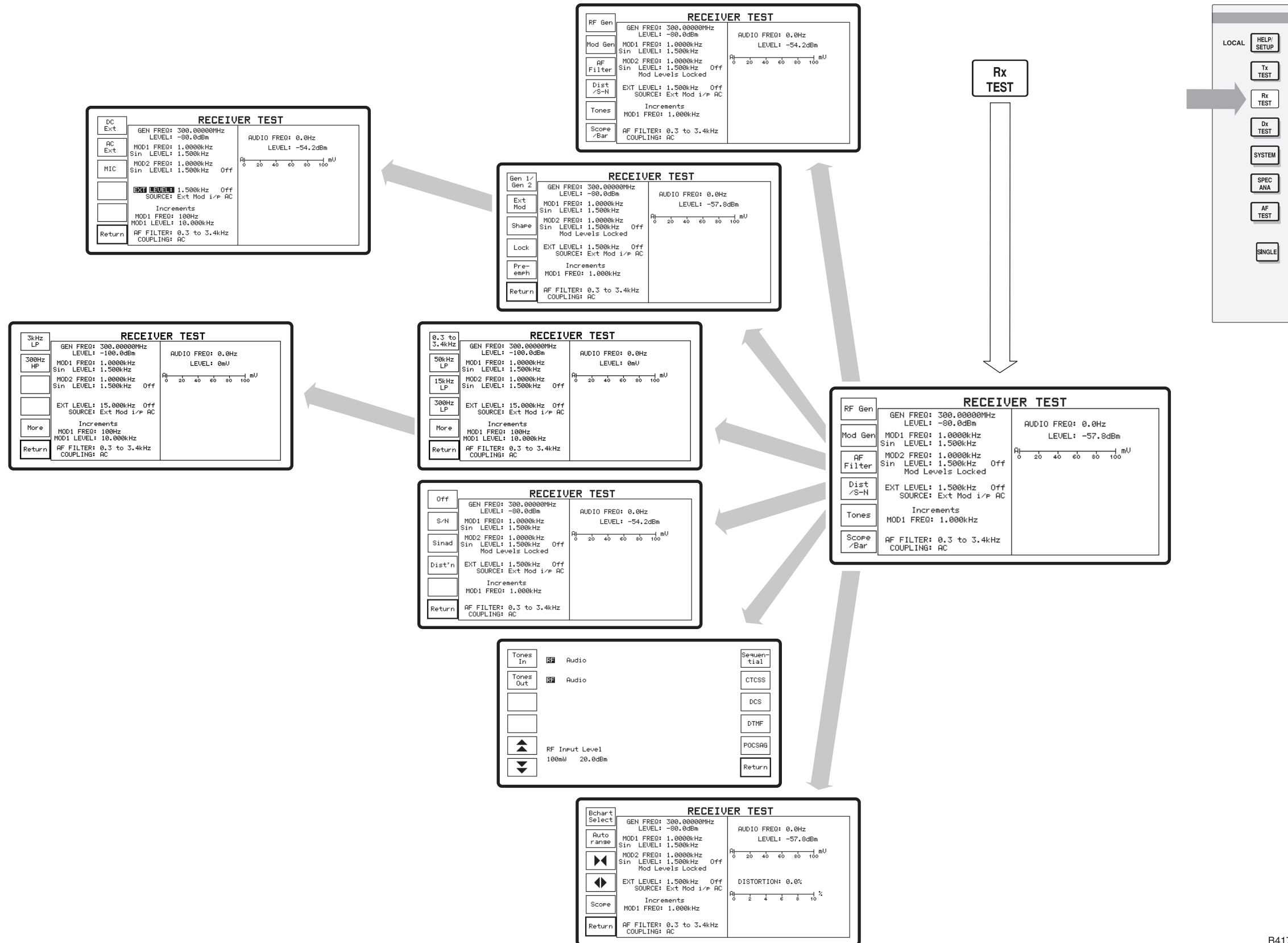
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To Printer: Trim A3 printed sheets by 0.75" (19mm) from right edge to clear binder.



C4178

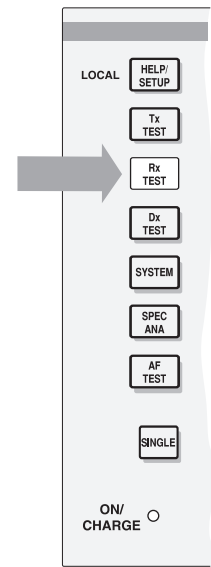
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Test mode screen and menu (3.0). Rx TEST with next levels.

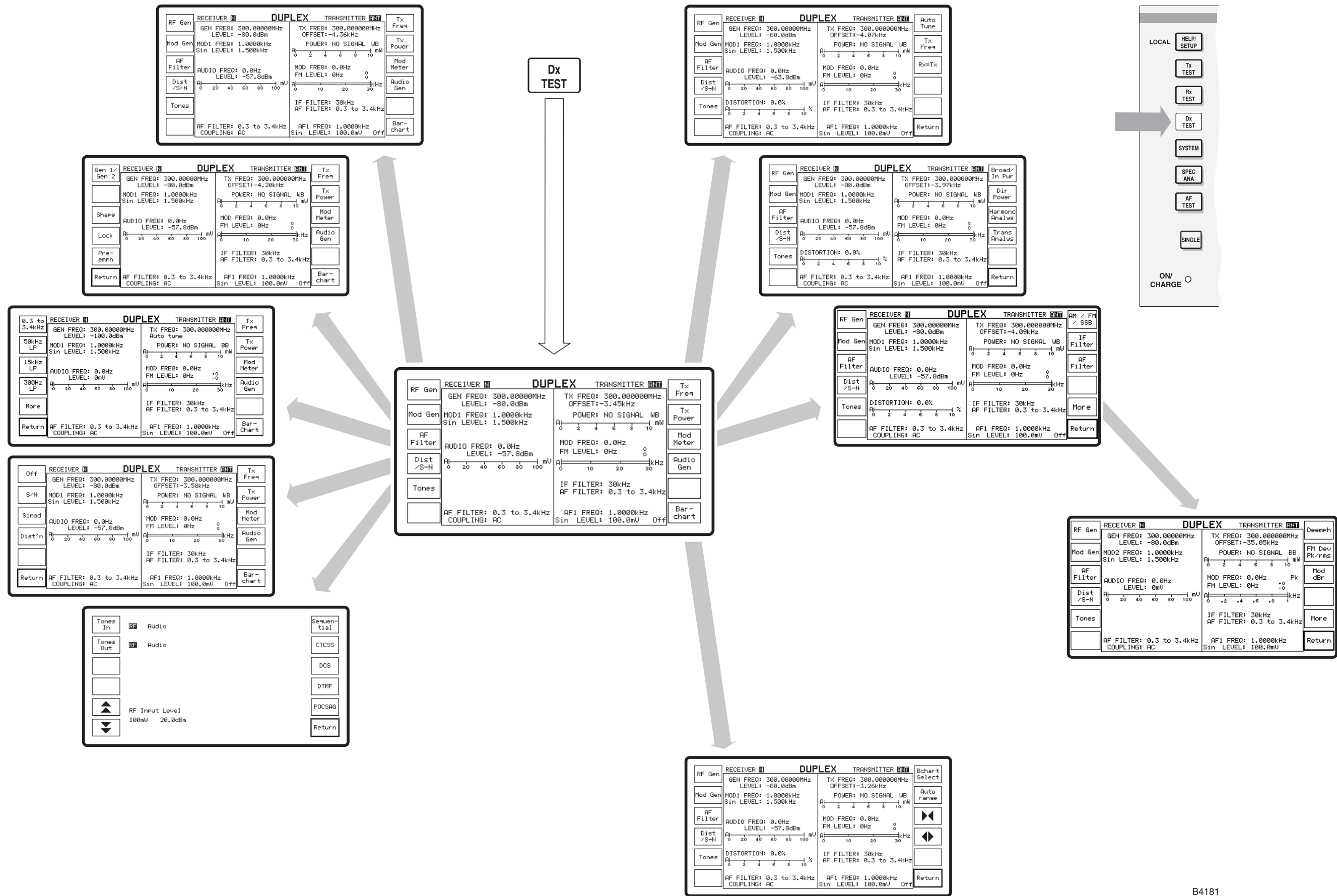
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B4179



C4180

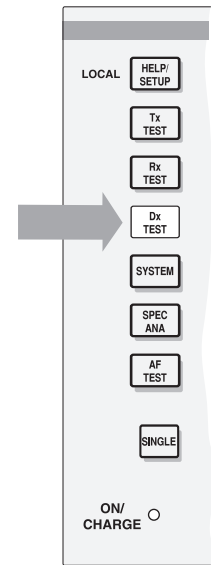
Fold out diagram number (3.0)



Test mode screen and menu (4.0). Dx TEST with next levels.

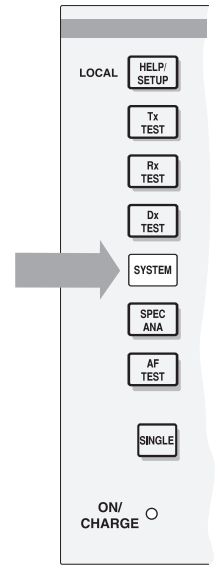
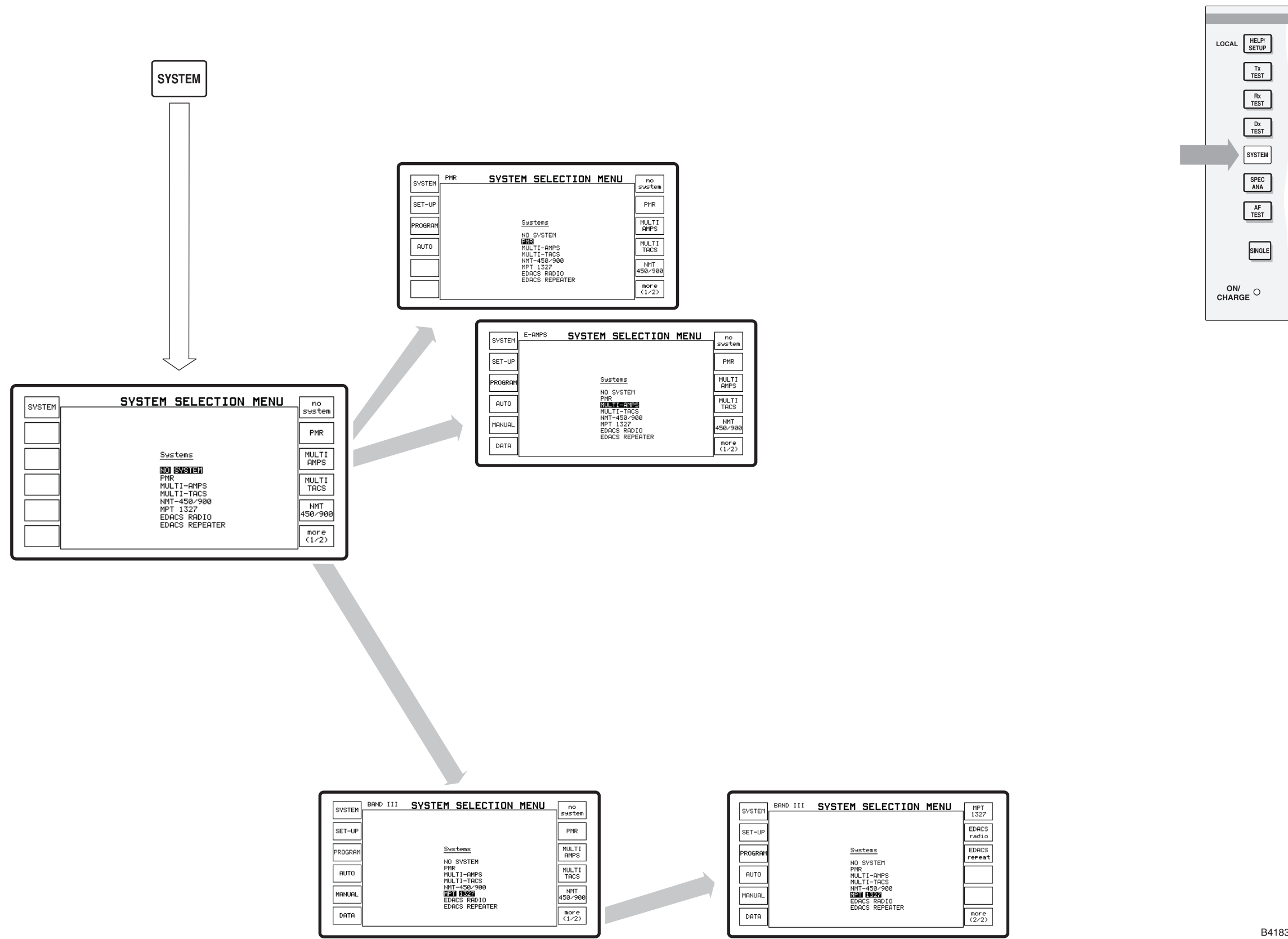
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B4181



C4182

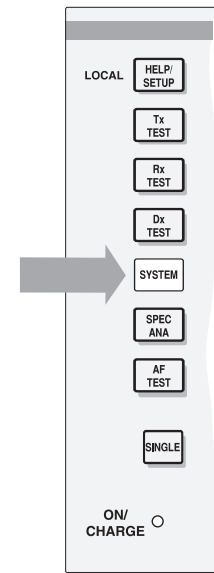
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Test mode screen and menu (5.0). SYSTEMS with next levels.

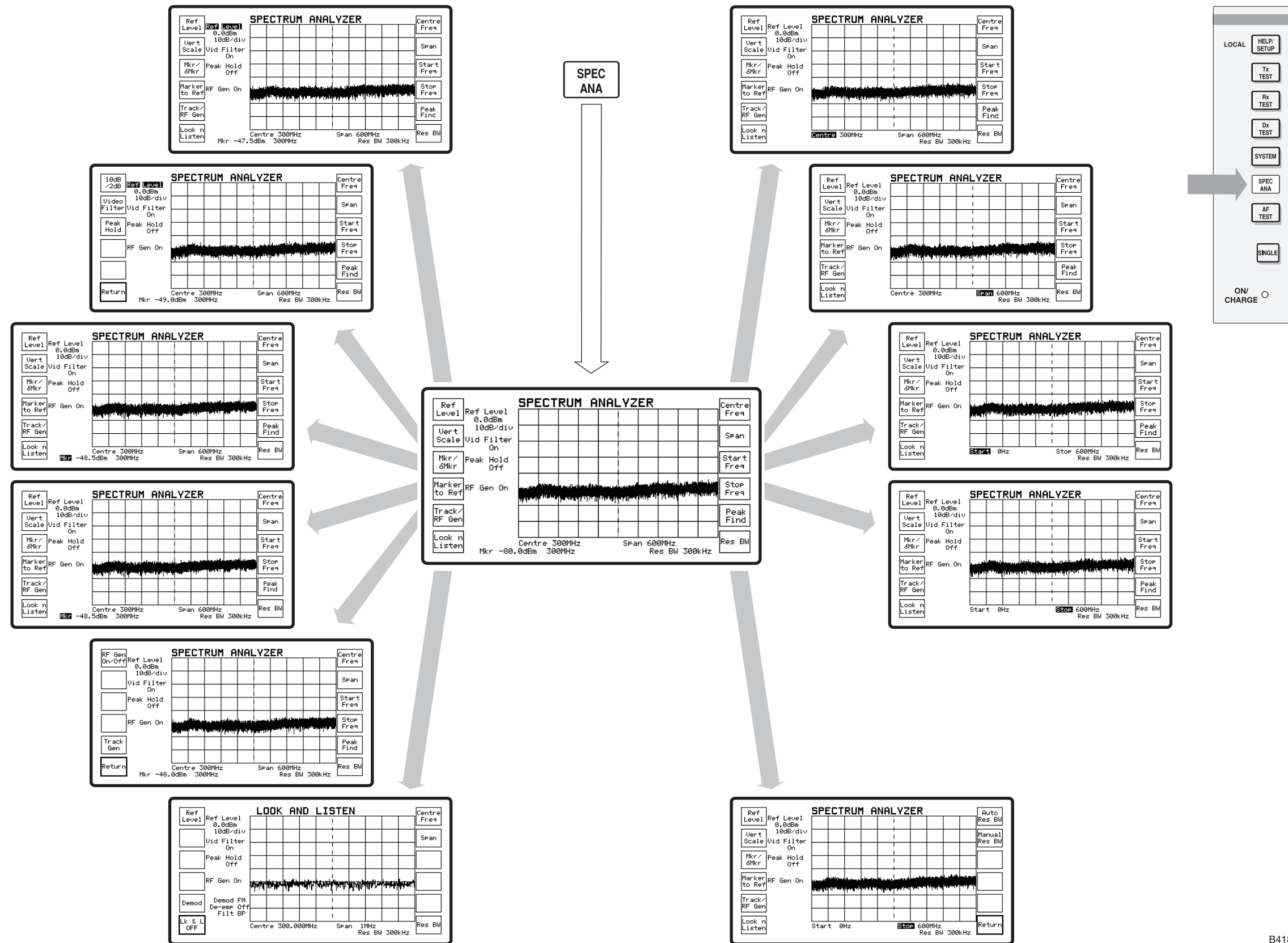
B4183

To Printer: Trim A3 printed sheets by 0.75" (19mm) from right edge to clear binder.



B4184

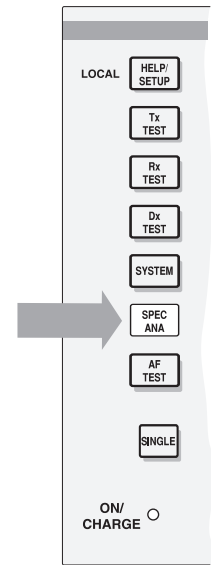
Fold out diagram number (5.0)



Test mode screen and menu (6.0). SPEC ANA with next levels.

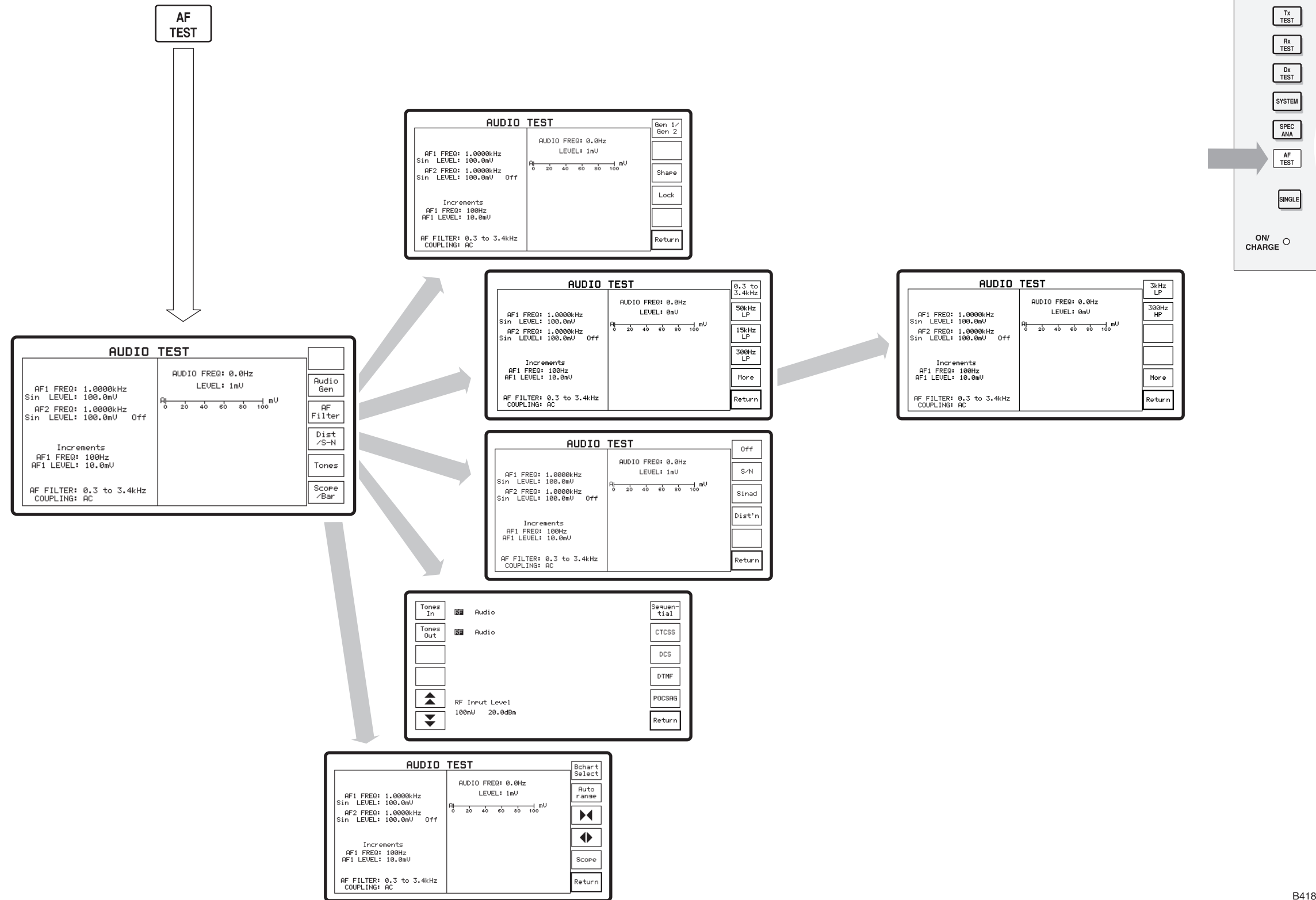
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B4185



C4186

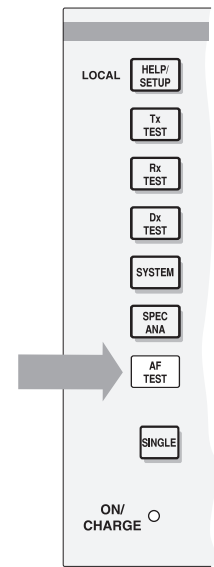
Fold out diagram number (6.0)



Test mode screen and menu (7.0). AF TEST with next levels.

To Printer: Trim A3 printed sheets by 0.75" (19mm) from right edge to clear binder.

B4187



C4188

Fold out diagram number (7.0)

Chapter 4

TECHNICAL DESCRIPTION

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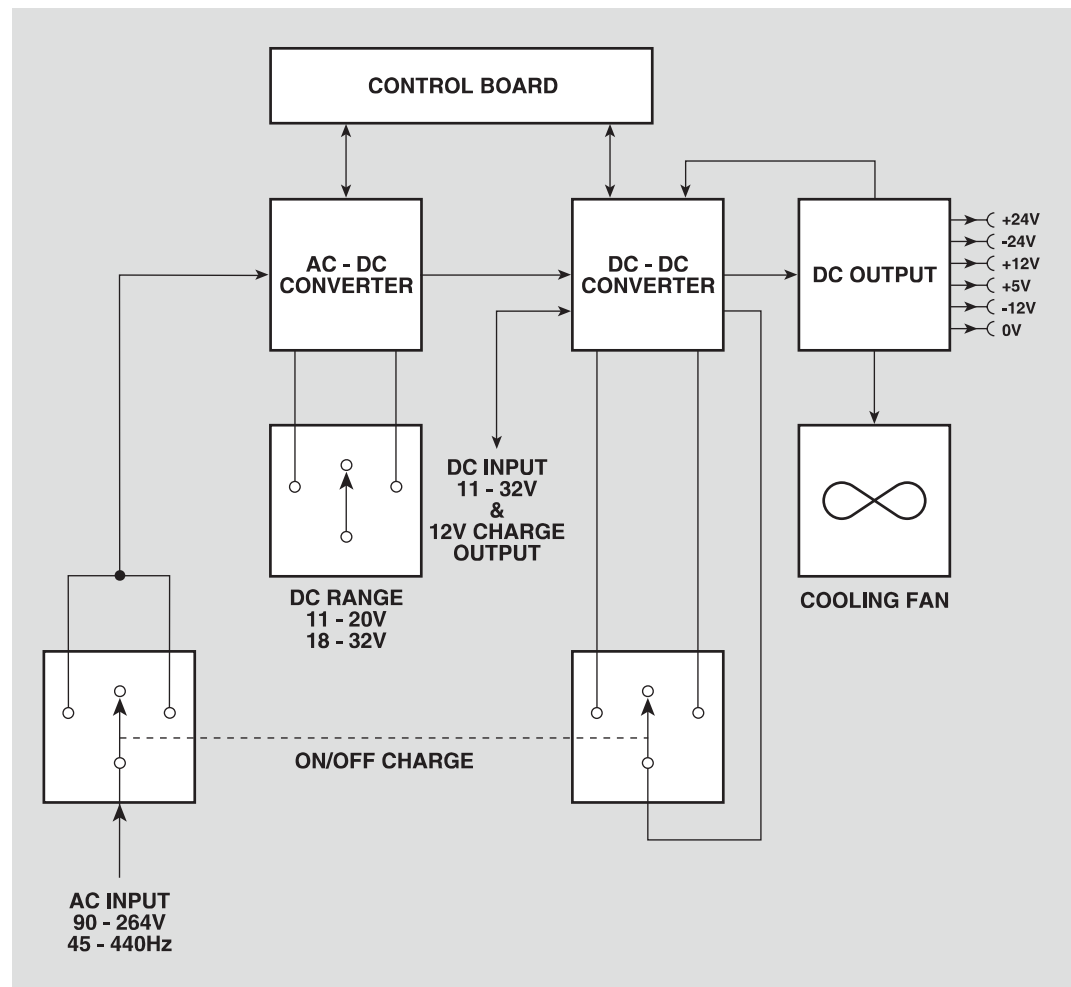
Overview

This simple description is provided to give the user an insight into the working of the Service Monitor at the block diagram level. See Fig. 4-2 *Simplified block diagram*.

The power supply and display unit are described first. The functional circuit blocks of each test mode are then described in sequence.

The Service Monitor is of modular construction, comprising a number of printed circuit boards, (at least 15, depending on options included). These are housed in two sub-assemblies, along with input and output attenuators, power supply, front panel, rear panel and display unit modules. The Service Monitor is microprocessor controlled and software driven.

Power supply



C3113

Fig. 4-1 Block diagram of power supply module

The power supply module is a switched mode design which will operate from an AC supply of 90 to 265 V, 45 Hz to 440 Hz or a DC supply of 11 to 32 V.

The circuits of the instrument require supplies of:

+5 V	3.0 A
+12 V	2.5 A
-12 V	1.2 A
36 V	100 mA output

An additional requirement is for a charging facility to provide a trickle charge to the DC supply when the instrument is working from the AC supply and a recharge facility from the AC supply when the instrument is not operating.

The AC supply enters the instrument through a connector on the rear panel and passes through a fuse and two poles of a triple pole, double throw switch. This switch selects the operate condition, the charge condition or off. The supply then enters the power supply module where it is fed to a bridge rectifier in the AC-DC converter to produce an unregulated DC supply. The voltage of this will depend on the supply voltage as the full range of AC input voltage is covered without range switching.

The second stage of the AC-DC converter produces semi-regulated DC supplies of 12 V or 24 V using a 60 kHz switched mode oscillator and transformer coupling. This transformer also provides the safety isolation barrier.

The DC external or the DC supply from the AC-DC converter is used to drive the DC-DC converter.

The DC output circuits producing the four output supplies are each fed from an individual winding on the DC-DC converter output transformer.

Regulation is applied to the DC-DC converter from the output current and voltage sensing circuits.

The charging supply circuits are contained within the DC-DC converter.

Current monitoring to provide regulation is obtained from the three common-return supplies and voltage monitoring from the +5 V supply.

The 36 V is generated by adding a 24 V floating supply onto the +12 V supply rail.

The floating 24 V supply has a voltage regulator configured within it.

A control circuit PCB contains the components for frequency control and regulation of both converters.

The third pole of the power on-off and charge switch is connected to the DC-DC converter circuits through plug and sockets. The DC voltage range selector switch, fitted to the rear panel, is similarly connected.

In the 'charge' position the DC-DC converter is turned off, allowing the full output of the AC-DC converter to be available for charging a 12 V lead-acid battery.

The display

The display device is a module containing:- a liquid crystal display with an active viewing area 156 mm x 78 mm; a logic board which processes data from the microprocessor to assemble the display information; and a back lighting system to provide illumination for the viewing area.

The viewing area is composed of a 400 X 200 dot matrix with a white background which turns blue where activated. The logic within the display assembly, using latches and shift registers, addresses the 80,000 pixels of the display from 3 control lines and 4 data lines.

The display contrast is dependent on the voltage supplied to the liquid crystal display matrix. This AC voltage is derived within the module from a DC voltage supplied from the microprocessor board B2. It is an infinitely variable voltage fed from a digital to analogue converter, allowing the contrast to be set for optimum viewing.

Illumination for the display is provided by a cold cathode fluorescent tube (CCFT) built into the display module. The supply for the back light is from three op-amps located on the microprocessor board B2. The op-amps are gated by the microprocessor through a latch to provide four levels of brightness and an off condition.

The DC supply is fed to a CCFT inverter which provides the control voltages for the tube.

Fig. 4-2 Simplified block diagram

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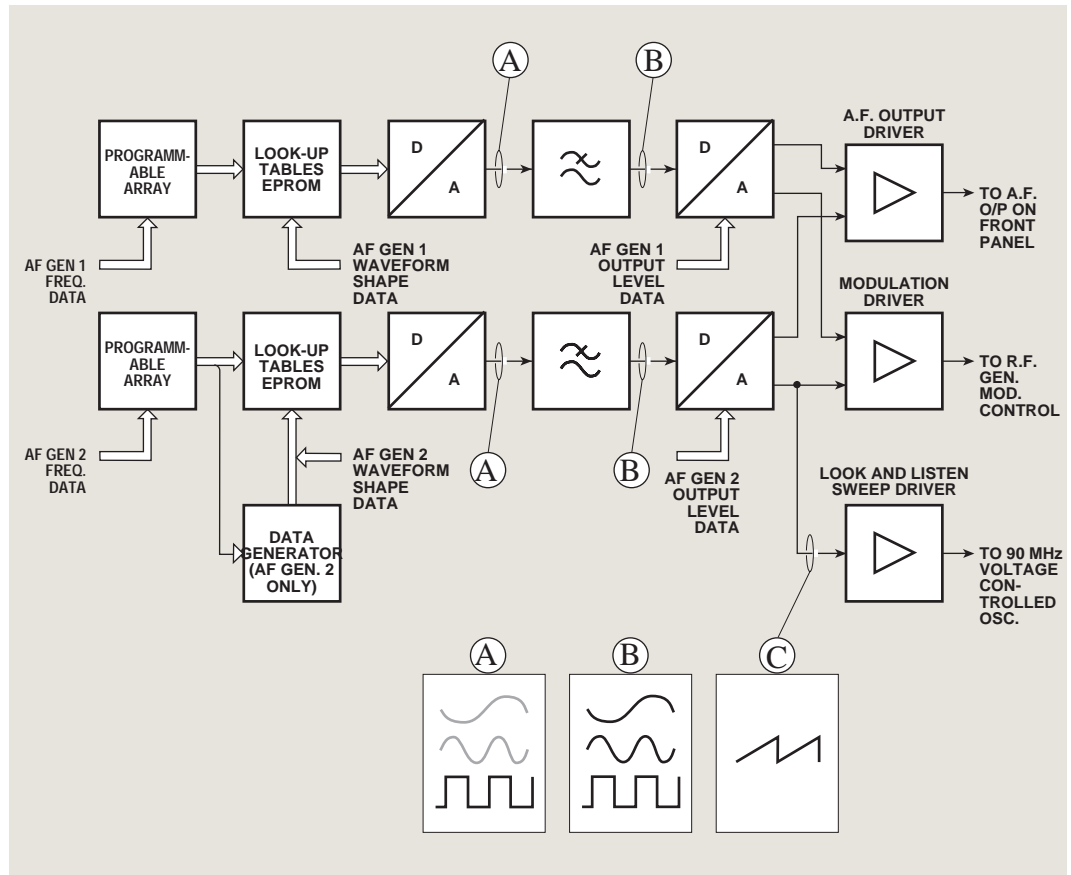


Tx test mode

When operating in the Tx TEST mode the Service Monitor has to provide a source of modulation for the transmitter being tested and also analyse the RF output signal from the transmitter.

Modulation sources

The modulating signal is provided by one or both of the audio generators or the data generator and is taken from the AF output connector on the front panel.



C1412

Fig. 4-3 AF generator detailed block diagram

Audio generators

Included in the monitor are two audio generators, shown as ‘AF generators’ on the simplified block diagram. They are used as modulation sources for the Tx, Rx and Dx TEST modes and as audio test signal generators in the AF TEST mode. Fig. 4-3 is a detailed block diagram of the AF generators. They have a frequency range of 20 Hz to 20 kHz. The output waveform of either generator can be switched between sine wave or square wave. Both generators are of similar design, with minor variations. The generator designated ‘GEN 2’ is also used for other functions which do not conflict with its functions as an audio generator. These uses will be mentioned where relevant.

Each of the circuits function in the following manner:-

Instruction as to the frequency of the required signal is latched into a programmable array device, which generates a repetitive digital output sequence recurring at the required frequency. The digital output from the programmable array is transferred as a stream of 13 bit parallel data into an EPROM. This holds look-up tables containing shape details of sine wave and square wave signals.

Output from the EPROM is as 8 bit parallel information corresponding to the selected shape and at the repetition frequency instructed by the information latched into the programmable array device.

The EPROM output is applied to a digital to analogue converter which, by converting each digital value to the corresponding analogue level, produces the required signal. The mean output level from the digital to analogue converter is constant. The analogue output is filtered by a 50 kHz low-pass active filter, to remove any spikes created by the digital generation process. The output from the filter has a peak to peak level of 5.7 V.

Output level is controlled by a digital to analogue converter, configured as a digital level control circuit. The constant level AF signal is applied to the reference voltage level input, while the digital input register is supplied with the data relating to the level of output signal required. The output from the digital to analogue converter will be a replica of the signal at the reference voltage terminal but proportionally reduced, relative to the data values at the digital input terminals.

After buffering, the AF generator outputs are switched to the AF output drivers for impedance matching, prior to routing to the AF OUTPUT connector on the front panel. The output level available at the AF output connector is infinitely variable from 0.1 mV to 4.0 V RMS.

Note: The AF generators are also used as modulation sources for receiver testing. Therefore the options available to the user when carrying out duplex tests are :-

Both generators to modulate the transmitter under test, receiver test signal not modulated.

Both generators to modulate the receiver test signal, transmitter under test not modulated.

One generator to modulate the transmitter under test and one to modulate the receiver test signal.

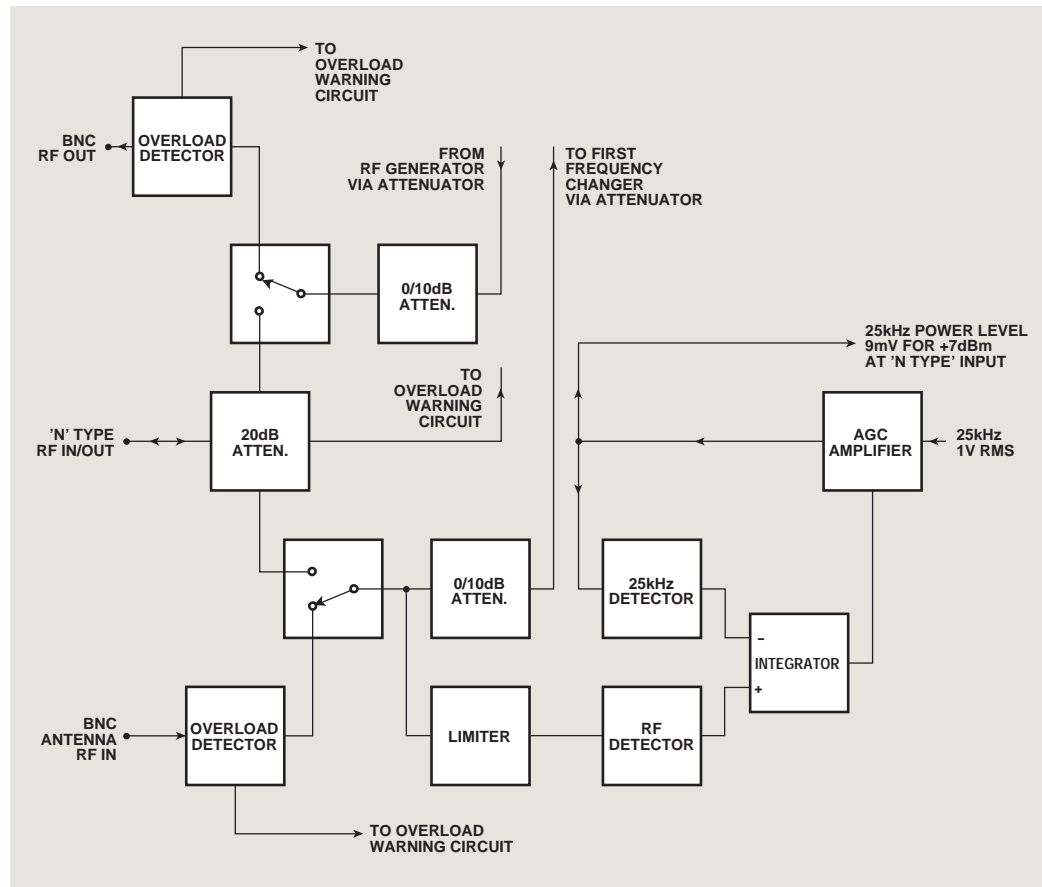
Data generator

The data generator is a 'D type' flip-flop, used to control AF generator 2 when pulsed tones are required as modulation, such as for Digitally Coded Squelch applications. The Q1 output of the data generator IC is used as the A13 address line on the lookup table EPROM. The data generator will thereby directly switch this line, which is arranged to cause full output or no output. The result is that data applied to the flip-flop D2 input, will appear as tone pulses at the output of AF generator 2.

When not required to produce data, the data generator is configured as a transparent flip-flop, with the A13 address line functioning normally.

Receiver circuits

Input switching



C1411

Fig. 4-4 Input switching and broad band power meter block diagram

The RF signal from the transmitter enters the monitor at either the BNC antenna input or the 'N Type' connector on the input/output switching board. A detailed block diagram of the input switching board is shown in Fig. 4-4 *Input switching and broad band power meter block diagram*.

The 'N type' connector, which is also used as an output for receiver testing, has a 20 dB power attenuator, 20 dB between it and the input/output switching circuits.

The RF signal, from the transmitter under test, can be within the frequency range of 100 kHz to 1.05 GHz. A 10 dB attenuator pad can be switched into the transmitter test RF path by the instrument software.

Broad band power meter

A proportion of the signal is fed directly to the broad band power meter circuits. The RF signal is passed through a diode detector and the resultant DC signal integrated with a similar signal derived from a 25 kHz signal from board B2. As the integration is carried out using the inverting and non-inverting inputs of an operational amplifier, a stable condition will result when the two inputs are of the same value.

The output from the integrator is used as a control signal for an AGC amplifier acting on the 25 kHz signal, with the output from the AGC amplifier supplying the integrator. The loop will therefore remain stable with the AGC amplifier output voltage exactly equalling the voltage of the RF input to the detector. This voltage is taken to the voltmeter ranging circuits on the AF Analyzer Board B1 and then to the AF voltmeter circuit on the microprocessor board.

Overload detection

An overload detection circuit is activated if power in excess of 1.0 W is applied to the BNC antenna connector or to the BNC RF output connector. The overload detect lines are activated and trigger the overload warning message from the microprocessor. A temperature sensor, in physical contact with the 20 dB pad on the 'N type' connector, triggers the overload circuit in the event of excessive power being applied to that connector for a period long enough to cause an excessive temperature rise.

Switched attenuator

A switched attenuator with one 40 dB pad, one 20 dB pad or 0 dB attenuation, selectable in any combination and controlled by the instrument software, is situated between the input switching board A11/1 and the first frequency changer/mixer board A2.

IF circuits

First frequency changer/mixer

The RF signal from the switched attenuator, enters the first frequency changer/mixer board A2 and passes through an overload prevention circuit, which limits any input signal to approximately 0.7V peak. The signal then passes either directly, or through a 20 dB amplifier, to the 1st mixer.

First local oscillator

The mixer is also supplied with a signal from the first local oscillator board A8/1. This oscillator is a fractional 'N' controlled oscillator, which can be made to run at any frequency between 1.36 and 2.36 GHz, in increments of 1 Hz. The actual frequency is determined by the control system of the monitor. If the transmitter test frequency is known and has been entered into the monitor as a 'Tx FREQ' using the data input keys, the oscillator will be made to run at a frequency 1.3593 GHz above this value.

By mixing this signal with that from the input circuits, the output from the mixer will contain a signal of 1.3593 GHz.

Where the required frequency of the monitor receiver circuits is to be established by the 'Auto Tune' function, the variable oscillator is made to sweep through its operating range by the instrument's software. When a signal is detected at the demodulators, the sweep rate is slowed and locked.

Filtering in the mixer output removes the upper frequency components of the mixing process.

Second frequency changer/mixer

The signal from the first mixer is further reduced in frequency by a second frequency changing mixer which has an output of 79.3 MHz. This is on the second and third mixer board A3. The signal arriving at board A3 is first passed through a 1.3593 GHz band-pass filter and is then applied to the input of the second mixer.

Second local oscillator

The local oscillator signal for the second mixer has a frequency of 1.280 GHz and is generated on the second and third oscillator board A9/1. This oscillator is a phase locked loop device, locked to the instrument's 10 MHz reference oscillator.

The output from the second mixer is passed through a 79.3 MHz band-pass filter, to remove the unwanted products of the mixing process, before being given 20 dB amplification.

The 79.3 MHz IF signal is split and fed to two independent mixers.

The secondary feed supplies the 90 MHz swept local oscillator board A10. This operates as a swept oscillator when the spectrum analyzer Look and Listen function, is active, as described later. It provides a locked 90 MHz signal for the third mixer at other times.

The primary path is through a band-pass filter with 5 MHz bandwidth, to the main 90 MHz 3rd mixer. This mixer is on the second and third mixer board A3.

Third frequency changer/mixer

A third frequency change is made to the signal to achieve a final IF of 10.7 MHz.

The local oscillator signal for the third mixer is provided by the voltage controlled oscillator on A10. This oscillator runs at 90 MHz and for normal transmitter testing is locked to the output of a 90 MHz reference oscillator on the second and third oscillator board A9/1.

Bandwidth filters

The 10.7 MHz output from the third mixer in the Tx TEST path, passes from the second and third mixer board A3 to the 10.7 MHz IF and Log amplifier board A4/1.

Filters on this board provides the bandwidth filtering for the signal path in the Tx TEST mode and also for the SPEC ANA mode. The bandwidths provided are 3 MHz, 300 kHz, 30 kHz, 3 kHz and 300 Hz, using crystal filters controlled by signals from the micro processor.

A direct, un-filtered path is also provided.

After filtering, the signal is passed to the demodulators on the audio processor board B1/2.

Demodulators

AM demodulator

The demodulators are located on the audio processor board B1/2. The IF signal from the IF and Log amplifier board A4/1, is fed to a phase splitter circuit which provides anti-phase outputs for the AM demodulator. The outputs from the phase splitter are taken to the positive and negative inputs of the balanced demodulator. The demodulator is also fed with balanced unmodulated inputs, obtained from the modulated 10.7 MHz signal, by way of a phase-splitting limiter.

The demodulator produces a balanced output equal to the difference between the two input signals. This will have an AF component equalling the modulation signal and a DC component relating to the level of the IF signal. The modulation is fed to the AF switching circuits while the DC component is used for automatic gain control.

FM demodulator

FM demodulation is performed by a pulse width discriminator operating at 700 kHz. The signal for this is obtained by mixing the 10.7 MHz output from the limited signal fed to the AM demodulator, with the 10.0 MHz reference frequency and passing the resultant signal through a low-pass filter.

The 700 kHz signal containing the FM information is fed into a both halves of a dual monostable flip-flop. By putting this signal to A1 and B2 inputs, the Q-outputs from the monostables will be in anti-phase. By summing the two output signals the resultant signal will be a true representation of the modulation.

SSB demodulator (optional)

The single sideband demodulator circuits are all contained on the SSB demodulator board A15.

When the SSB demodulation function is selected the first local oscillator of the Service Monitor is set to a frequency which will produce a final IF of 10.625 MHz (from an input frequency equal to the carrier frequency) rather than the 10.7 MHz IF produced for all other modes. The IF signal for the SSB board is obtained from the third mixer on A3, through a 10.7 MHz low-pass filter on A4/1.

It is applied to a variable gain circuit which is used to control the input level for the SSB demodulator circuits.

After leaving the gain control circuit the signal is then mixed in a double balanced mixer with a 10 MHz signal from the instrument reference oscillator. The output from the mixer will contain a 625 kHz component. This is passed through a 625 kHz low pass filter, to one input of another double balanced mixer. The second input is fed with a reference signal of 625 kHz derived from the 10 MHz reference through a 'divide by 16' circuit. The output from the double balanced mixer will be zero when no modulation is present on the input signal. When modulation is applied, the

output signal will equal the difference in frequency between the original carrier frequency and the original sideband frequency. Either an upper sideband signal or lower sideband signal will produce an output. This will equal the frequency of the applied modulation. The demodulated signal is fed to the input of the audio routing circuits.

De-emphasis filter

The output from the discriminator passes through a 163 kHz low-pass filter and then the 750 μ s de-emphasis filter before being routed by the demodulation selection switches. The de-emphasis filter can be by-passed as part of the test set-up.

RF counter

A sample of the 10.7 MHz IF signal is taken from one output of the phase splitter/limiter and supplied to the IF counter circuit, also located on B1/2.

This counter measures the mean frequency of the IF signal and the result is written into memory. By making a calculation using the reading from the RF counter and the division ratios from the three local oscillator control loops, the instrument software can establish the mean frequency of the transmitter output.

Measurement ranging circuits

The evaluation of RF level, modulation depth, modulation deviation, distorted levels etc. are all made using a metering circuit on the microprocessor board B2/1. Before the various levels can be measured, each must be conditioned so as to bring the minimum and maximum levels of each parameter within the range of the metering circuit. The signals to be measured are all brought to the analyzer ranging circuits on the audio processor board B1/2. Signals relating to RF power input to the instrument and power readings from an auxiliary power head are passed through various switched gain amplifiers before leaving the board to be measured.

Measurements to the demodulated AF signals are made after filtering to the selected AF filter pass band. The AF filters are located on the audio processor board and offer the choice of 300 Hz-3.4 kHz band-pass; 15 kHz low-pass; 300 Hz low-pass and the full bandwidth of 50 kHz.

The selected filters are switched into the AF circuit before the ranging amplifiers.

Distortion/SINAD filter

The 1.0 kHz active notch filter, used to make distortion percentage and SINAD measurements, is also on the audio processor board B1/2. This filter is switched into circuit to make comparison measurements against the un-filtered path.

Oscilloscope function

The oscilloscope function when used within the Tx TEST mode displays the waveform of the demodulated signal. The signal for this is taken from the AF filter output and after passing through level converting amplifier circuits is fed to an analogue to digital converter located on the microprocessor board B2/1. The digital levels relating to the waveform are written into a digital signal processor which generates the oscilloscope display. The values are incorporated into the display and updated continually.

Rx test mode

The Rx TEST mode uses the signal from the RF signal generator circuits, as an input signal for the receiver under test. The AF signal, produced by the demodulator within the receiver, is analysed within the Service Monitor to produce results of the test.

Selecting the Rx TEST mode does not disable the functions of the Tx TEST mode. The receiver circuits remain active at their last settings. The AF generators will also continue operating at their last settings unless either is enabled as a modulation generator. Calling up one modulation

generator will allow the other to function as an AF generator for the Tx TEST mode, but using both as modulation sources will remove both from Tx TEST use.

RF generator

The RF signal is produced within the monitor by a fractional N controlled oscillator with a range of 1,280.1 MHz to 2,280.0 MHz. This is located on the RF generator oscillator board A13/1. The oscillator and its control system are of a complex design in order to meet strict requirements of frequency stability, low phase noise and very fast settling after a change of frequency. The output from this oscillator is fed to the RF generator mixer board A12/1, where it is combined with a signal taken from the output of the second local oscillator on A9/1.

The mixer output is filtered by a 1050 MHz low-pass filter to remove all unwanted frequencies, before passing to the RF output amplifier board and AM modulator board A6/1.

Modulators

The Rx TEST signal can be either AM or FM modulated.

The selected modulation signal, from either or both of the AF generators, from the data generator or from an external source, is conditioned and level corrected within the modulation control circuits on the audio processor board B1/2.

Frequency modulation is applied by injection into the fractional N control loop, thereby influencing the generated frequency. When the signal is FM modulated, the AM modulator is held in a 0% modulation state.

AM modulation is applied to the signal using a pin diode modulator, located within the output amplifier circuits on A6. The output level of the Rx TEST signal is also controlled using the pin diode modulator.

The signal controlling the attenuation level of the pin diode modulator, is a composite signal containing the amplitude modulation component obtained from the modulation source and a DC component representing the required output level.

They are combined into one modulation signal using a digital to analogue converter on the audio processor board B1/2

RF amplifier

The signal level from the AM modulator is increased by 50 dB by a three stage RF amplifier before passing through the output control attenuator to the RF switching unit and the RF output sockets.

Audio generators

The audio generators on the B1/2 are used to provide AF Modulation to the RF test signal generated on the RF generator oscillator board A13/1. The operation of the generators is as described for the Tx TEST mode but rather than the output level being called up as an output voltage, this is specified as a modulation level. The necessary calculations are performed by the instrument software.

The DATA GENERATOR facility is available in the Rx TEST mode.

Modulation control

The output from each generator is taken through selector switches to a summing amplifier at the input to the modulation control circuits. The signal from an external modulation source or from the modulation options circuits is also summed in at this point. An external modulation source can be connected to the EXTERNAL MOD IN connector on the rear panel and is passed through a level control circuit of the same type as that in the AF generator circuit, incorporating a digital to analogue converter, with the signal input to the voltage reference point and the level set by the value on the digital input.

The summed modulation signal is taken through a modulation correction level control circuit before being routed to either the FM attenuator digital to analogue converter or to the RF level

digital to analogue converter. This device provides fine level control of the RF signal by applying a DC level to the AM modulator as described earlier.

Pre-emphasis filter

A 750 μ s pre-emphasis filter is included on the audio processor board and is switched into the FM modulation path when selected as part of the Rx TEST set-up.

AF measuring circuits

The AF output signal from the receiver under test is fed into the AF INPUT connector of the Service Monitor. This signal is directly fed to the audio processor board and applied to a switched divide by 2/divide by 20 circuit. It is then routed through two paths, one to the AF filtering and measuring path, the other to the oscilloscope input circuits.

Oscilloscope function

When used in the Rx TEST mode, the oscilloscope displays the AF input signal fed to the AF input connector.. The signal is passed through a sensitivity control circuit for scope calibration before following the same path as used in the Tx TEST mode.

Dx test mode

The Dx TEST mode uses all the circuit elements described in the preceding sections. The technical description is valid for all three modes. The display presentation allows parameters applicable to transmitter testing and receiver testing to be seen simultaneously.

Spectrum analyzer mode

Data to be presented as the active trace on the spectrum analyzer display is obtained through the following circuits:-

The input frequency of the Service Monitor is made to sweep through the frequency range selected on the display by sweeping the first local oscillator, located on A7/1. Any signals which fall within the sweep range will pass through the IF circuits of the Service Monitor.

The output from the third mixer is amplified and filtered on A4/1, then fed to a logarithmic amplifier. The 10.7 MHz signal is detected to produce a DC signal, the level of which is relative to the level of the RF signal input. The DC voltage is digitised by an analogue to digital converter on the Microprocessor board B2/1. The digital value obtained is stored in RAM at a memory location which is related to the sweep position and to the value.

Each time the display is refreshed, the contents of each display location address will provide the latest data, thus updating the display. The refresh rate is approx. 11 per second.

Look and listen function

When the look and listen function of spectrum analyzer mode is selected, the operation is modified. In order to demodulate the centre frequency of the span, the signal fed to the demodulator must be obtained from a fixed frequency point. As the frequency span in the look and listen function is limited to 2 MHz, the frequency sweep can be applied at the third mixer stage. A ramp voltage is generated within AF generator 2 on the AF board B1/2 and applied to the 90 MHz voltage controlled oscillator on A10. The 10.7 MHz IF signal will thus have swept over the selected range to produce a Frequency vs Signal Level display.

The signal fed to the modulator meter is obtained from the Look and Listen third mixer, located on the second and third local oscillator board A9/1. The demodulated AM or FM signal is amplified, to provide a low impedance output which is fed to the loudspeaker. It is also fed to the ACCESSORY connector on the front panel.

A 90 MHz reference oscillator on A9/1 provides the local oscillator signal for this mixer. It also provides a 90 MHz reference for the 90 MHz voltage controlled swept oscillator on A10.

AF test mode

The AF TEST mode requires a signal source to apply to the circuit or equipment under test and a measuring facility to analyse the resultant output signal.

The signal source is provided by the audio generators as for the Tx TEST mode and the AF measuring circuits configured as for the Rx TEST mode. The RF generator and IF local oscillators are disabled. The power metering and modulation metering functions are also disabled.

Systems mode

The systems mode of the Service Monitor allows the instrument to test communications equipment which is designed for operation on dedicated systems such as cellular mobile radio telephone systems and trunking radio telephone systems. Automatic testing is performed using various test programs. These can be made to check all functions of the system, the signalling only or any intermediate choice of functions, depending on the user's requirements.

The data processing needed to carry out these tests is handled by a 68000 microprocessor and three Digital Signal Processors (DSPs) on the cellular radio systems board B3/1.

The board has 1 M byte of EPROM which contains the cellular systems software and the built-in test sequences.

The user defined sequences and user set-ups are held in 256 k byte of NOVRAM.

One of the DSPs generates the signals required to simulate the system signals, the other two handle the signals received from the mobile.

A gate array is used for communication between the 68000 microprocessor and the DSPs.

Interfacing between the digital circuits on B3/1 and analogue circuits of the Service Monitor is handled by a dual 18-bit digital to analogue converter for the Service Monitor to mobile signals and by a 12-bit analogue to digital converter for signals from the mobile.

 Simplified block diagram

Chapter 5

ACCEPTANCE TESTING

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Introduction

Test procedures described in this chapter may be simplified and of restricted range compared with those that relate to the generally more comprehensive factory test facilities which are necessary to demonstrate complete compliance with the specifications.

Performance limits quoted are for guidance and should not be taken as guaranteed performance specifications unless they are also quoted in the section *Performance data* in Chapter 1.

When making tests to verify that the instrument meets the stated performance limits, always allow for the uncertainty of the test equipment.

Results tables

A set of Results tables, each with a blank results column, is provided at the end of this chapter. It is suggested that these tables are copied, and the test results entered on the copies.

The Results table that is appropriate to each particular test or part of a test is referred to at the relevant point in the test procedure.

Before starting

In line with best practice in electronic measurement, it is recommended that the Unit Under Test (UUT) is allowed to stabilize for thirty minutes after switch on to obtain optimum performance.

The key presses necessary to set UUT parameters may differ slightly from those stated in the text, depending on the version of software fitted.

To minimise the number of key presses that the user needs to make to obtain the correct instrument settings, each section assumes that the instrument is being configured from the instrument 'factory default power on state'. To ensure that this occurs, initially press the following keys: [HELP/SETUP], [Setup], [Setup page 2], toggle [Power Up From], until *Preset Store 1* is shown highlighted in inverse video. Each time the instrument is now powered up, it will enter its default power on state.

The instructions relating to test equipment operation assume that the test equipment used for each test is that suggested in the *Example* column of the following table (where there is more than one, the first item).

Test equipment

Description	Minimum specification	Example
Frequency counter	400 kHz to 1.05 GHz. 1 Hz resolution, external standard In/Out.	IFR* 2440 or EIP 25B
RF power meter	± 0.1 dB from 10 MHz to 1 GHz.	IFR* 6960/A/B + 6912 and 6920 sensor
Measuring receiver	−21 dBm to −127 dBm, 2.5 MHz to 1 GHz.	HP 8902A + 11772A sensor
Spectrum analyzer	400 kHz to 3 GHz, noise floor < −127 dBm.	IFR* 2383
50 Ω sealed load		
2-turn 25 mm loop		
Low-noise FM demodulator	Residual FM to be less than 2 Hz up to 1 GHz.	IFR* 2305 + IFR* 2041
Modulation meter	RF I/P 500 kHz to 1.05 GHz AM. Measurement accuracy up to 85% depth: ± 1% of reading at 1 kHz mod rate, ± 2.5% of reading for mod rates from 30 Hz to 50 kHz RF I/P 500 kHz to 1.05 GHz FM. Measurement accuracy ± 0.5% of reading ± 1 least significant changing digit at 1 kHz mod rate for deviation > 5 kHz	IFR* 2305
DVM	1 % accuracy AC measurement, 20 Hz to 50 kHz. DC measurement to 1 mV.	Solatron 7150+
Audio analyzer	Capable of measuring distortion from 1 kHz to 15 kHz down to 0.1% and AC measurement in a CCITT bandwidth.	IFR* 2965/ HP 8903B
LF generator	50 Hz to 50 kHz, external frequency standard In/Out, 30 mV to 5 V RMS.	IFR* 2965/ HP 3325
RF signal generator	100 kHz to 1.05 GHz, RF level accuracy ± 1 dB. AM depth 0 to 95%, deviation 0 to 75 kHz. Modulation rate 10 Hz to 15 kHz.	IFR* 2041
Power splitter	6 dB 50 Ω 500 kHz to 1 GHz.	Weinschel 1870A
DC PSU	0 to 50 V.	
Calibrated power source	Accuracy 3.5% up to 500 MHz, 8.5% up to 1 GHz.	See broad band power test.

*IFR Ltd was previously known as Marconi Instruments Ltd

The minimum specifications for the test equipment listed above cover *all* requirements for these tests. The minimum specifications for the test equipment listed at the start of each test description apply to that test only.

RF output tests

Carrier frequency accuracy

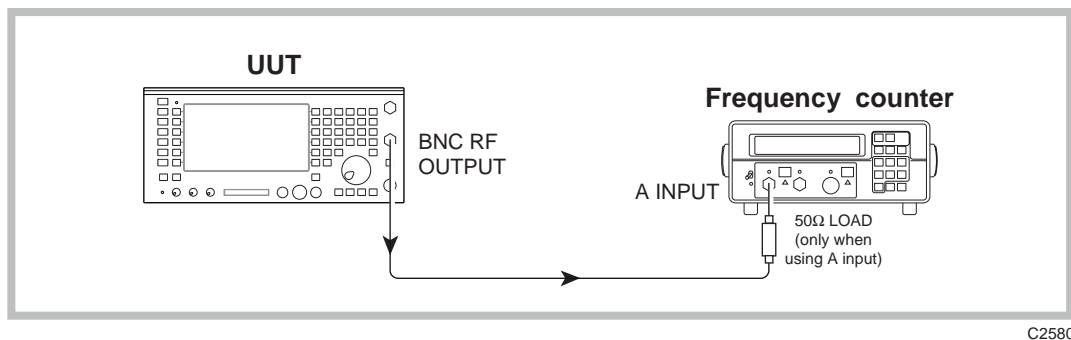
This check provides a conventional method of checking the signal generator frequency locking circuitry. It will confirm correct operation of phase lock loop and dividers. Overall accuracy is determined by the instrument's internal reference standard.

Specification

Frequency range:	400 kHz to 1.05 GHz
Accuracy:	As frequency standard ± 1 count
Resolution:	10 Hz

Test equipment

Description	Minimum specification	Example
Frequency counter	400 kHz to 1.05 GHz , 1 Hz resolution, external standard In/Out	IFR 2440 or E.I.P.25B



C2580

Fig. 5-1 Carrier frequency accuracy

- (1) Refer to Results table 5-1 on page 5-30. Connect the BNC RF output socket on the UUT to the A input on the counter (2440), as shown in Fig. 5-1. The connection to the A input should be made via a 50 Ω load, otherwise miscounting could occur.
- (2) Lock the reference standards of the instruments together.
- (3) Set the UUT to [Rx TEST], RF IN/OUT [SELECT] BNC output, [RF Gen], [LEVEL] 0 dBm, [FREQ] 400 kHz. All modulation and noise measurements should be switched OFF.
- (4) Set the counter to 1 Hz resolution.
- (5) Check that the counter reads between 399.999 and 400.001 kHz.
- (6) Repeat for the remaining frequencies shown in Table 5-1, checking that the counter displays the selected frequency ± 1 Hz. It will be necessary to disconnect the 50 Ω load and reconnect the UUT RF output to the A, B or C input of the counter where indicated.

Table 5-1 Carrier frequencies

Frequency	UUT area checked	2440 range
400.000 kHz	Oscillator, bottom	A
1050.00000 MHz	Oscillator, top	C
500.00000 MHz	Oscillator, middle	B
188.88888 MHz 177.77777 MHz 166.66666 MHz 155.55555 MHz 144.44444 MHz 133.33333 MHz 122.22222 MHz 111.11111 MHz	} Fractional N	} B B B B B B B B

RF output level

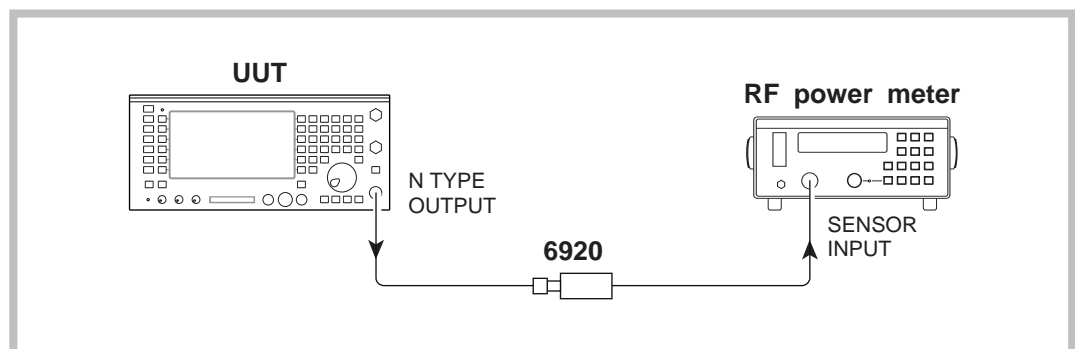
Specification

Level range: -127 dBm to -21 dBm (N-type socket)

Accuracy: ± 2 dB up to 1 GHz

Test equipment

Description	Minimum specification	Example
RF power meter	± 0.1 dB from 10 MHz to 1 GHz	IFR 6960/A/B + 6920 sensor
Measuring receiver	-21 dBm to -127 dBm, 2.5 MHz to 1 GHz	HP 8902A + 11772A sensor
Spectrum analyzer	Noise floor < -127 dBm	IFR 2383



C2581

Fig. 5-2 RF level set up

- (1) Refer to Results table 5-2 on page 5-30. Connect the sensor to the UUT N-type output socket, as shown in Fig. 5-2.
- (2) Set the UUT to [Rx TEST], RF IN/OUT [SELECT] N-type output/antenna input mode, [RF Gen], [LEVEL] -21 dBm, [FREQ] 10 MHz. All modulation and noise measurements should be switched OFF.

- (3) Check that the power meter indicates $-21 \text{ dBm} \pm 2 \text{ dB}$.
- (4) Select N-type output/N-type input mode and check that the level measured is $-21 \text{ dBm} \pm 2 \text{ dB}$.
- (5) Press RF IN/OUT [SELECT] until the mode returns to N-type output/antenna input.
- (6) Repeat steps 3 to 5 for 100 MHz and then in 100 MHz steps up to and including 1000 MHz.

ALC linearity

- (1) Refer to Results table 5-3 on page 5-31. Connect the sensor to the N-type output socket, as shown in Fig. 5-2.
- (2) Set the UUT to [RF Gen], [LEVEL] -21 dBm , [$\Delta \text{ INC}$] 1 dB , [FREQ] 10 MHz .
- (3) Increment the RF output of the UUT in 1 dB steps down to -38 dBm , ensuring that the indication on the power meter is within $\pm 2 \text{ dB}$ of each level set.
- (4) Return the UUT RF level to -21 dBm .
- (5) Set the UUT carrier frequency to 500 MHz and repeat step 3. Refer to Results table 5-4 on page 5-32.
- (6) Set the UUT carrier frequency to 1 GHz , return the level to -21 dBm and repeat step 3. Refer to Results table 5-5 on page 5-32.

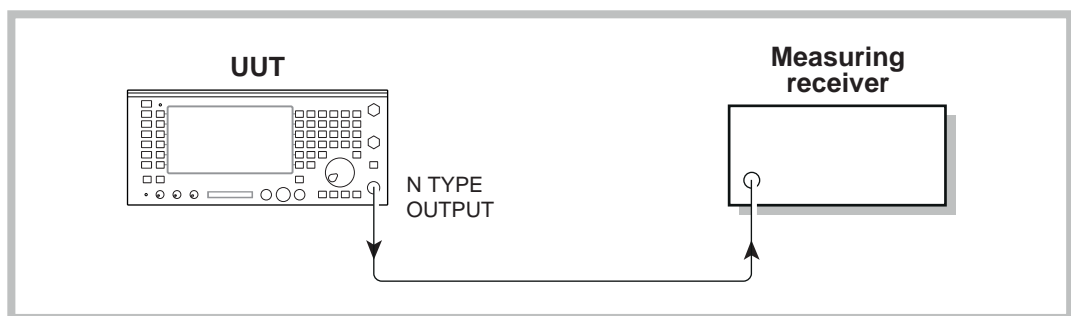
BNC output mode

No claim is made on the output level accuracy of the BNC socket. The following is a functional check to ensure correct internal operation.

- (1) Connect the 6920 sensor to the BNC output, as shown in Fig. 5-2.
- (2) Set the UUT to [Rx TEST], RF IN/OUT [SELECT] BNC output, [RF Gen], [LEVEL] -21 dBm , [FREQ] 10 MHz . All modulation and noise measurements should be switched OFF.
- (3) Check that the power meter indicates $-21 \text{ dBm} \pm 4 \text{ dB}$.
- (4) Repeat step 3 for 100 MHz and then in 100 MHz steps up to and including 1000 MHz .

Attenuator accuracy

The following test will confirm that the attenuator performs to the published performance specification. In the event of the receiver not being available, an alternative method to functionally test the attenuator is also suggested.



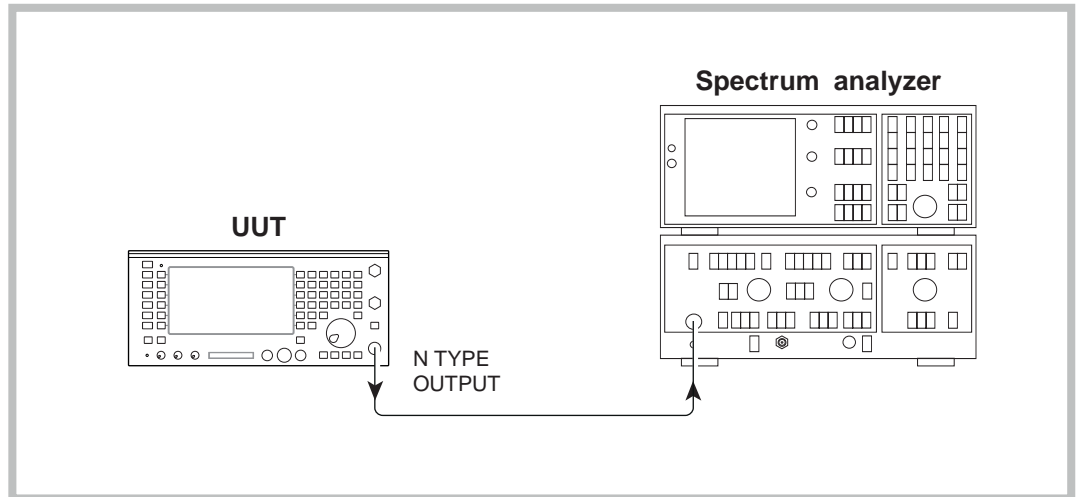
C2582

Fig. 5-3 RF level set up

- (1) Connect the test equipment as shown in Fig. 5-3.
- (2) Set the UUT to [RF Gen], [LEVEL], -21 dBm , [FREQ] 2.5 MHz .
- (3) Tune the receiver to the frequency set on the UUT RF Generator and measure the RF level.

- (4) Decrement the output of the UUT in 10 dB steps down to an RF level of -121 dBm measuring the RF level at each step.
- (5) Repeat steps 2 to 4 for frequencies of 500 and 1000 MHz.

Alternative attenuator functional check



C2583

Fig. 5-4 Attenuator functional check

- (1) Connect the test equipment as shown in Fig. 5-4.
- (2) Set the UUT to [Rx TEST], RF IN/OUT [SELECT] N-type output, [RF Gen], [LEVEL] -27 dBm, [Δ INC] 10 dB, [FREQ] 251 MHz. All modulation and noise measurements should be switched OFF.
- (3) Tune the Spectrum analyzer to the signal from the UUT. Using the UUT increment level down arrow key, reduce the level of the UUT output in 10 dB steps down to -127 dBm. At each 10 dB step ensure the level on the analyzer drops accordingly

Spectral purity

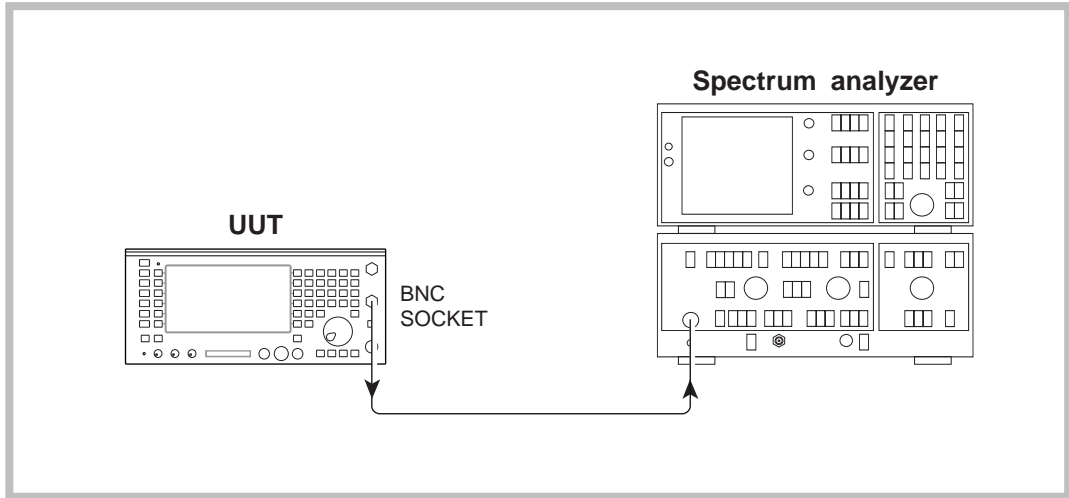
Harmonics, spurious, RF carrier leakage, residual FM.

Specification

Carrier range:	400 kHz to 1 GHz
Harmonics:	Better than -20 dBc.
Spurious signals	Better than -30 dBc (± 10 kHz to 1.5 MHz offset from carrier frequency or over range 600 - 700 MHz). Better than -40 dBc elsewhere.
Carrier leakage	Less than $0.5 \mu\text{V}$ PD generated in a 50Ω load by a 2 turn 25 mm loop 25 mm from the case with output level less than -40 dBm and terminated in a sealed 50Ω load.
Residual FM	Less than 15 Hz RMS (0.3 to 3.4 kHz) up to 500 MHz Less than 20 Hz RMS (0.3 to 3.4 kHz) up to 1000 MHz (with OCXO)

Test equipment

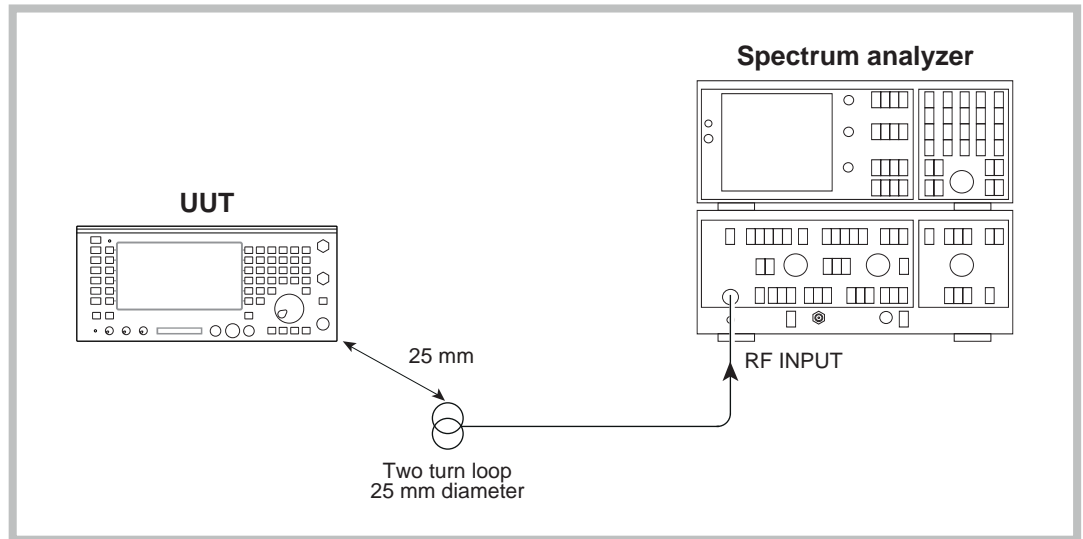
Description	Minimum specification	Example
Spectrum analyzer	400 kHz to 3 GHz noise floor better than – 127 dBm at 500 MHz	IFR 2383
50 Ω sealed load		
2 turn 25 mm loop		
Low-noise FM demodulator	Residual FM to be less than 2 Hz up to 1 GHz	IFR 2305 + IFR 2041



C2584

Fig. 5-5 Carrier harmonics & spurious check

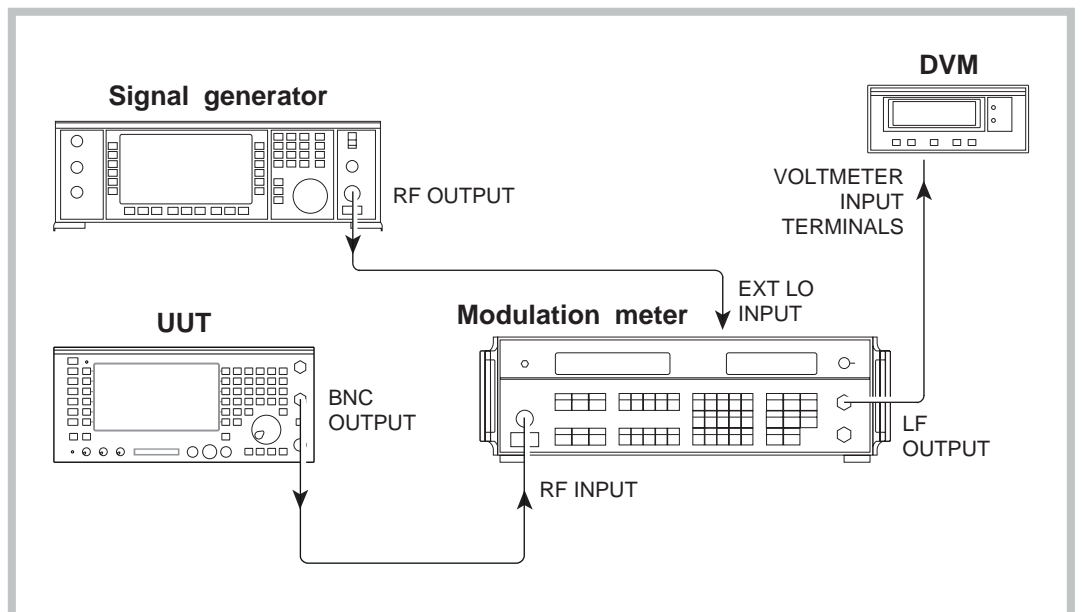
- (1) Refer to Results table 5-6 on page 5-33. Connect the Spectrum analyzer to the BNC socket on the UUT, as shown in Fig. 5-5.
- (2) Set the UUT to [Rx TEST], RF IN/OUT [SELECT] BNC output, [RF Gen], [LEVEL] 0 dBm, [FREQ] 0.4 MHz. All modulation and noise measurements should be switched OFF.
- (3) Tune the Spectrum analyzer to view the harmonics shown in the second harmonic and third harmonic column of Results table 5-6, checking that they are within the above specification.
- (4) Repeat steps (2) and (3) for the remaining frequencies shown in the table.
- (5) Refer to Results table 5-7 on page 5-33. Set the UUT to [Rx TEST], RF IN/OUT [SELECT] BNC output, [RF Gen], [LEVEL] 0 dBm, [FREQ] 0.4 MHz.
- (6) Use the Spectrum analyzer to check that any spurious signals are < -40 dBc. Repeat for UUT carrier frequencies of 500 MHz and 1000 MHz. Repeat for a UUT carrier frequency of 650 MHz checking that any spurious signals are < -30 dBc.



C2585

Fig. 5-6 RF carrier leakage check

- (7) Refer to Results table 5-8 on page 5-33. Connect the test equipment as shown in Fig. 5-6, with the 50 Ω load connected to the BNC socket of the UUT.
- (8) Set the UUT to [Rx TEST], RF IN/OUT [SELECT] BNC output, [RF Gen], [LEVEL] -40 dBm, [FREQ] 501.9873 MHz.
- (9) Tune the Spectrum analyzer to monitor 501.9873 MHz. Set other Spectrum analyzer controls to allow the display of signals below -121 dBm (if using the 2383, this can be set to meter mode).
- (10) Hold the loop 25 mm away from the UUT case and check that the level picked up on the Spectrum analyzer is less than 0.5 μ V PD.
- (11) To confirm the low residual FM of the UUT, the use of an extremely low-noise FM demodulator is necessary; this is achieved by using the IFR 2041 Low-noise signal generator as the local oscillator for the 2305. Connect the test equipment as shown in Fig. 5-7.



C3362

Fig. 5-7 Residual FM checks

- (12) Refer to Results table 5-9 on page 5-33. Set the UUT to [Rx TEST], RF IN/OUT [SELECT] BNC output, [RF Gen], [LEVEL] 0 dBm, [FREQ], 1000 MHz, [Mod Gen], [Gen1/Gen2], to select modulation generator 2, and then [LEVEL], 1 kHz. After this key sequence modulation generator 2 should be providing 1 kHz deviation at 1 kHz modulation rate. Modulation generator 1 should be OFF.
- (13) Set the signal generator into low noise mode 1 and to provide a signal of 55.63889 MHz at 0 dBm.
- (14) Set the Modulation meter to measure FM in a 300 Hz to 3.4 kHz bandwidth with noise averaging on. Select external LO by pressing FREQ TUNE, 0, ENTER. External LO should now appear in the top left of the modulation window display and the frequency window should display the IF frequency of 1.5 MHz ±150 kHz. Note the DEVIATION LEVEL (Hz) displayed on the modulation meter. Set the LF LEVEL control on the front panel of the modulation meter to the horizontal mark and press HOLD ON/OFF.
- (15) Set the DVM to measure AC volts and make a note of the voltage displayed MOD VOLTAGE (V).
- (16) On the UUT press [ON/OFF] to switch modulation generator 2 OFF, then note the RESIDUAL VOLTAGE (V) displayed on the DVM.
- (17) The residual FM in HZ RMS. can now be calculated as follows:-

$$\text{RESIDUAL FM} = \frac{\text{RESIDUAL VOLTAGE} \times \frac{\text{DEVIATION LEVEL}}{\sqrt{2}}}{\text{MOD VOLTAGE}}$$

- (18) Set the UUT RF Generator and the local oscillator to the frequencies shown in Results table 5-9, confirming that the residual FM indicated on the Modulation meter is within the limits shown in the right hand column.

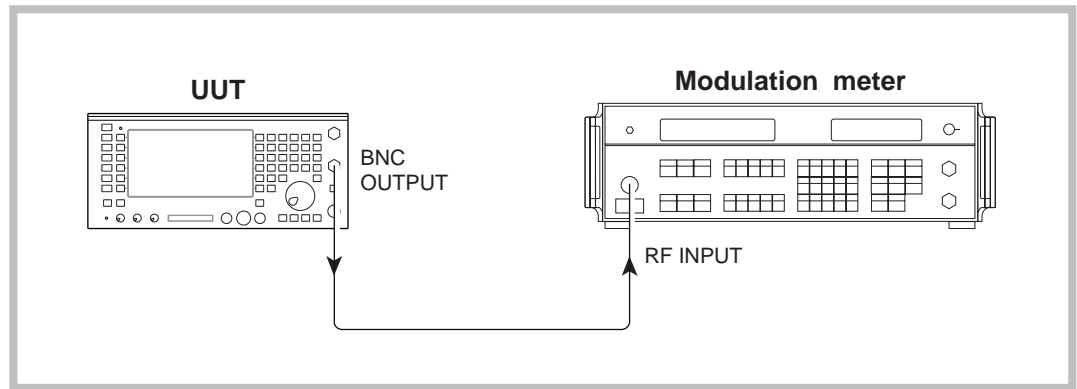
Amplitude modulation

Specification

Carrier range:	400 kHz to 1.05 GHz
Resolution:	1%
Accuracy (up to 85% AM) Carrier frequency 1.5 to 400 MHz.	±7% of setting ± 1 digit for modulation frequency 1 kHz. ±10% of setting ± 1 digit for modulation frequencies of 50 Hz to 5 kHz. ±15% of setting ±1 digit for modulation frequencies from 50 Hz to 15 kHz.
Distortion:	Less than 2% at 1 kHz for modulation depth 30% , CCITT weighted.

Test equipment

Description	Minimum specification	Example
Modulation meter	RF I/P 500 kHz to 400 MHz AM Measurement accuracy up to 85% depth:- ±1% of reading at 1 kHz mod rate. ±2.5% of reading for mod rates from 50 Hz to 15 kHz	IFR 2305



C2587

Fig. 5-8 Internal AM accuracy checks

- (1) Refer to Results table 5-10 on page 5-34. Connect the test equipment as shown in Fig. 5-8 (BNC output socket on UUT).
- (2) Set the UUT to [Rx TEST], RF IN/OUT [SELECT] BNC output, [RF Gen], [LEVEL] 0 dBm, [FREQ] 1.5 MHz, [Mod Gen], [Gen 2], [FREQ] 1 kHz, [LEVEL] 50%.
- (3) Set the Modulation meter to monitor AM in a 0.3 to 3.4 kHz bandwidth.
- (4) Check the Modulation meter for a reading within $\pm 7\%$ of setting ± 1 digit.
- (5) Repeat step 4, but with the UUT RF generator set to each of the remaining carrier frequencies shown in the Results table 5-10 on page 5-34.
- (6) Refer to Results table 5-11 on page 5-34. Set the UUT to [RF Gen], [FREQ] 100 MHz, [LEVEL] 5 dBm, [Δ INC] 1 dB, [Mod Gen], [Gen 2], [LEVEL] 70% and check the Modulation meter for a reading within $\pm 7\%$ of setting ± 1 digit. Using the level decrement arrow key, decrement the RF level by 1 dB and repeat check. Repeat in 1 dB decrements down to -15 dBm.
- (7) Refer to Results table 5-12 on page 5-35. Set the UUT to [RF Gen], [LEVEL] 0 dBm, [Mod Gen], [Gen 2], [LEVEL] 5%.
- (8) Check that the Modulation meter reads within $\pm 7\%$ of setting ± 1 digit. Repeat for UUT AM depths of 10, 20, 30, 40, 50, 60, 70, and 85%.
- (9) Refer to Results table 5-13 on page 5-35. On the UUT, press [FREQ] 65 Hz to set Mod Gen 2 to 65 Hz.
- (10) Set the Modulation meter to monitor AM in a 30 Hz to 50 kHz flat bandwidth.
- (11) Check the Modulation meter for a reading within $\pm 10\%$ of setting ± 1 digit.
- (12) Repeat step 11 with the UUT set to each of the following mod rates:- 140 Hz, 500 Hz, 2 kHz, and 5 kHz.
- (13) Set the UUT mod rate to 15 kHz and check the Modulation meter for a reading within $\pm 15\%$ of setting ± 1 digit.
- (14) Refer to Results table 5-14 on page 5-35. Reset Mod Gen 2 frequency to 1 kHz and level to 30%.
- (15) Set the Modulation meter to monitor AM in a 0.3 to 3.4 kHz bandwidth.
- (16) Connect the LF output from the Modulation meter to the AF input on the UUT. Select the 0.3 to 3.4 kHz AF Filter on the UUT and select distortion measurement.
- (17) Check that the distortion indicated on the UUT display is less than 2 %.

Frequency modulation

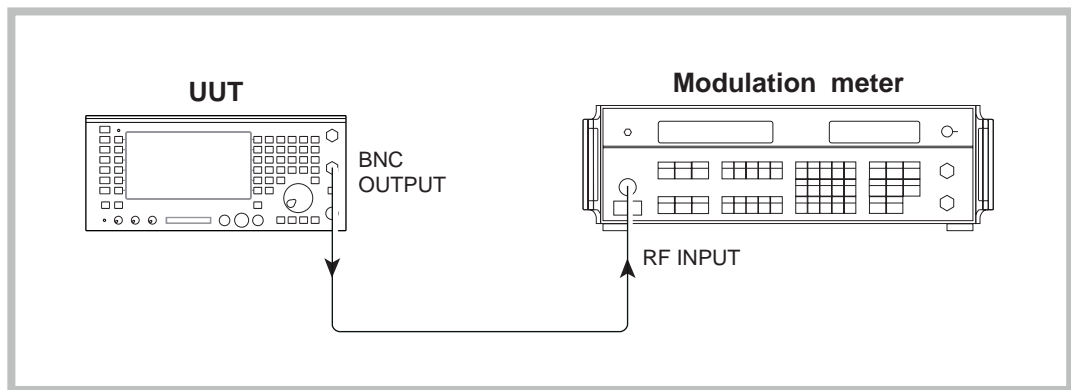
Specification

Carrier range	400 kHz to 1.05 GHz
Accuracy[†]	$\pm 5\% \pm 10$ Hz at 1 kHz modulating frequency. $\pm 10\% \pm 10$ Hz for modulating frequencies from 50 Hz to 15 kHz.
Distortion	Less than 1% at 1 kHz for deviation of 5 kHz, CCITT Weighted.

[†] At low modulation levels the residual AM/FM may become significant

Test equipment

Description	Minimum specification	Example
Modulation meter	RF I/P 500 kHz to 1.05 GHz FM Measurement accuracy $\pm 0.5\%$ of reading ± 1 least significant changing digit at 1 kHz mod rate for deviation > 5 kHz	IFR 2305



C2587

Fig. 5-9 Internal FM accuracy checks

- Refer to Results table 5-15 on page 5-36. Connect the test equipment as shown in Fig. 5-9. (BNC output on UUT).
- Set the UUT to [Rx TEST], RF IN/OUT [SELECT] BNC output, [RF Gen], [LEVEL] 0 dBm, [FREQ] 0.5 MHz, [Mod Gen], [Gen 2], [LEVEL] 10 kHz, [FREQ] 1 kHz. All other modulation generators and noise measurements should be switched OFF.
- Set the Modulation meter to monitor FM in a 50 Hz to 15 kHz bandwidth, Noise averaging on.
- Check the Modulation meter indicates a reading within $\pm 5\% \pm 10$ Hz of the deviation set. Repeat with the UUT set to each of the remaining carrier frequencies shown in the Results table 5-15.
- Refer to Results table 5-16 on page 5-36. Set the UUT to [RF Gen], [FREQ] 600 MHz, [Mod Gen], [Gen 2], [LEVEL] 75 kHz.
- Check the modulation meter indicates a reading within $\pm 5\% \pm 10$ Hz of the deviation set. Repeat with the UUT set to provide deviations of 50 kHz, 25 kHz and 5 kHz.
- Refer to Results table 5-17 on page 5-36. With the deviation still set at 5 kHz, connect the LF output of the Modulation meter to the AF input of the UUT. (Set the LF [LEVEL] control to the brown marker on the Modulation meter.)
- Select the 0.3 to 3.4 kHz AF Filter on the UUT and select distortion measurement.
- Check that the distortion indicated on the UUT is less than 1%.

- (10) Switch distortion measurement off.
- (11) Refer to Results table 5-18 on page 5-36. Set the UUT Mod Gen 2 to provide 10 kHz deviation level at a frequency of 50 Hz.
- (12) Select the 30 Hz to 50 kHz filter on the Modulation meter.
- (13) Check that the Modulation meter reads 10 kHz deviation $\pm 10\% \pm 10$ Hz. Repeat for UUT modulation frequencies of 10 kHz and 15 kHz.

AF output tests

Audio generator output level

Specification

Level range: 0.1 mV to 4 V RMS
Accuracy: $\pm 5\% \pm 1$ resolution 50 Hz to 15 kHz

Test equipment

Description	Minimum specification	Example
DVM	1 % accuracy 50 Hz to 15 kHz	Solatron 7150+



C2588

Fig. 5-10 Audio generator level accuracy checks

- (1) Refer to Results table 5-19 on page 5-37. Connect the test equipment as shown in Fig. 5-10, connecting the UUT AF Gen output socket to the DVM voltmeter input terminals.
- (2) Set the DVM to measure Volts AC RMS.
- (3) Set the UUT to [AF TEST], [Audio Gen] 1 [FREQ] 1 kHz, [LEVEL] 4 V (ensure that AF Gen 2 is OFF). Check that the DVM reads the level set $\pm 5\% \pm 1$ mV. Repeat with frequencies of 50 Hz, 150 Hz, 500 Hz, 2 kHz, 5 kHz, 10 kHz and 15 kHz in turn, checking that the DVM reads the level set $\pm 5\% \pm 1$ mV.
- (4) Set the UUT to [AF Gen 1], [FREQ] 1 kHz, [LEVEL] 20.0 mV. Repeat with the level set to 400 mV. Check that for each level the DVM reads the level set $\pm 5\% \pm 0.1$ mV. Repeat with the level set, in turn, to 1000 mV, 2000 mV and 3000 mV, and check that in each case the DVM reads the level set $\pm 5\% \pm 1$ mV.
- (5) Refer to Results table 5-20 on page 5-37. Repeat the above checks for AF Gen 2 with AF Gen 1 switched OFF.

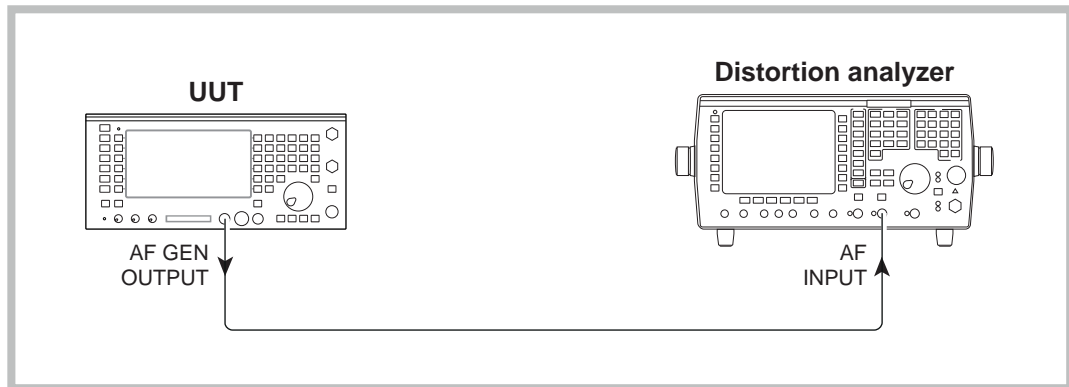
Audio generator distortion

Specification

Distortion:	Less than 0.5% at 1 kHz. Less than 1% from 50 Hz to 15 kHz .
--------------------	---

Test equipment

Description	Minimum specification	Example
Distortion analyzer	Capable of measuring distortion from 1 kHz to 15 kHz down to 0.1%.	IFR 2965 or HP8903B



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Fig. 5-11 Audio generator signal purity checks

- (1) Refer to Results table 5-21 on page 5-38. Connect the UUT AF GEN output to the AF input of the distortion meter, as shown in Fig. 5-11.
- (2) Set the UUT to [AF TEST], [Audio Gen], [FREQ] 1 kHz, [LEVEL] 4 V. Audio Gen 1 should be set to sinewave and Audio Gen 2 should be OFF.
- (3) Set the Distortion meter to measure distortion at 1 kHz in a 0.3 to 3.4 kHz bandwidth..
- (4) Check that the distortion indicated is less than 0.5%.
- (5) Repeat step (4) with AF Gen 1 level set to 100 mV.
- (6) Set the Distortion meter to measure distortion in a 20 kHz Low-pass bandwidth.
- (7) Set AF Gen 1 to provide 4 V at a frequency of 2 kHz. Check that the distortion indicated on the Distortion meter is less than 1%. (If a 2965 is being used, see the Operating Manual for instructions on setting distortion measurement to different frequencies.) Repeat at 5 kHz. Set the low-pass bandwidth on the distortion meter to NONE and repeat with AF Gen 1 set to provide 15 kHz.
- (8) Refer to Results table 5-22 on page 5-38. Repeat the above procedure, except this time with AF Gen 1 switched OFF and AF Gen 2 ON.

Audio generator frequency

This is a functional check only. The Audio generator frequency is derived digitally and provided that the hardware is operational its accuracy will be maintained. The instrument's internal reference frequency is checked elsewhere. This check is listed at this point as it is one of the AF generator tests, but it should be carried out after the UUT audio frequency meter has been checked (see AF input tests; AF frequency meter).

Specification

Frequency accuracy:	0.01 Hz \pm frequency standard < 180 Hz
	0.1 Hz \pm frequency standard >180 Hz

- (1) Refer to Results table 5-23 on page 5-38. Connect the UUT AF GEN OUT socket to the UUT AF INPUT socket.
- (2) Set the UUT to [AF TEST], [AF Filter], [50 kHz LP] to set the Audio Input filter to 50 kHz Low-pass.
- (3) Set [Audio Gen], [LEVEL] 1 V, [FREQ] 10 Hz. Audio generator 2 should be switched OFF. Check that the frequency indicated on the UUT audio counter is within the limits shown in Results table 5-23. Repeat with the remaining frequencies shown in the table.
- (4) Refer to Results table 5-24 on page 5-39. Repeat checks with AF GEN 2.

AF input tests

Audio frequency meter

This test confirms the accuracy of the audio counter hardware. Overall accuracy is governed by the instrument reference frequency. The reference is checked independently elsewhere. Note: If the LF generator is not available then the Audio generator frequency check will confirm that the audio frequency meter is functional.

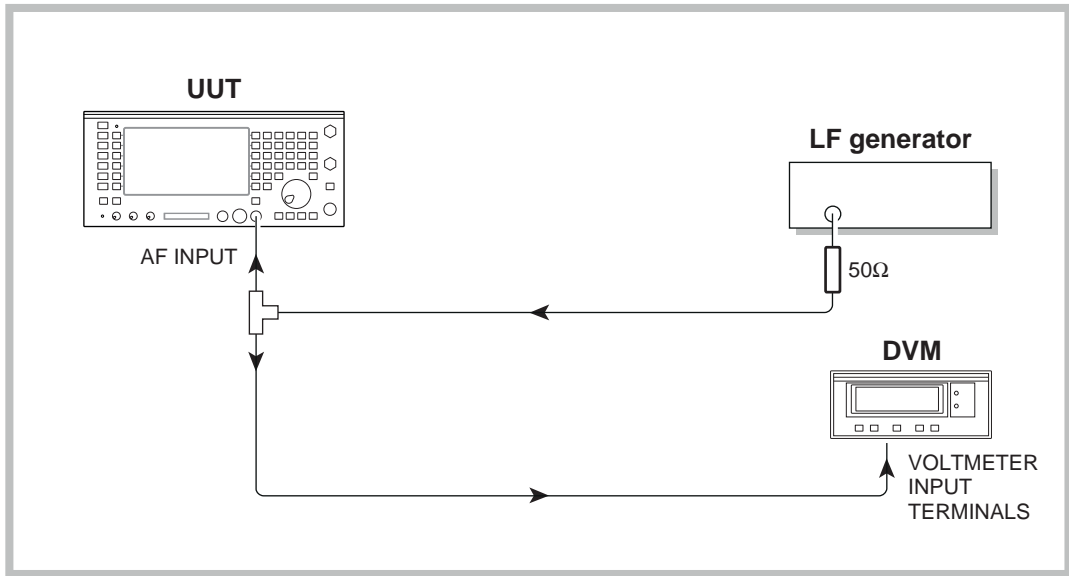
Specification

Frequency range:	20 Hz to 20 kHz
Resolution:	0.1 Hz, less than 10 kHz 1 Hz, at 10 kHz and above.
Accuracy:	As frequency standard \pm digit \pm resolution
Sensitivity:	50 mV

Test equipment

Description	Minimum specification	Example
LF generator	20 Hz to 20 kHz frequency external standard In/Out	HP 3325B
DVM	1 % accuracy 20 Hz to 20 kHz	Solatron 7150+

- (1) Refer to Results table 5-25 on page 5-39. Connect the equipment as shown in Fig. 5-12 connecting to the UUT AF input socket. The frequency standards of the UUT and LF generator should be locked together. The 50 Ω load is in circuit because the LF generator used indicates level across 50 Ω .
- (2) Set the UUT to [AF TEST]. Press [AF Filter], [50kHz LP] to set the Audio Input filter to 50 kHz Low-pass.
- (3) Set the DVM to monitor Volts AC.
- (4) Set the LF generator to the first frequency shown in the Results table 5-25, and adjust the level for an indication of 50 mV RMS on the DVM. Check that the frequency indicated on the UUT audio counter is within the limits shown. Repeat for the remaining frequencies in the table.



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Fig. 5-12 Audio frequency meter check

**Audio voltmeter
Specification**

- Level accuracy:** $\pm 3\% \pm 3 \text{ mV} \pm \text{resolution}$ 20 Hz to 50 kHz (DC and 20 Hz to 50 kHz when DC coupled)
- Resolution:** 1 mV or 1% of reading.

Test equipment

Description	Minimum specification	Example
LF generator	50 Hz to 50 kHz 30 mV to 5 V RMS.	IFR 2965
DC power supply	0 to 50 V	
DVM	DC measurement and AC measurement 20 Hz to 50 kHz.	Solatron 7150+

- (1) Refer to Results table 5-26 on page 5-40. Connect the equipment as shown in Fig. 5-13, connecting the LF generator output to the UUT AF input and via a T-piece to a DVM.
- (2) Set the UUT to [AF TEST] press [AF Filter], [50 kHz LP] to set the Audio Input filter to 50 kHz Low-pass. Press AC/DC coupling until AC coupled is displayed.
- (3) Set the DVM to measure Volts AC and the LF generator to frequency 1 kHz , level 30 mV RMS (adjust until the DVM indicates as close to 30 mV as possible). Check that the level indicated on the UUT voltmeter is within $\pm 3\% \pm 3 \text{ mV} \pm \text{resolution}$ of the level indicated on the DVM.
- (4) Repeat step 3 with LF generator levels of 200 mV, 0.4 V, 0.8 V, 2 V, 4.5 V.
- (5) This step is a functional check only and confirms that the audio filters switch in correctly with minimal insertion loss. Set the UUT AF filter to 15 kHz LP and check that the UUT voltmeter indicates within $\pm 6\% \pm 3 \text{ mV} \pm \text{resolution}$ of the level measured with the 50 kHz LP. Repeat with the 0.3 to 3.4 kHz band-pass filter. Set the LF generator to 100 Hz and set the UUT filter back to 50 kHz LP. Note the reading and then set the UUT filter to 300 Hz LP. Check that the UUT voltmeter indicates within $\pm 6\% \pm 3 \text{ mV} \pm \text{resolution}$ of the level measured with the 50 kHz LP.

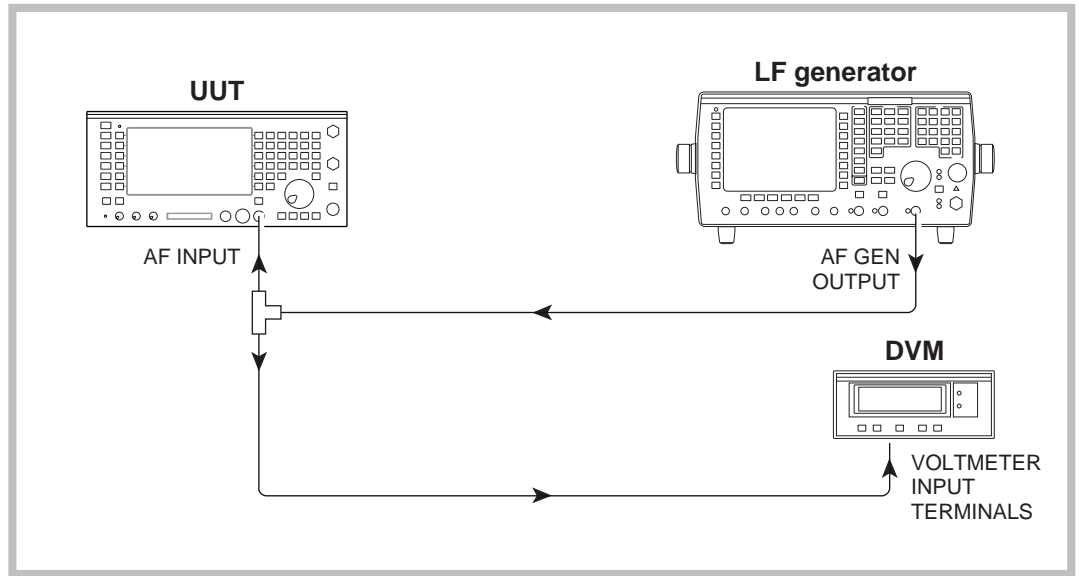


Fig. 5-13 Audio voltmeter level accuracy checks

- (6) Set the UUT AF filter to 50 kHz LP.
- (7) Set the LF generator to frequency 50 Hz level 1 V RMS (adjust until DVM indicates as close to 1 V as possible). Check that the level indicated on the UUT voltmeter is within $\pm 3\%$ ± 3 mV \pm resolution of the level indicated on the DVM.
- (8) Repeat step 7 with LF generator frequencies of 100 Hz, 500 Hz, 10 kHz, 30 kHz and 50 kHz.
- (9) Set the UUT AF input to DC coupled and substitute the LF generator with the DC power supply. Set the external DVM to monitor DC volts.
- (10) Set the DC supply to 25 V (adjust until DVM indicates as close to 25 V as possible). Check that the level indicated on the UUT voltmeter is within $\pm 3\%$ ± 3 mV \pm resolution of the level indicated on the DVM. Repeat this step with the DC supply set to 50 V.

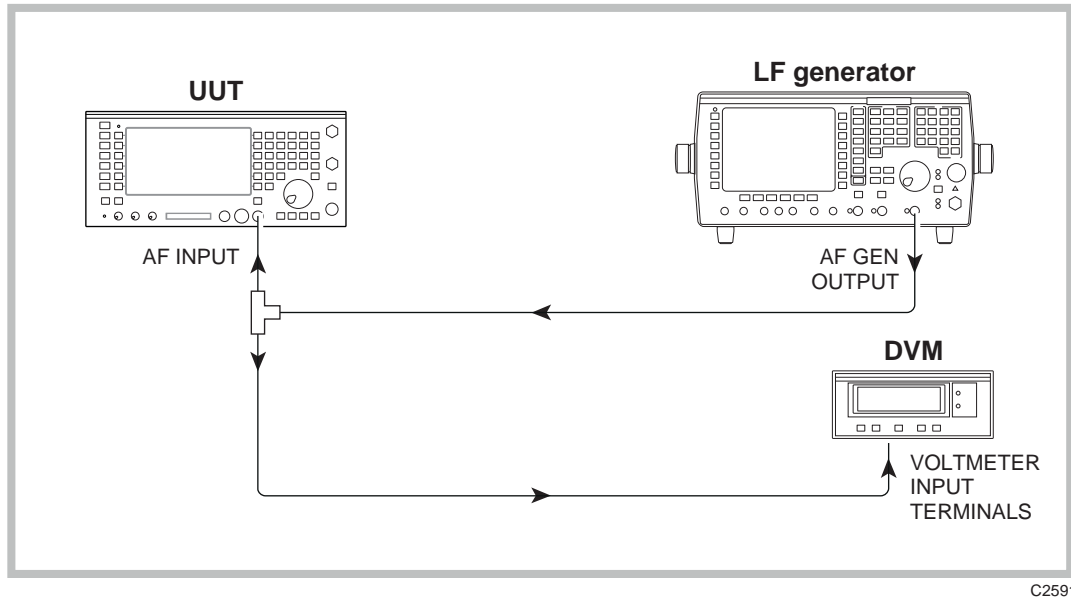
Audio oscilloscope

Specification

- Voltage accuracy:** $\pm 5\%$ of full scale DC to 50 kHz (3 Hz to 50 kHz AC coupled).
- Ranges:** 10 mV/div to 20 V/div in a 1, 2, 5 sequence.
- Graticule:** 10 horizontal by 6 vertical.

Test equipment

Description	Minimum specification	Example
LF generator	10 Hz to 20 kHz 10 mV to 12 V peak to peak.	IFR 2965
DVM	DC measurement and AC measurement 20 Hz to 20 kHz.	Solatron 7150+
DC PSU	0 to 30 V	



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Fig. 5-14 Audio oscilloscope check

- (1) Refer to Results table 5-27 on page 5-40. Connect the equipment as shown in Fig. 5-14, connecting to the AF input of the UUT.
- (2) Set the UUT to [AF TEST], [Scope/Bar], [Scope], [AC DC] set to AC coupling. Set the Scope timebase to 200 μ s/div.
- (3) Set the LF generator to provide 1 kHz at each of the levels shown in Results table 5-27, at the same time selecting the relevant vertical scale on the UUT. In each case adjust the LF generator level until the trace occupies the full six divisions. Set the DVM to measure Volts AC. Note the level on the DVM and check that it lies within the limits shown in the table.
- (4) Disconnect the LF generator.
- (5) Set the UUT oscilloscope to 5 V/div and the AF input to DC coupled. With no signal applied use the front panel SCOPE position control to set the trace onto the bottom graticule line.
- (6) Set the DVM to measure DC volts.
- (7) Connect the DC supply in place of the LF generator and adjust its level until the oscilloscope trace sits on the graticule line two divisions down from the top of the display. Check that the DVM indicates a level within the limits shown in the above table.
- (8) Temporarily remove the DC PSU, set the UUT oscilloscope to 10 V/div and use the front panel SCOPE position control to set the trace onto the bottom graticule line. Reconnect the DC PSU and adjust its level until the oscilloscope trace sits on the graticule line two divisions up from the bottom of the display. Check that the DVM indicates a level within the limits shown in the above table. Repeat for the final range shown in the above table but this time adjusting the DC PSU level until the trace sits on the graticule line 1 division up from the bottom of the display.
- (9) Remove the DC PSU and reconnect the LF generator. Set the DVM to measure Volts AC.
- (10) Refer to Results table 5-28 on page 5-41. Set the UUT to 1 V/div, 50 ms/div.
- (11) Set the LF generator to the first frequency shown in Results table 5-28 at the same time selecting the relevant timebase on the UUT. Adjust the LF generator level until the trace occupies the full six divisions. Note the level on the DVM and check that it lies within the limits shown in the table.

AF distortion & SINAD meter

Specification

Frequency range:	1 kHz.
Distortion meter accuracy	$\pm 5\%$ of reading $\pm 0.5\%$ distortion.
SINAD meter accuracy	± 1 dB.

- (1) Refer to Results table 5-29 on page 5-41. Connect UUT AF INPUT to UUT AF GEN OUT.
- (2) Set the UUT to [AF TEST], [Audio Gen], [LEVEL] 1 V. Press [Gen 1/Gen2] to select AF Gen 2, then [FREQ] 400 Hz, [LEVEL] 20 mV, [ON]. This should cause AF Gen 1 to be set to 1 kHz, 1 V, and AF Gen 2 to 400 Hz, 20 mV. If these values are not set, make the required adjustments to achieve them.
- (3) Press [Return], [DIST/S-N], [DIST'N] to switch the UUT distortion meter on.
- (4) Check that the distortion meter reads between 1.4 and 2.6% distortion, i.e. 2% distortion $\pm 5\%$ of reading $\pm 0.5\%$ distortion.
- (5) Set AF Gen 2 level to 250 mV.
- (6) Select AF Gen 1 level and adjust until the UUT voltmeter reads 1.00 V.
- (7) Check that the distortion meter reads between 23.2 and 26.8% distortion, i.e. 25% distortion $\pm 5\%$ of reading $\pm 0.5\%$ distortion.
- (8) Press [Return], [DIST/S-N], [Sinad] to switch the UUT SINAD meter on.
- (9) Check that the SINAD meter reads 12 dB ± 1 dB.

RF input tests

Modulation analyzer - FM

Specification

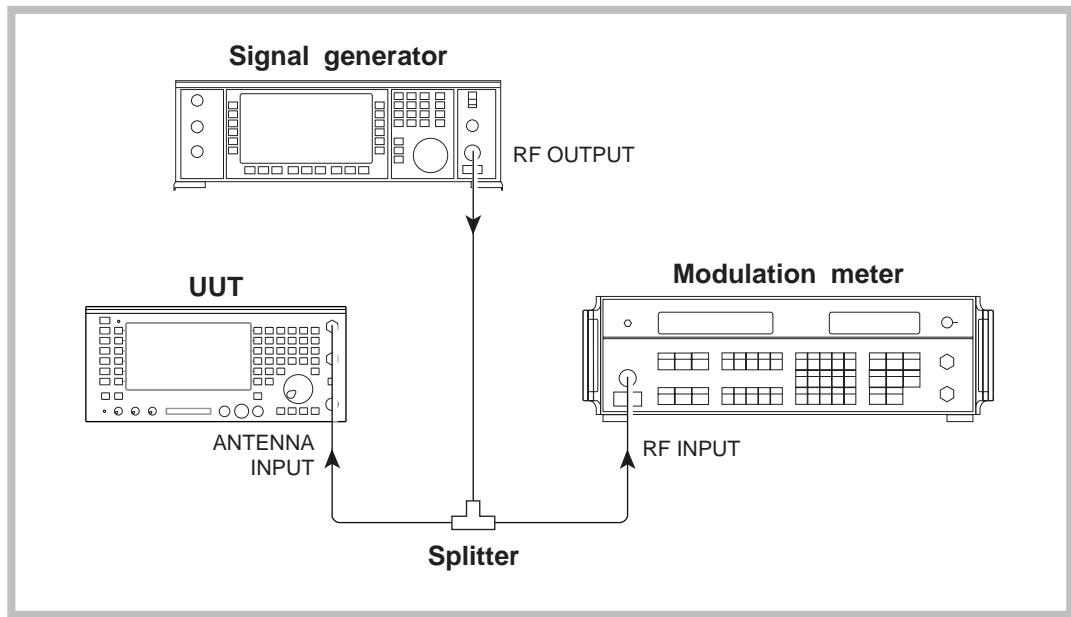
Frequency range:	100 kHz to 1.05 GHz.
Modulation frequency range:	10 Hz to 15 kHz.
Deviation range:	0 to 75 kHz.
Resolution:	10 Hz below 2 kHz deviation 1% above 2 kHz deviation
Accuracy (see Note 1)	$\pm 5\% \pm$ resolution at 1 kHz modulation frequency. $\pm 7.5\% \pm$ resolution for modulation frequencies from 50 Hz to 10 kHz.
Demodulation distortion	Less than 2% at 1 kHz and 5 kHz FM,
Demodulation scope accuracy	$\pm 10\%$
Demodulation output socket	200 mV peak to peak $\pm 10\%$ per 1 kHz deviation
Demodulation filters	300 Hz LP, 300 Hz HP, 3 kHz LP, 0.3 to 3.4 kHz BP, 15 kHz LP, 50 kHz LP, 750 μ s de-emphasis
Residual FM:	Less than 30 Hz (300 Hz to 3.4 kHz)

Note 1:

At low modulation levels, the residual AM/FM may become significant.

Test equipment

Description	Minimum specification	Example
RF signal generator	5.5 MHz to 1 GHz Deviation 0 to 75 kHz Modulation rate 10 Hz to 15 kHz.	IFR 2041
Modulation meter	RF I/P 5.5 MHz to 1 GHz FM Measurement accuracy $\pm 0.5\%$ of reading ± 1 least significant changing digit at 1 kHz mod rate for deviation > 5 kHz.	IFR 2305
Power splitter	6 dB 50 Ω 5.5 MHz to 1 GHz.	WEINSCHEL 1870A
DVM	1 % accuracy 1 kHz	Solatron 7150+



C2592

Fig. 5-15 Modulation meter FM

- (1) Refer to Results table 5-30 on page 5-41. Connect the equipment as shown in Fig. 5-15, connecting the incoming signal to the antenna input socket of the UUT.
- (2) Set the Modulation meter to monitor FM in a 50 Hz to 15 kHz bandwidth, noise averaging on.
- (3) Set the UUT to [Tx TEST], RF IN/OUT [SELECT] antenna BNC input socket. From the power up default, the instrument should already be set to demodulate FM with an IF filter of 30 kHz and AF filter of 0.3 to 3.4 kHz selected. Check that this is the case and select if necessary.
- (4) On the UUT, set [Tx Freq] 5.5 MHz. Set the RF signal generator to provide a signal of 5.5 MHz with 20 kHz deviation at 1 kHz modulation rate. Set the RF level to 6 dBm. (If a 2041 is being used then it should be set to normal noise mode.)
- (5) Check that the deviation level indicated on the UUT is within $\pm 5\%$ \pm resolution of the deviation indicated on the external Modulation meter.
- (6) Repeat steps 4 and 5 for RF carrier frequencies of 500 MHz and 1000 MHz.
- (7) Manually tune the UUT to 300 MHz and set the RF signal generator to provide 300 MHz with 20 kHz deviation.
- (8) Select the 50 kHz low-pass filter by pressing [return], [Mod Meter], [AF Filter], [50kHz LP], and check the UUT still indicates 20 kHz deviation. (Functional check only.)

- (9) Select the 300 Hz high-pass filter by pressing *[more]*, *[300Hz HP]*, and check that the UUT still indicates 20 kHz deviation. (Functional check only.)
- (10) Select the 3 kHz low-pass filter and check that the UUT still indicates 20 kHz deviation. (Functional check only.)
- (11) *Refer to Results table 5-31 on page 5-41.* Select the 300 Hz low-pass filter by pressing *[more]*, *[300Hz LP]*.
- (12) Set the RF signal generator to provide a signal of 300 MHz with 20 kHz deviation at 50 Hz modulation rate. On the external Modulation meter select the 10 Hz to 300 kHz filter. Check that the deviation level indicated on the UUT is within $\pm 7.5\% \pm$ UUT resolution of the deviation indicated on the modulation meter.
- (13) Set the RF signal generator modulation rate to 5 kHz and the UUT AF Filter to 15 kHz LP. Check that the deviation level indicated on the UUT is within $\pm 7.5\% \pm$ UUT resolution of the deviation indicated on the Modulation meter.
- (14) Set the RF signal generator modulation rate to 10 kHz and the UUT AF Filter to 50 kHz LP. Check that the deviation level indicated on the UUT is within $\pm 7.5\% \pm$ UUT resolution of the deviation indicated on the Modulation meter.
- (15) *Refer to Results table 5-32 on page 5-41.* On the UUT select an AF filter of 0.3 to 3.4 kHz and an IF filter of 3 kHz.
- (16) Set the external Modulation meter bandwidth to 50 Hz to 15 kHz.
- (17) Set the RF signal generator modulation rate to 1 kHz and set 250 Hz deviation.
- (18) Check that the deviation level indicated on the UUT is within $\pm 5\% \pm$ UUT resolution of the deviation indicated on the Modulation meter..
- (19) On the UUT select an IF filter of 30 kHz . Set the RF signal generator to provide a deviation of 10 kHz and check that the deviation level indicated on the UUT is within $\pm 5\% \pm$ UUT resolution of the deviation indicated on the Modulation meter.
- (20) On the UUT select an IF filter of 300 kHz. Set the RF signal generator to provide a deviation of 50 kHz and check that the deviation level indicated on the UUT is within $\pm 5\% \pm$ UUT resolution of the deviation indicated on the Modulation meter. Repeat at 75 kHz.
- (21) *Refer to Results table 5-33 on page 5-42.* Select the UUT demodulation oscilloscope by pressing *[Return]*, *[Scope/Bar]*, *[Scope]*. Using the oscilloscope horizontal and vertical soft keys select a vertical scale of 25 kHz/div and a horizontal scale of 200 μ s/div.
- (22) Adjust the deviation level from the RF signal generator until the 1 kHz trace on the oscilloscope occupies the full six deviations.
- (23) Check that the deviation indicated on the external Modulation meter is between 67.5 and 82.5 kHz.
- (24) Adjust the deviation level from the RF signal generator until the external Modulation meter reads 75.0 kHz deviation. Leave all settings unaltered while carrying out step 25.
- (25) *Refer to Results table 5-34 on page 5-42.* Connect the DEMOD OUT socket on the rear of the UUT to the DVM. Set the DVM to monitor Volts AC and check that the level indicated is between 4.77 V and 5.83 V.
- (26) Set the RF signal generator modulation rate to 2 kHz.
- (27) On the UUT press *[Return]*, *[Mod Meter]*, *[Deemph]* to switch de-emphasis on.
- (28) Check that the deviation reading on the UUT drops by approximately half, i.e. to 37.5 kHz. (functional check).
- (29) Press *[Deemph]* to switch the de-emphasis filter off and then *[Return]*, *[Scope/Bar]*, *[Bar Chart]*, *[Return]*, to switch the oscilloscope off.
- (30) Remove the splitter and Modulation meter and connect the RF signal generator directly to the UUT antenna input.

- (31) Refer to Results table 5-35 on page 5-42. Set the RF signal generator to provide a signal of 300 MHz at 6 dBm with 5 kHz deviation at 1 kHz modulation rate.
- (32) On the UUT select the 0.3 to 3.4 kHz AF filter and the 30 kHz IF filter.
- (33) On the UUT switch distortion measurement ON and check that the distortion reading indicates less than 2%.
- (34) Set the UUT to [Tx FREQ] 300 MHz and set the RF signal generator to provide a signal of 300 MHz with 5 kHz deviation at 1 kHz modulation rate. (The 2041 should be set to low noise mode.)
- (35) Note the voltage reading on the DVM connected to the DEMOD OUT socket of the UUT (*Reading 1*).
- (36) Switch the RF signal generator modulation off and note the reading on the DVM (*Reading 2*).
- (37) Calculate the residual FM as shown below and check that it indicates 35 Hz or less (functional check only).

$$(Reading\ 2 \div Reading\ 1) \times 5000$$

Modulation analyzer - AM

Specification

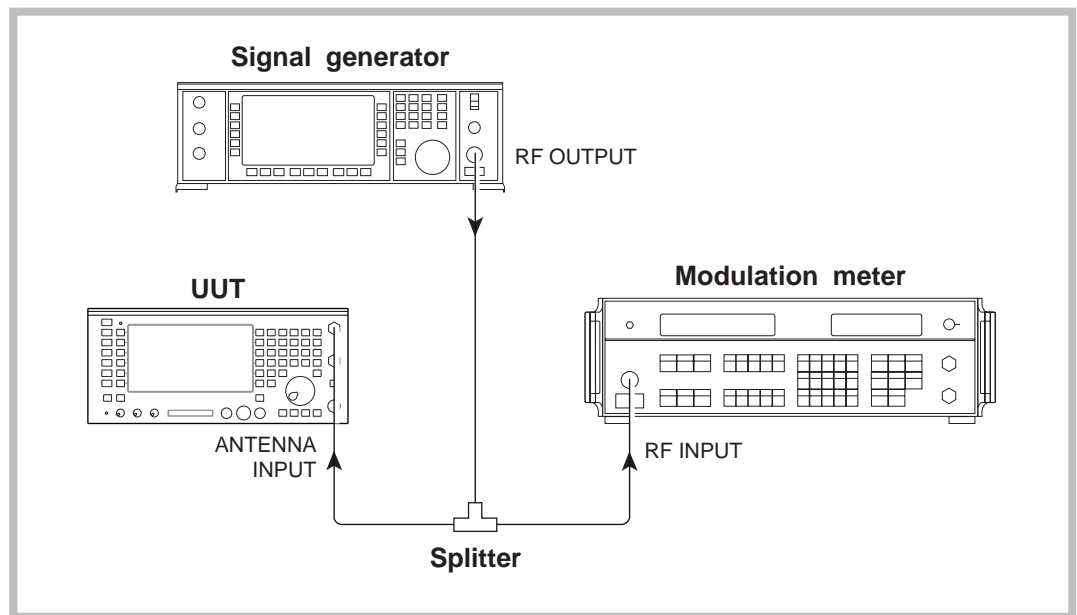
- Frequency range:** 100 kHz to 1.05 GHz.
- Modulation frequency range:** 10 Hz to 15 kHz.
- AM depth range:** 0 to 99% (manually tuned)
0 to 90% below 100 MHz
0 to 80% from 100 to 400 MHz
- Resolution:** 1% AM
- Accuracy (see Note 1)** ±5% of reading ±1 digit at 1 kHz.
±8.5% of reading ±1 digit from 50 Hz to 10 kHz
- Demodulation distortion (1):** Less than 2% at 1 kHz & 30% AM (CCITT weighted).
- Residual AM:** Less than 1% (0.3 to 3.4 kHz)

Note 1:

- (1) At low modulation levels, the residual AM/FM may become significant.

Test equipment

Description	Minimum specification	Example
RF signal generator	500 kHz to 1 GHz AM depth 0 to 95% Modulation rate 30 Hz to 15 kHz.	IFR 2041
Modulation meter	RF I/P 500 kHz to 1 GHz AM Measurement accuracy ±1% of reading ±1 least significant changing digit at 1 kHz mod rate for depths up to 95%.	IFR 2305
Power splitter	6 dB 50 Ω 500 kHz to 1 GHz.	WEINSCHEL 1870A



C2592

Fig. 5-16 Modulation analyzer - AM

- (1) Refer to Results table 5-36 on page 5-42. Connect the equipment as shown in Fig. 5-16, connecting the incoming signal to the antenna input socket of the UUT.
- (2) Set the Modulation meter to monitor AM in a 50 Hz to 15 kHz bandwidth, Noise averaging on.
- (3) Set the UUT to [Tx TEST], RF IN/OUT [SELECT] antenna input socket, [Mod Meter]. Press the [AM/FM] soft key to set the UUT to demodulate AM. From the power up default, the instrument should already have an IF filter of 30 kHz and AF filter of 0.3 to 3.4 kHz selected. Check that this is the case and select if necessary.
- (4) Tune the UUT to 500 kHz by pressing [Return], [Tx Freq] 500 kHz. Set the RF signal generator to provide a signal of 500 kHz with 70% AM at 1 kHz modulation rate. Set the RF level to 6 dBm. (If a 2041 is being used, it should be set to normal noise mode.)
- (5) Check that the AM depth indicated on the UUT is within $\pm 5\%$ of reading ± 1 digit of the depth indicated on the external Modulation meter.
- (6) Repeat steps 4 and 5 for RF carrier frequencies of 500 MHz and 1050 MHz.
- (7) Refer to Results table 5-37 on page 5-42. On the UUT, select the 300 Hz low-pass filter and TX FREQ 100 MHz.
- (8) Set the external modulation monitor bandwidth to 30 Hz to 50 kHz.
- (9) Set the RF signal generator to provide a signal of 100 MHz with 70% depth at 50 Hz modulation rate. Check that the modulation depth indicated on the UUT is within $\pm 8.5\%$ of reading ± 1 digit of the depth indicated on the Modulation meter.
- (10) On the UUT select the 50 kHz low-pass AF filter and the 300 kHz IF filter. Change the modulation rate on the RF signal generator to 10 kHz and check that the modulation depth indicated on the UUT is within $\pm 8.5\%$ of reading ± 1 digit, of the depth indicated on the Modulation meter.
- (11) Refer to Results table 5-38 on page 5-43. When finished, select the 0.3 to 3.4 kHz filter on both the UUT and the external Modulation meter. Select the 30 kHz IF filter on the UUT.
- (12) Set the RF signal generator modulation rate to 1 kHz and set 5% AM depth.
- (13) Check that the AM depth indicated on the UUT is within $\pm 5\%$ of reading ± 1 digit of the depth indicated on the Modulation meter. Repeat with the RF signal generator set to provide depths of 20%, 50%, 80%, and 95%.

- (14) Refer to Results table 5-39 on page 5-43. Select the Oscilloscope on the UUT. Set a timebase of 500 μ s/div and a vertical scale of 10%/div.
- (15) Set the RF signal generator to provide 60% AM, adjusting this level until the demodulated signal on the display occupies the full six divisions. Check that the modulation indicated on the external Modulation meter is 60% \pm 10%.
- (16) Remove the splitter and Modulation meter and connect the RF signal generator directly to the UUT BNC input.
- (17) Refer to Results table 5-40 on page 5-43. Set the RF signal generator to provide a signal of 100 MHz at 6 dBm with 30% depth at 1 kHz modulation rate.
- (18) On the UUT, switch the oscilloscope off by selecting bar chart then select distortion measurement ON.
- (19) Check that the distortion reading on the UUT indicates less than 2%

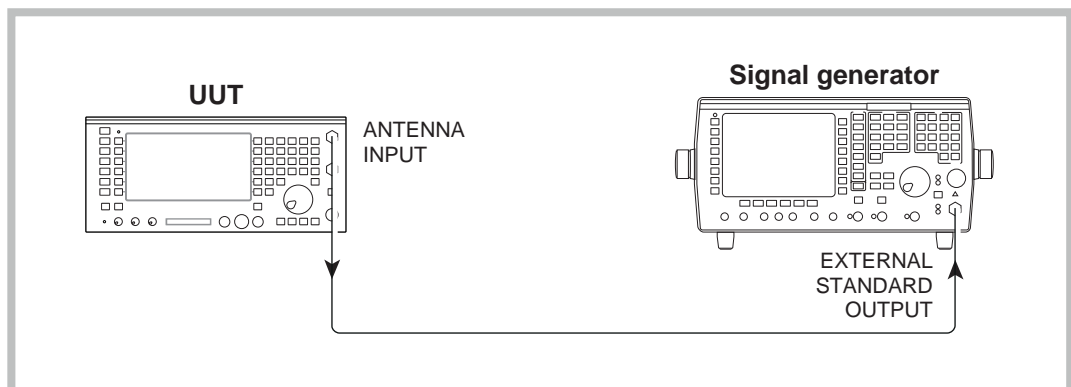
RF frequency meter

Specification

Frequency range:	100 kHz to 1.05 GHz
Resolution:	1 Hz or 10 Hz selectable
Accuracy	As frequency standard \pm resolution
Sensitivity autotuned	5 mW (N-type), 0.05 mW (antenna port)
Sensitivity manual tuned	-34 dBm (N-type), -60 dBm (antenna port)

Test equipment

Description	Minimum specification	Example
RF signal generator	100 kHz to 1.05 GHz	IFR 2965 or IFR 2041
RF power meter	\pm 0.1 dB from 10 MHz to 1 GHz	IFR 6960/A/B + 6920 sensor



C2593

Fig. 5-17 RF frequency meter

- (1) Refer to Results table 5-41 on page 5-43. Connect the equipment as shown in Fig. 5-17, connecting the incoming signal to the antenna input socket of the UUT. Lock the Service Monitor external standard input to the external standard output of the signal generator.
- (2) Set the UUT to [Tx TEST], RF IN/OUT [SELECT] antenna BNC input socket. Press [HELP/SETUP], [Setup], and toggle RF counter resolution until 1 Hz is displayed in reverse field, then press [Return], [Return] to get back to the TX test display.
- (3) On the UUT, press [Tx Freq] 10 MHz. Set the RF signal generator to provide a signal of 10 MHz at an RF level of -60 dBm. Check this level by removing the RF test signal connection from the UUT and applying it to the RF power meter. Adjust the level if necessary, then reconnect the UUT.
- (4) Check that the offset indicated on the UUT is 0 Hz ±1 Hz.
- (5) Repeat steps 3 & 4 for frequencies of 500 MHz and 1.05 GHz.
- (6) Refer to Results table 5-42 on page 5-44. Press the [Auto Tune] key on the UUT.
- (7) Set the RF signal generator to provide a signal of 1000 MHz at a level of -13 dBm (check and set this level on the power meter). Check that the UUT autotunes to the incoming frequency and the Frequency counter indicates the frequency ± 1 Hz. Repeat at 500 MHz and 10 MHz.
- (8) Disconnect the external reference from the UUT and connect an external reference with an accuracy of 1 part in 10⁹ or better to the RF signal generator.
- (9) Refer to Results table 5-43 on page 5-44. Set the RF signal generator to provide a frequency of 1000 MHz at a level of 0 dBm.
- (10) Check that the UUT indicates a frequency between 999.999500 MHz and 1000.000500 MHz. If the instrument is fitted with option 3, the high stability (OCXO) internal frequency standard, check that the reading falls between the limits 999.999750 and 1000.000250. The test limits in this step are for guidance and assume that the internal frequency standard has been recently adjusted. Ageing and stability have to be considered when establishing the *real* test limits.

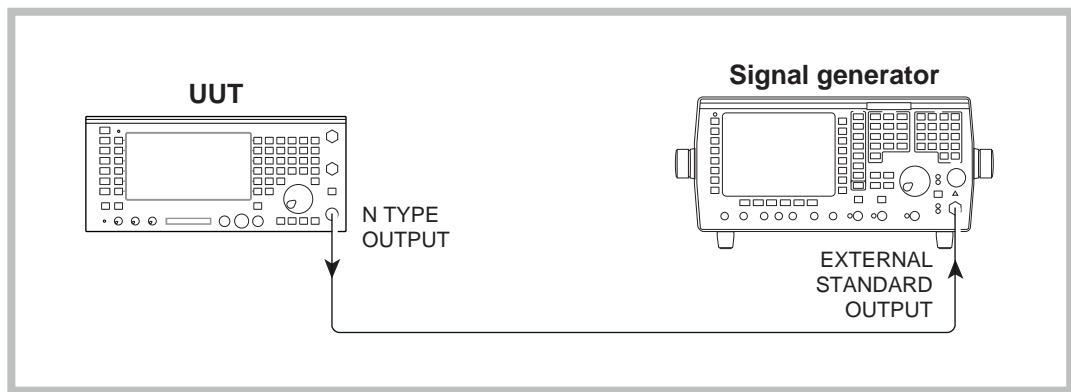
RF spectrum analyzer

Specification

Frequency range:	100 kHz to 1.0 GHz.
Resolution bandwidth	300 Hz, 3, 30, 300 kHz, 3 MHz.
On screen dynamic range:	80 dB.
On screen linearity:	Typically ± 2 dB ± resolution (10 dB/div) (10 dB above the noise floor)
Resolution:	0.1 dB on 2 dB/ division 0.5 dB on 10 dB/ division
Level flatness	±1 dB ± resolution over 50 MHz span.

Test equipment

Description	Minimum specification	Example
RF signal generator	100 kHz to 1 GHz. Level accuracy ±0.85 dB	IFR 2041
RF power meter	±0.1 dB from 10 MHz to 1 GHz	IFR 6960/A/B + 6912 sensor



C2594

Fig. 5-18 RF spectrum analyzer checks

- (1) Refer to Results table 5-44 on page 5-44. Set the UUT to [SPEC ANA], [Centre Freq] 101 MHz, [Span] 1 kHz, BNC antenna input socket, [Ref Level] -30.0 dBm.
- (2) With nothing connected to the UUT, check that the noise floor is on or below the bottom graticule line of the display. (80 dBm dynamic range.)
- (3) Connect the equipment as shown in Fig. 5-18, connecting the incoming signal to the N-type input socket of the UUT. Set the UUT to N-type input.
- (4) On the UUT, select [Res BW] [Manual Res BW], [30 kHz], [Ref Level] to 0 dBm.
- (5) Set the RF signal generator to provide a signal at 101 MHz at a level of 0 dBm. Adjust the RF signal generator level until the trace sits at the top of the screen. Check that the level set on the RF signal generator is 0 dBm \pm 4 dB (Functional test only). Note this reading (reading 1).
- (6) Reduce the RF signal generator RF level until the trace sits on the graticule line 1 division down from the top line. Check that the level set on the RF signal generator is 10 dB down from reading 1 \pm 3 dB (functional test only).
- (7) Reduce the RF signal generator RF level until the trace sits on the graticule line 2 divisions down from the top line. Check that the level set on the RF signal generator is 20 dB down from reading 1 \pm 3 dB (functional test only).
- (8) Reduce the RF signal generator RF level until the trace sits on the graticule line 3 divisions down from the top line. Check that the level set on the RF signal generator is 30 dB down from reading 1 \pm 3 dB (functional test only).
- (9) Reduce the RF signal generator RF level until the trace sits on the graticule line 4 divisions down from the top line. Check that the level set on the RF signal generator is 40 dB down from reading 1 \pm 3 dB (functional test only).
- (10) Reduce the RF signal generator RF level until the trace sits on the graticule line 5 divisions down from the top line. Check that the level set on the RF signal generator is 50 dB down from reading 1 \pm 3 dB (functional test only).
- (11) On the UUT press [Return], [Return],[Centre Freq], 100 MHz, [Span], 52 MHz, [Res BW], [Manual Res BW], [3 MHz], [Vert Scale] toggle [10/2 dB/DIV] until 2 dB per division is displayed.
- (12) Set the RF signal generator to 100 MHz and -6.0 dBm. Check and set this level on the power meter and then connect to the UUT.
- (13) Make a note of how many divisions down from the top of screen that the peak of the signal appears.
- (14) Repeat steps 12 and 13 for RF signal generator frequencies of 75 MHz, 88 MHz, 112 MHz and 125 MHz.

- (15) Check that the difference between the highest and the lowest point noted is less than 1.1 divisions.
- (16) To functionally test the look/listen facility first set the following on the UUT. Select the *[Return]* , soft key at the bottom right hand corner of the display and then *[Return]* , *[Centre Freq]*, 300 MHz, *[Return]*, *[Vert Scale]*, toggle *[10/2DB /DIV]* until 10 dB per division is displayed, *[Span]*, 100 kHz, *[Res BW]*, *[Auto Res BW]*.
- (17) Set the RF signal generator to provide a signal of 300 MHz at a level of –10 dBm. A signal should now appear at the centre of the UUT display and be on or close to 1 division down from the top of the display.
- (18) On the UUT select look and listen mode by pressing the *[Return]* soft key at the bottom left hand corner of the display and then the *[Look n Listen]* soft key.
- (19) Check that the signal is still at the centre of the display and on or close to 1 division down from the top of the display.
- (20) Set the RF signal generator to provide 10 kHz deviation at 1 kHz modulation rate on the 300 MHz signal.
- (21) Check that the UUT display now shows an FM modulated signal. Turn the front panel volume control up and check that a 1 kHz tone can be heard. This verifies the operation of the look/listen mode of the Spectrum analyzer. The tracking generator is in reality the instrument signal generator and is therefore tested when the signal generator is checked.

RF broad band power meter

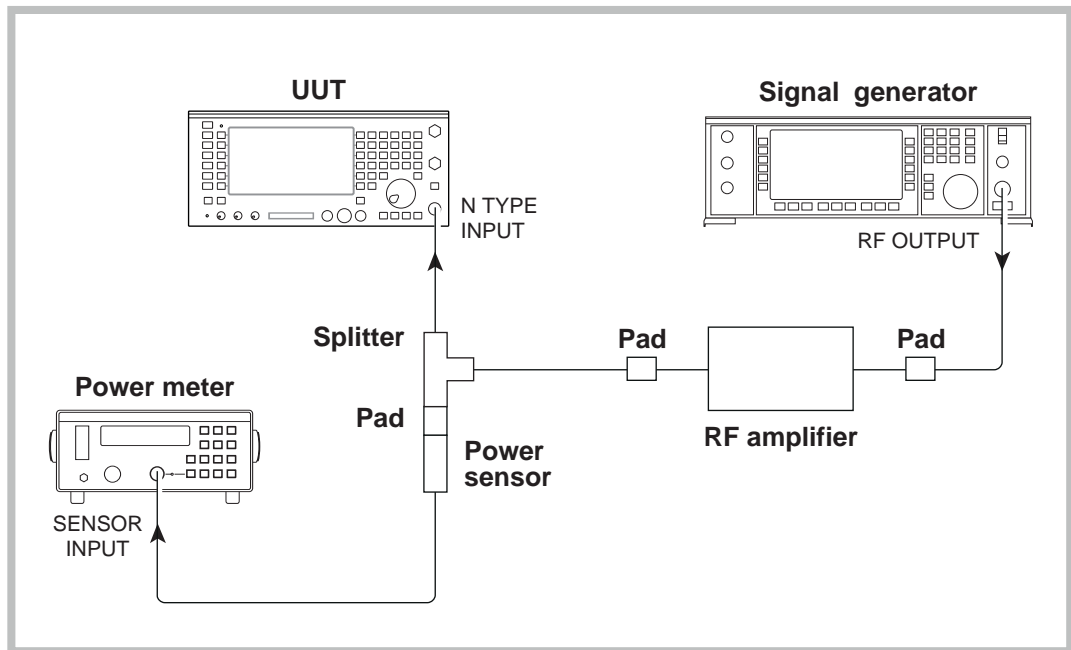
Specification

Frequency range:	200 kHz to 1.05 GHz.
Accuracy:	± 10% ± resolution.
Resolution:	0.1 dB

Test equipment

Description	Minimum specification	Example
Calibrated RF power source consisting of:-	Accuracy better than 2.1%..	See below.
RF signal generator	11 MHz to 1 GHz frequency range, RF level 13 dBm	IFR 2041
Power splitter	6 dB 50 Ω 11 MHz to 1 GHz.	Weinschel 1870A
RF Amplifier	3W 40 dB gain 11 MHz to 1000 MHz	IFR 2177 or AR5W1000 MHz
Attenuator pads	Values dependent upon amplifier used.	
RF power meter	±0.1 dB from 11 MHz to 1 GHz	IFR 6960/A/B + 6912 sensor

- (1) Refer to Results table 5-45 on page 5-45. Set the UUT to [Tx TEST], [SELECT] N-type input socket (i.e. only the ⊕ LED on). From power up, the instrument should already be set to Autotune mode with wide band power meter (WB) selected.
- (2) Connect the equipment as shown in Fig 5-19, connecting to the N-type input socket on the UUT.
- (3) Set the calibrated power source to provide a signal at 11 MHz and 100 mW(+20 dBm) to the UUT input. Note the level on the UUT broad band power meter and check that it is within the stated specification. Repeat at 100 MHz and then in 100 MHz steps up to and including 1000 MHz.



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Fig. 5-19 RF broad band power meter checks

- (1) Set the calibrated power source to provide 100 MHz and 100 mW. Press [SELECT] on the UUT to select N-type input/output, i.e. both LEDs above the N-type socket on. Note the level on the UUT broad band power meter and check that it is within the stated specification.
- (2) Set the calibrated power source to provide 5 mW(+7 dBm). Note the level on the UUT broad band power meter and check that it is within the stated specification.
- (3) Press [SELECT] on the UUT to select N-type input, i.e. only the \oplus LED on. Note the level on the UUT broad band power meter and check that it is within the stated specification.
- (4) Press [SELECT] on the UUT to select the antenna input socket and connect the calibrated power source to this. Note the level on the UUT broad band power meter and check that it is within 15% (functional check only).

Notes

- (1) The power meter/sensor , splitter and two pads associated with these items form the calibrated part of the source.
- (2) The attenuator pad values are dependent upon the gain of the amplifier used. They should be chosen so that when the signal generator is set to its maximum output level the power arriving at the sensor is below +25 dBm i.e. not enough to damage the sensor.
- (3) If a calibrated power source is not available, the UUT power measurement can be functionally checked using an RF signal generator and power meter by checking the signal generator level before applying it to the UUT. It should be noted that no guarantees can be given of the mismatch uncertainties that may be introduced if this method is used.

Options if fitted

Options 2, 10, 11, 12, 13, 14, 15, 16 & 22

- Option 10 - NMT
- Option 11 - AMPS
- Option 12 - TACS
- Option 13 - MPT1327
- Option 14 - PMR TEST
- Option 15 - EDACS Radio
- Option 16 - EDACS Repeater
- Option 22 - POCSAG Decode

Option 2 - Analog system card required for above options.

The Analog system options make use of the circuitry already tested under the standard instrument tests but also have an additional circuit card (option 2). This card contains digital circuitry to cater for data generation, data decoding and test programme execution. The card also uses digital signal processing to implement digitally any special filtering required. The most effective way of testing these options is to ensure that it is possible to call up a fitted option and then carry out a functional test with a respective mobile for the given option. For details on connection of mobiles to the UUT, refer to the relevant Operating Manual Supplement for the option fitted.

Acceptance Test Results Tables

For 2945A [], 2946A [], serial number _____ / _____

Results table 5-1 Carrier frequency accuracy

Frequency	Lower limit	Upper limit	Result
400.000 kHz	399.999	400.001	_____
1050.00000 MHz	1049.999999	1050.000001	_____
500.00000 MHz	499.999999	500.000001	_____
188.88888 MHz	188.888879	188.888881	_____
177.77777 MHz	177.777769	177.777771	_____
166.66666 MHz	166.666659	166.666661	_____
155.55555 MHz	155.555549	155.555551	_____
144.44444 MHz	144.444439	144.444441	_____
133.33333 MHz	133.333329	133.333331	_____
122.22222 MHz	122.222219	122.222221	_____
111.11111 MHz	111.111109	111.111111	_____

Results table 5-2 Signal generator level (-21 dBm) versus frequency (MHz)

Frequency	Lower limit (dBm)	Upper limit (dBm)	Result N-type out/ Antenna in	Result N-type out/ N-type in
10 MHz	-23	-19	_____	_____
100 MHz	-23	-19	_____	_____
200 MHz	-23	-19	_____	_____
300 MHz	-23	-19	_____	_____
400 MHz	-23	-19	_____	_____
500 MHz	-23	-19	_____	_____
600 MHz	-23	-19	_____	_____
700 MHz	-23	-19	_____	_____
800 MHz	-23	-19	_____	_____
900 MHz	-23	-19	_____	_____
1000 MHz	-23	-19	_____	_____

Results table 5-3 ALC linearity at 10 MHz

Level (dBm)	Lower limit	Upper limit	Result
-21	-23.0	-19.0	_____
-22	-24.0	-20.0	_____
-23	-25.0	-21.0	_____
-24	-26.0	-22.0	_____
-25	-27.0	-23.0	_____
-26	-28.0	-24.0	_____
-27	-29.0	-25.0	_____
-28	-30.0	-26.0	_____
-29	-31.0	-27.0	_____
-30	-32.0	-28.0	_____
-31	-33.0	-29.0	_____
-32	-34.0	-30.0	_____
-33	-35.0	-31.0	_____
-34	-36.0	-32.0	_____
-35	-37.0	-33.0	_____
-36	-38.0	-34.0	_____
-37	-39.0	-35.0	_____
-38	-40.0	-36.0	_____

Results table 5-4 ALC linearity at 500 MHz

Level (dBm)	Lower limit	Upper limit	Result
-21	-23.0	-19.0	_____
-22	-24.0	-20.0	_____
-23	-25.0	-21.0	_____
-24	-26.0	-22.0	_____
-25	-27.0	-23.0	_____
-26	-28.0	-24.0	_____
-27	-29.0	-25.0	_____
-28	-30.0	-26.0	_____
-29	-31.0	-27.0	_____
-30	-32.0	-28.0	_____
-31	-33.0	-29.0	_____
-32	-34.0	-30.0	_____
-33	-35.0	-31.0	_____
-34	-36.0	-32.0	_____
-35	-37.0	-33.0	_____
-36	-38.0	-34.0	_____
-37	-39.0	-35.0	_____
-38	-40.0	-36.0	_____

Results table 5-5 ALC linearity at 1000 MHz

Level (dBm)	Lower limit	Upper limit	Result
-21	-23.0	-19.0	_____
-22	-24.0	-20.0	_____
-23	-25.0	-21.0	_____
-24	-26.0	-22.0	_____
-25	-27.0	-23.0	_____
-26	-28.0	-24.0	_____
-27	-29.0	-25.0	_____
-28	-30.0	-26.0	_____
-29	-31.0	-27.0	_____
-30	-32.0	-28.0	_____
-31	-33.0	-29.0	_____
-32	-34.0	-30.0	_____
-33	-35.0	-31.0	_____
-34	-36.0	-32.0	_____
-35	-37.0	-33.0	_____
-36	-38.0	-34.0	_____
-37	-39.0	-35.0	_____

-38	-40.0	-36.0	_____
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Results table 5-6 Carrier harmonic test points at 0 dBm

Frequency (MHz)	Second harmonic (MHz)	Result	Third harmonic (MHz)	Result	Upper limit (dBc)
0.4	0.8	_____	1.2	_____	-20
100.0	200.0	_____	300.0	_____	-20
300.0	600.0	_____	900.0	_____	-20
500.0	1000.0	_____	1500.0	_____	-20
700.0	1400.0	_____	2100.0	_____	-20
900.0	1800.0	_____	2700.0	_____	-20
1000.0	2000.0	_____	3000.0	_____	-20

Results table 5-7 Spurious signals (carrier at 0 dBm)

Carrier frequency (MHz)	Spurious measured	Upper limit (dBc)
0.4	_____	-40
500	_____	-40
1000	_____	-40
650	_____	-30

Results table 5-8 RF carrier leakage (carrier at 501.9873 MHz)

Carrier frequency (MHz)	Upper limit	Leakage detected
501.9873	0.5 μ V PD	_____

Results table 5-9 Residual FM test points

UUT RF generator frequency (MHz)	Local oscillator frequency (MHz)	Limits (Hz)	Result
1000	55.63889	20	_____
400	50.18750	15	_____
100	50.75000	15	_____

Results table 5-10 AM versus carrier frequency (50% depth at 1 kHz rate)

Carrier frequency (MHz)	Lower limit (%)	Upper limit (%)	Result (%)
1.5	45.5	54.5	_____
50	45.5	54.5	_____
100	45.5	54.5	_____
150	45.5	54.5	_____
200	45.5	54.5	_____
250	45.5	54.5	_____
300	45.5	54.5	_____
350	45.5	54.5	_____
400	45.5	54.5	_____

Results table 5-11 AM versus carrier level (100 MHz, 70% depth at 1 kHz rate)

Carrier level (dBm)	Lower limit (%)	Upper limit (%)	Result (%)
5	64.1	75.9	_____
4	64.1	75.9	_____
3	64.1	75.9	_____
2	64.1	75.9	_____
1	64.1	75.9	_____
0	64.1	75.9	_____
-1	64.1	75.9	_____
-2	64.1	75.9	_____
-3	64.1	75.9	_____
-4	64.1	75.9	_____
-5	64.1	75.9	_____
-6	64.1	75.9	_____
-7	64.1	75.9	_____
-8	64.1	75.9	_____
-9	64.1	75.9	_____
-10	64.1	75.9	_____
-11	64.1	75.9	_____
-12	64.1	75.9	_____
-13	64.1	75.9	_____
-14	64.1	75.9	_____
-15	64.1	75.9	_____

Results table 5-12 AM linearity (100 MHz, 0 dBm at 1 kHz rate)

Am depth set (%)	Lower limit (%)	Upper limit (%)	Result (%)
5	3.65	6.35	_____
10	8.3	11.7	_____
20	17.6	22.4	_____
30	26.9	33.1	_____
40	36.2	43.8	_____
50	45.5	54.5	_____
60	54.8	65.2	_____
70	64.1	75.9	_____
85	79.1	91.95	_____

Results table 5-13 AM versus modulation frequency (100 MHz, 85% depth)

AM frequency (kHz)	Lower limit (%)	Upper limit (%)	Result (%)
0.065	75.5	94.5	_____
0.140	75.5	94.5	_____
0.500	75.5	94.5	_____
2	75.5	94.5	_____
5	75.5	94.5	_____
15	71.25	98.75	_____

Results table 5-14 AM demodulation distortion (100 MHz, 30% depth)

Distortion upper limit (%)	Result (%)
2	_____

Results table 5-15 FM versus carrier frequency (at 10 kHz deviation 1 kHz rate)

Carrier frequency (MHz)	Lower limit (kHz)	Upper limit (kHz)	Result
0.5	9.490	10.510	_____
10	9.490	10.510	_____
100	9.490	10.510	_____
200	9.490	10.510	_____
300	9.490	10.510	_____
400	9.490	10.510	_____
500	9.490	10.510	_____
600	9.490	10.510	_____
700	9.490	10.510	_____
800	9.490	10.510	_____
900	9.490	10.510	_____
925	9.490	10.510	_____
975	9.490	10.510	_____
1050	9.490	10.510	_____

Results table 5-16 FM linearity checks (at 600 MHz carrier frequency 1 kHz rate)

Deviation frequency (kHz)	Lower limit (kHz)	Upper limit (kHz)	Result
75	71.24	78.76	_____
50	47.49	52.51	_____
25	23.74	26.26	_____
5	4.74	5.26	_____

Results table 5-17 FM distortion

Modulation frequency (kHz)	Distortion upper limit (%)	Result
1	1	_____

Results table 5-18 FM versus modulation frequency (at 600 MHz carrier frequency, 10 kHz deviation)

Modulation frequency	Lower limit (kHz)	Upper limit (kHz)	Result
50 Hz	8.99	11.01	_____
10 kHz	8.99	11.01	_____
15 kHz	8.99	11.01	_____

Results table 5-19 Audio generator 1 output level

AF generator 1 frequency (Hz)	Level (mV)	Lower limit (mV)	Upper limit (mV)	Result
1000	4000	3799	4201	_____
50	4000	3799	4201	_____
150	4000	3799	4201	_____
500	4000	3799	4201	_____
2000	4000	3799	4201	_____
5000	4000	3799	4201	_____
10000	4000	3799	4201	_____
15000	4000	3799	4201	_____
1000	20.0	18.9	21.1	_____
1000	400.0	379.9	420.1	_____
1000	1000	949	1051	_____
1000	2000	1899	2101	_____
1000	3000	2849	3151	_____

Results table 5-20 Audio generator 2 output level

AF generator 2 frequency (Hz)	Level (mV)	Lower limit (mV)	Upper limit (mV)	Result
1000	4000	3799	4201	_____
50	4000	3799	4201	_____
150	4000	3799	4201	_____
500	4000	3799	4201	_____
2000	4000	3799	4201	_____
5000	4000	3799	4201	_____
10000	4000	3799	4201	_____
15000	4000	3799	4201	_____
1000	20.0	18.9	21.1	_____
1000	400.0	379.9	420.1	_____
1000	1000	949	1051	_____
1000	2000	1899	2101	_____
1000	3000	2849	3151	_____

Results table 5-21 Audio generator 1 distortion

AF generator 1 frequency (Hz)	Level (mV)	Distortion upper limit (%)	Result
1000	4000	0.5	_____
1000	100.0	0.5	_____
2000	4000	1.0	_____
5000	4000	1.0	_____
15000	4000	1.0	_____

Results table 5-22 Audio generator 2 distortion

AF generator 2 frequency (Hz)	Level (mV)	Distortion upper limit (%)	Result
1000	4000	0.5	_____
1000	100.0	0.5	_____
2000	4000	1.0	_____
5000	4000	1.0	_____
15000	4000	1.0	_____

Results table 5-23 Audio generator 1 frequency (functional)

AF generator 1 setting	Lower limit	Upper limit	Result
10 Hz	9.9 Hz	10.1 Hz	_____
500 Hz	499.9 Hz	500.1 Hz	_____
1.0000 kHz	999.9 Hz	1000.1 Hz	_____
1.1111 kHz	1.1110 kHz	1.1112 kHz	_____
2.2222 kHz	2.2221 kHz	2.2223 kHz	_____
3.333 kHz	3.3328 kHz	3.3332 kHz	_____
4.444 kHz	4.4438 kHz	4.4442 kHz	_____
5.555 kHz	5.5548 kHz	5.5552 kHz	_____
6.666 kHz	6.6658 kHz	6.6662 kHz	_____
7.777 kHz	7.7768 kHz	7.7772 kHz	_____
8.888 kHz	8.8878 kHz	8.8882 kHz	_____
9.999 kHz	9.9988 kHz	10.0010 kHz	_____
15.000 kHz	14.999 kHz	15.0010 kHz	_____
20.000 kHz	19.9989 kHz	20.0011 kHz	_____

Results table 5-24 Audio generator 2 frequency (functional)

AF generator 2 setting	Lower limit	Upper limit	Result
10 Hz	9.9 Hz	10.1 Hz	_____
500 Hz	499.9 Hz	500.1 Hz	_____
1.0000 kHz	999.9 Hz	1000.1 Hz	_____
1.1111 kHz	1.1110 kHz	1.1112 kHz	_____
2.2222 kHz	2.2221 kHz	2.2223 kHz	_____
3.333 kHz	3.3328 kHz	3.3332 kHz	_____
4.444 kHz	4.4438 kHz	4.4442 kHz	_____
5.555 kHz	5.5548 kHz	5.5552 kHz	_____
6.666 kHz	6.6658 kHz	6.6662 kHz	_____
7.777 kHz	7.7768 kHz	7.7772 kHz	_____
8.888 kHz	8.8878 kHz	8.8882 kHz	_____
9.999 kHz	9.9988 kHz	10.0010 kHz	_____
15.000 kHz	14.999 kHz	15.0010 kHz	_____
20.000 kHz	19.9989 kHz	20.0011 kHz	_____

Results table 5-25 Audio frequency meter

LF generator frequency	Level (mV)	Lower limit	Upper limit	Result
20 Hz	50	19.8 Hz	20.2 Hz	_____
1 kHz	50	999.8 Hz	1000.2 Hz	_____
20 kHz	50	19.9989 kHz	20.0011 kHz	_____

Results table 5-26 Audio voltmeter accuracy

Frequency	DVM reading (mV)	UUT coupling	UUT lower limit* (mV) ‡	UUT upper limit* (mV) †	Result
1 kHz	30	AC	25.1	34.9	_____
1 kHz	200	AC	189	211	_____
1 kHz	400	AC	381	419	_____
1 kHz	800	AC	765	835	_____
1 kHz	2000	AC	1917	2083	_____
1 kHz	4500	AC	3317	4683	_____
50 Hz	1000	AC	957	1043	_____
100 Hz	1000	AC	957	1043	_____
500 Hz	1000	AC	957	1043	_____
10 kHz	1000	AC	957	1043	_____
30 kHz	1000	AC	957	1043	_____
50 kHz	1000	AC	957	1043	_____
DC	25000	DC	23997	26003	_____
DC	50000	DC	47997	52003	_____

† The upper and lower limits in the above table are calculated on the assumption that it was possible to set the exact level. If it is not possible to achieve this, the limits will need to be calculated for the DVM reading obtained.

Results table 5-27 Oscilloscope accuracy

LF generator level (mV RMS)	UUT (Volts/div)	DVM lower limit	DVM upper limit	Result
21.2	10 mV/div	20.15	22.27	_____
42.4	20 mV/div	40.3	44.54	_____
106	50 mV/div	100.7	111.4	_____
212	100 mV/div	201.5	222.7	_____
424	200 mV/div	403.0	445.4	_____
1061	500 mV/div	1007.5	1113.5	_____
2121	1 V/div	2.015	2.227	_____
4242	2 V/div	4.030	4.454	_____
DC supply				
20 V	5 V/div	18.5 V	21.5 V	_____
20 V	10 V/div	17 V	23 V	_____
20 V	20 V/div	14 V	26 V	_____

Results table 5-28 Oscilloscope

LF generator frequency	UUT timebase	DVM lower limit	DVM upper limit	Result
10 Hz	50 ms/div	2.015 V	2.227 V	_____
10 kHz	50 μs/div	2.015 V	2.227 V	_____
20 kHz	50 μs/div	2.015 V	2.227 V	_____

Results table 5-29 Distortion & SINAD meter

Distortion/SINAD set	Lower limit	Upper limit	Result
2%	1.4%	2.6 %	_____
25%	23.2%	26.8 %	_____
12 dB	11.0 dB	13.0 dB	_____

Results table 5-30 FM measurement versus carrier frequency (1 kHz rate)

Carrier frequency (MHz)	Deviation (kHz)	IF filter (kHz)	AF filter	Lower limit (kHz) †	Upper limit (kHz) †	Result
5.5	20	30	0.3 to 3.4	18.8	21.2	_____
500	20	30	0.3 to 3.4	18.8	21.2	_____
1000	20	30	0.3 to 3.4	18.8	21.2	_____

Results table 5-31 FM measurement versus modulation rate

Modulation rate	AF filter	Deviation (kHz)	Lower limit (kHz) †	Upper limit (kHz) †	Result
50 Hz	300 Hz LP	20	18.4	21.6	_____
5 kHz	15 kHz LP	20	18.4	21.6	_____
10 kHz	50 kHz LP	20	18.4	21.6	_____

Results table 5-32 FM measurement versus deviation level (1 kHz rate)

Deviation level	IF bandwidth	Lower limit (kHz) †	Upper limit (kHz) †	Result
250 Hz ‡	3 kHz	0.2275	0.2725	_____
10 kHz	30 kHz	9.4	10.6	_____
50 kHz	300 kHz	47	53	_____
75 kHz	300 kHz	70.5	79.5	_____

† The upper and lower limits in Results table 5-30, Results table 5-31, and Results table 5-32 are calculated on the assumption that it was possible to set the exact level on the external Modulation meter. If it is not possible to achieve this, the limits will need to be calculated for the readings obtained.

‡ For the lower deviation in Results table 5-32, subtract the residual FM reading from the measured result.

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Results table 5-33 FM demodulation oscilloscope

Carrier frequency (MHz)	Deviation (kHz)	Lower limit (kHz)	Upper limit (kHz)	Result
300	75	67.5	82.5	_____

Results table 5-34 FM demodulation output socket

Carrier frequency (MHz)	Deviation (kHz)	Lower limit	Upper limit	Result
300	75	4.77 V	5.83 V	_____

Results table 5-35 FM demodulation distortion (1 kHz rate)

Carrier frequency (MHz)	Deviation (kHz)	Upper limit	Result
300	5	2%	_____

Results table 5-36 AM measurement versus carrier frequency (1 kHz rate)

Carrier frequency (MHz)	Depth (%)	Lower limit (% †)	Upper limit (% †)	Result
0.5	70	65.5	74.5	_____
500	70	65.5	74.5	_____
1050	70	65.5	74.5	_____

Results table 5-37 AM measurement versus modulation rate

Modulation rate	Depth (%)	Lower limit (% †)	Upper limit (% †)	Result
50 Hz	70	63	77	_____
10 kHz	70	63	77	_____

Results table 5-38 AM measurement versus AM depth (1 kHz rate)

Depth (%)	Lower limit (%) †	Upper limit (%) †	Result
5	3.75	6.25	_____
20	18	22	_____
50	46.5	53.5	_____
80	75	85	_____
95	89	100	_____

Results table 5-39 AM demodulation oscilloscope

Carrier frequency (MHz)	Depth (%)	Lower limit (%) †	Upper limit (%) †	Result
100	60	54	66	_____

† The upper and lower limits in Results table 5-36, Results table 5-37, Results table 5-38, and Results table 5-39 are calculated on the assumption that it was possible to set the exact level on the external Modulation meter. If it is not possible to achieve this, the limits will need to be calculated for the DVM readings obtained.

Results table 5-40 AM demodulation distortion (1 kHz rate)

Carrier frequency (MHz)	Depth (%)	Upper limit (%)	Result
100	30	2	_____

Results table 5-41 RF frequency meter (at -60 dBm antenna input, manual tuned)

Carrier frequency (MHz)	Offset lower limit (Hz)	Offset upper limit (Hz)	Result
10	-1	1	_____
500	-1	1	_____
1050	-1	1	_____

ACCEPTANCE TESTING

Results table 5-42 RF frequency meter (at -13 dBm (0.05 mW) antenna input autotuned)

Carrier frequency (MHz)	Lower limit (MHz)	Upper limit (MHz)	Result
1000	999.999999	1000.000001	_____
500	499.999999	500.000001	_____
10	9.999999	10.000001	_____

Results table 5-43 Internal frequency standard

Carrier frequency (MHz)	Lower limit (MHz)	Upper limit (MHz)	Result
Standard (TCXO) 1000	999.999500	100.000500	_____
Option 3 (OCXO) 1000	999.999750	100.000250	_____

Results table 5-44 Spectrum analyzer

Parameter	Limits	Result
Dynamic range	≥80 dB	_____
Level flatness	2.2 dB	_____

Results table 5-45 RF broad band power meter (N-type input)

Frequency (MHz)	Input level (dBm)	Lower limit (dBm)	Upper limit (dBm)	Result
N-input				
11	20	19.4	20.5	_____
100	20	19.4	20.5	_____
200	20	19.4	20.5	_____
300	20	19.4	20.5	_____
400	20	19.4	20.5	_____
500	20	19.4	20.5	_____
600	20	19.4	20.5	_____
700	20	19.4	20.5	_____
800	20	19.4	20.5	_____
900	20	19.4	20.5	_____
1000	20	19.4	20.5	_____
N in / N out				
100	20	19.4	20.5	_____
100	7	6.4	7.5	_____
N input				
100	7	6.4	7.5	_____

The upper and lower limits in the table above are calculated on the assumption that it was possible to set the exact input level required. If it is not possible to achieve this, the limits will need to be calculated in proportion to the power applied.

Appendix A

DIRECTIONAL POWER HEADS

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Precautions

WARNING

CAUTION

Note

These terms have specific meanings in this manual:

WARNING

information to prevent personal injury.

CAUTION


information to prevent damage to the equipment.

Note

important general information.

Hazard symbols

The meaning of hazard symbols appearing on the equipment is as follows:

Symbol	Nature of hazard
	RF Hazard

Safety

This product has been designed and tested in accordance with BS4743 'Specification for safety requirements for electronic measuring apparatus' and IEC Publication 348 'Safety requirements for electronic measuring apparatus'.

WARNING

RF hazard

When measuring high VSWR ratios, hazardous voltages may be present on the line due to standing waves. Under these conditions, it is dangerous to operate the equipment with the covers removed.

WARNING

Toxic hazards

Some of the components used in this equipment may include resins and other materials which give off toxic fumes if incinerated. Take appropriate precautions, therefore, in the disposal of these items.

Précautions

WARNING**CAUTION****Note**

Les termes suivants ont, dans ce manuel, des significations particulières:

WARNING

contient des informations pour éviter toute blessure au personnel.

CAUTION

contient des informations pour éviter les dommages aux équipements.

Note

contient d'importantes informations d'ordre général.

Symboles Signalant Un Risque

Symbole

Nature du risque



Danger RF

Securite

Cet appareil a été conçu et testé conformément aux normes BS4743 "Spécifications des conditions de sécurité pour instruments de mesure électronique" et CEI Publication 348 "Conditions de sécurité pour instruments de mesure électronique".

WARNING

Danger RF

Lors de la mesure de T.O.S. de valeur importante, des tensions dangereuses dues aux ondes stationnaires peuvent apparaître sur l'alimentation. Dans ces conditions il est dangereux de faire fonctionner l'appareil sans ses capots de protection.

WARNING

Danger produits toxiques

Certains composants utilisés dans cet appareil peuvent contenir des résines et d'autres matières qui dégagent des fumées toxiques lors de leur incinération. Les précautions d'usages doivent donc être prises lorsqu'on se débarrasse de ce type de composant.

Vorsichtsmaßnahmen

WARNING

CAUTION

Note

Diese Hinweise haben eine bestimmte Bedeutung in diesem Handbuch:


WARNING dienen zur Vermeidung von Verletzungsrisiken.

CAUTION dienen dem Schutz der Geräte.

Note enthalten wichtige Informationen.

Gefahrensymbole

Die Gefahrensymbole auf den Geräten sind wie folgt:

Symbol	Gefahrenart
	Hochfrequenz

Sicherheit

Dieses Gerät wurde in Übereinstimmung mit BS4743 und IEC 348 entwickelt und geprüft.

WARNING

Hochfrequenz

Bei Messung von hohen Stehwellenverhältnissen können sich auf der Leitung gefährliche Spannungen aufbauen. In solchen Fällen darf das Gerät nicht bei geöffnetem Gehäuse betrieben werden.

WARNING

Warnung vor giftigen Substanzen

In einigen Bauelementen dieses Geräts können Epoxyharze oder andere Materialien enthalten sein, die im Brandfall giftige Gase erzeugen. Bei der Entsorgung müssen deshalb entsprechende Vorsichtsmaßnahmen getroffen werden.

Precauzioni

WARNING**CAUTION****Note**

Questi termini vengono utilizzati in questo manuale con significati specifici:


WARNING riportano informazioni atte ad evitare possibili pericoli alla persona.

CAUTION riportano informazioni per evitare possibili pericoli all'apparecchiatura.

Note riportano importanti informazioni di carattere generale.

Simboli di pericolo

Significato dei simboli di pericolo utilizzati nell'apparato:

Simbolo	Tipo di pericolo
	Rischio a RF

Sicurezza

Questo prodotto è stato progettato e provato secondo le norme BS4743 "Specification for safety requirements for electronic measuring apparatus" e la pubblicazione IEC 348 "Safety requirements for electronic measuring apparatus".

WARNING

Rischio a RF

Durante la misura di ROS di valori elevati, la presenza di onde stazionarie può causare tensioni pericolose. In queste condizioni è quindi rischioso usare lo strumento coi coperchi rimossi.

WARNING

Pericolo sostanze tossiche

Alcuni dei componenti usati in questo strumento possono contenere resine o altri materiali che, se bruciati, possono emettere fumi tossici. Prendere quindi le opportune precauzioni nell'uso di tali parti.

Precauciones

WARNING

CAUTION

Note

Estos términos tienen significados específicos en este manual:

WARNING contienen información referente a prevención de daños personales.

CAUTION contienen información referente a prevención de daños en equipos.

Note contienen información general importante.

Símbolos de peligro

Los significados de los símbolos de peligro que aparecen en los equipos son los siguientes:

Símbolo **Naturaleza del peligro**



Riesgo de RF

Seguridad

Este producto ha sido diseñado y probado según las normas, BS4743 'Especificaciones de los requisitos de seguridad para instrumentos electrónicos de medida' e IEC publicación 348 'Requisitos de seguridad para instrumentos electrónicos de medida'.

WARNING



Riesgo de RF

Cuando se miden valores elevados de ROE, pueden existir tensiones elevadas debido a ondas estacionarias. Bajo estas condiciones resulta peligroso operar con el equipo sin las tapas puestas.

WARNING



Aviso de toxicidad

Alguno de los componentes utilizados en este equipo pudieran incluir resinas u otro tipo de materiales que al arder produjeran sustancias tóxicas, Por tanto, tome las debidas precauciones en la manipulación de esas piezas.

Features

This accessory for IFR instruments is used to measure forward power, reverse power and VSWR in coaxial RF transmission lines and antenna systems. There are two versions as follows:-

Frequency range	Part no.
1 to 50 MHz (HF)	54421-002L
25 to 1000 MHz (UHF)	54421-003J

There are no controls fitted to the Directional Power Head. There are RF line input and output connectors, and a DIN socket for the lead to the Service Monitor. A 1 m lead assembly is available as an optional accessory. As the Directional Power Head is bi-directional, it can be connected either way round in the RF line.

The Directional Power Head is able to measure CW power or give an indication of peak envelope power (PEP) for AM and SSB. The *[PEP/CW]* key on the directional power meter screen is used to select the required measurement method.

A wide measurement range is available for both forward and reverse power. This can be from 10 mW to 400 W under certain some operating conditions. Range selection is automatic, controlled by the software within .

A system of compensated peak responding detectors is employed to ensure fast response times and a wide dynamic range. It should be noted that the instrument is accurately calibrated for signals with low harmonic content and noise.

Performance data - power head only

	HF version	UHF version
Frequency range:	1 MHz to 50 MHz.	25 MHz to 1000 MHz.
Power measurement (either direction)	See Fig. 1-2.	See Fig. 1-3.
Indication range for CW:	5 mW to 400 W.	5 mW to 400 W at 25 to 520 MHz, 5 mW to 200 W at 1000 MHz.
Indication range for PEP:	1 to 400 W.	1 to 400 W at 25 to 520 MHz, 1 to 200 W at 1000 MHz.
Maximum applied PEP:	1 kW.	1 kW at 25 to 100 MHz, 200 W at 1000 MHz.
CW power accuracy	The quoted figures apply when the Power Head is terminated by a load which has a VSWR of 1.1:1 or better and within the temperature range 18 to 26°C.	
Calibration at 1 W (with harmonics <-50 dBc):	±4.7% (±0.2 dB) at 30 MHz.	±4.7% (±0.2 dB) at 100 MHz.
Flatness:	±3.6% (±0.155 dB) at 1 to 50 MHz.	±5.9% (±0.25 dB) at below 520 MHz, ±9.6% (±0.4 dB) at 520 to 1000 MHz.
Linearity, relative to 1 W:	±3.5% (±0.15 dB) ±0.003% of maximum power of Head, at 10 mW to 400 W.	3.5% (±0.15 dB) ±0.01% of maximum power of Head.
Calibration, flatness and linearity combined (root of sum of squares):	±7% (±0.29 dB) ±0.003% of maximum power of Head.	±8% (±0.35 dB) ±0.01% of maximum power of Head, at 25 to 520 MHz, ±11% (±0.5 dB) ±0.01% of maximum power of Head, at 520 to 1000 MHz.
Effect of temperature outside 18 to 26 °C on calibration, flatness and linearity:	<±0.2%/°C (±0.008 dB/°C).	<±0.3%/°C (±0.015 dB/°C) at below 520 MHz, <±0.5%/°C (±0.02 dB/°C) at 520 to 1000 MHz.
VSWR measurement	See Fig. 1-3.	See Fig. 1-3.
VSWR indication:	1.0 to 99.9.	1.0 to 99.9.
VSWR accuracy at 18 to 26°C:	±12.5% for 1.1:1 to 2:1 (typically 3%), ±15% for 2:1 to 3:1 (typically 4%).	±16% for 1.1:1 to 2:1 (typically 5%), ±20% for 2:1 to 3:1 (typically 6%).

RF connectors

Type:	N sockets.	N sockets.
Characteristic impedance:	50 Ω nominal.	50 Ω nominal.
Insertion SWR:	<1.1:1 (return loss >26.4 dB) at 1 to 50 MHz.	<1.1:1 (return loss >26.4 dB) at 25 to 1000 MHz.
Insertion loss:	<0.05 dB.	<0.35 dB at up to 520 MHz, <0.65 dB at 520 to 1000 MHz.

Output connector

Type:	DIN 7-pin socket, standard Lead Assembly (3 m) to ACCESSORY socket on Service Monitor.
-------	---

Dimensions and weight

Height:	52 mm.	52 mm.
Width:	108 mm.	108 mm.
Depth:	114 mm.	114 mm.
Weight:	645 g.	850 g.

Radio frequency interference:

Electro-Magnetic Compatibility	Conforms with the protection requirements of the EEC Council Directive 89/336/EEC. Complies with the limits specified in the following standards: EN 55011 Class B CISPR 11 EN50082-1 IEC 801-2,3,4
--------------------------------	---

Safety:

Complies with IEC 348.

Environmental

Rated range of use:	0 to 50°C.
Limit range of operation:	0 to 55°C.

Conditions of storage and transport

Temperature:	-40 to +70°C.
Humidity:	Up to 90% RH.
Altitude:	Up to 2500 m (pressurised freight at 27 kPa differential (i.e. 3.9 lbf/in ²).

Performance data - in conjunction with 2945A

When the Power Head is used in conjunction with the Communications Service Monitor 2945A, the performance is identical to that of the Power Head alone with the exceptions and additions given below.

	HF version	UHF version
Power measurement		
Resolution:	1 mW or 0.1 dB	
Indication:	3 digits	
Setting:	Automatic ranging using 0 to 1, 0 to 3 and 0 to 10 scales.	
Accuracy (including errors due to frequency response, linearity and calibration uncertainties combined (root of sum of squares)):	±8% (±0.003% of maximum power of Head).	±9% (±0.01% of maximum power of Head) at 25 to 520 MHz, ±12% (±0.01% of maximum power of Head) at 520 to 1000 MHz.
VSWR measurements		
Resolution:	0.01	
Indication:	3 digits and analogue display.	
Setting:	Automatic ranging, analogue scales 1 to 2, 1 to 4 and 1 to 11.	

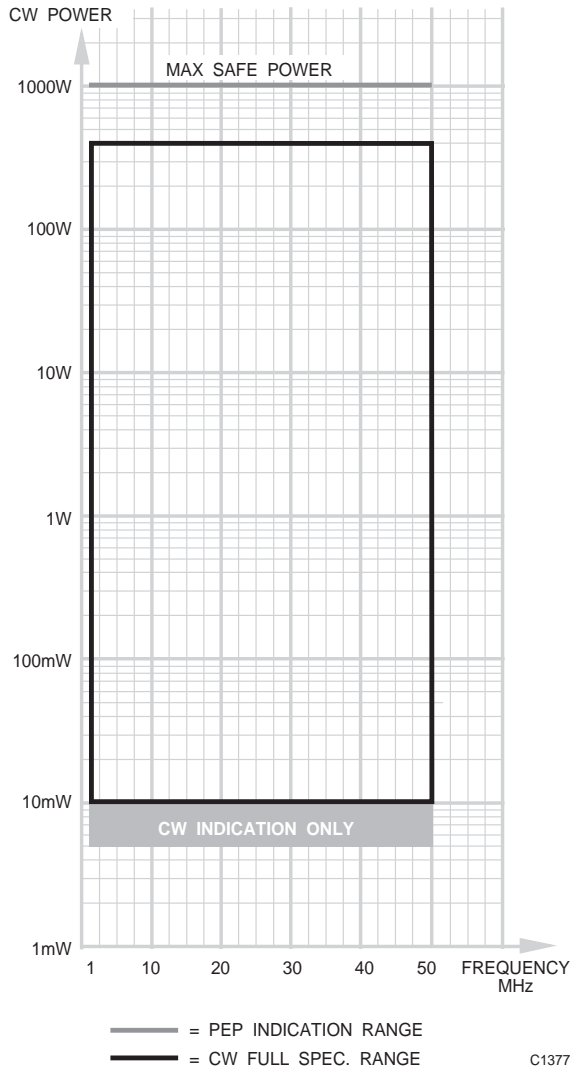


Fig. A-1 Power range of HF directional power head

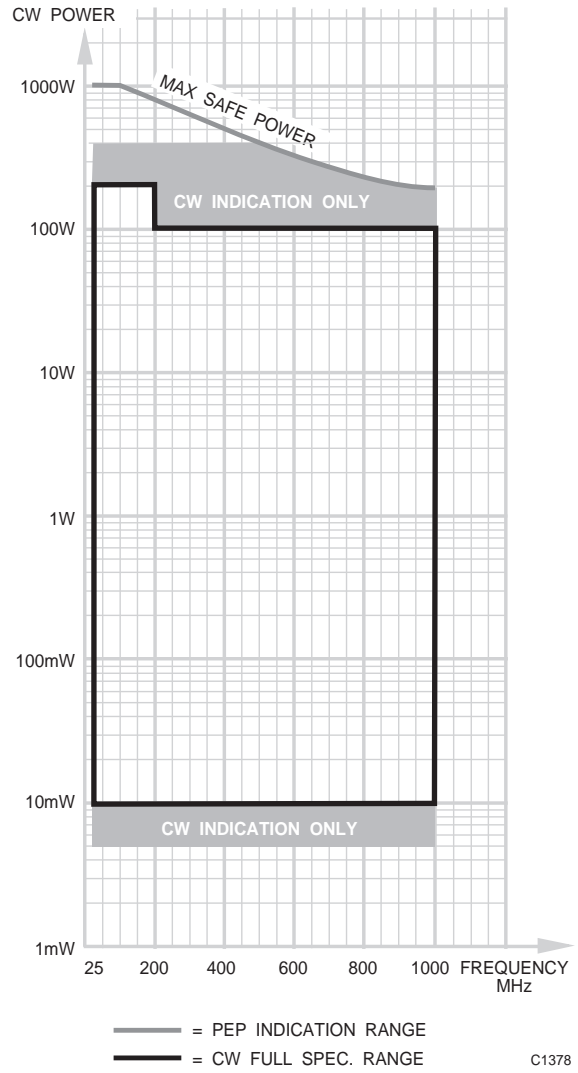
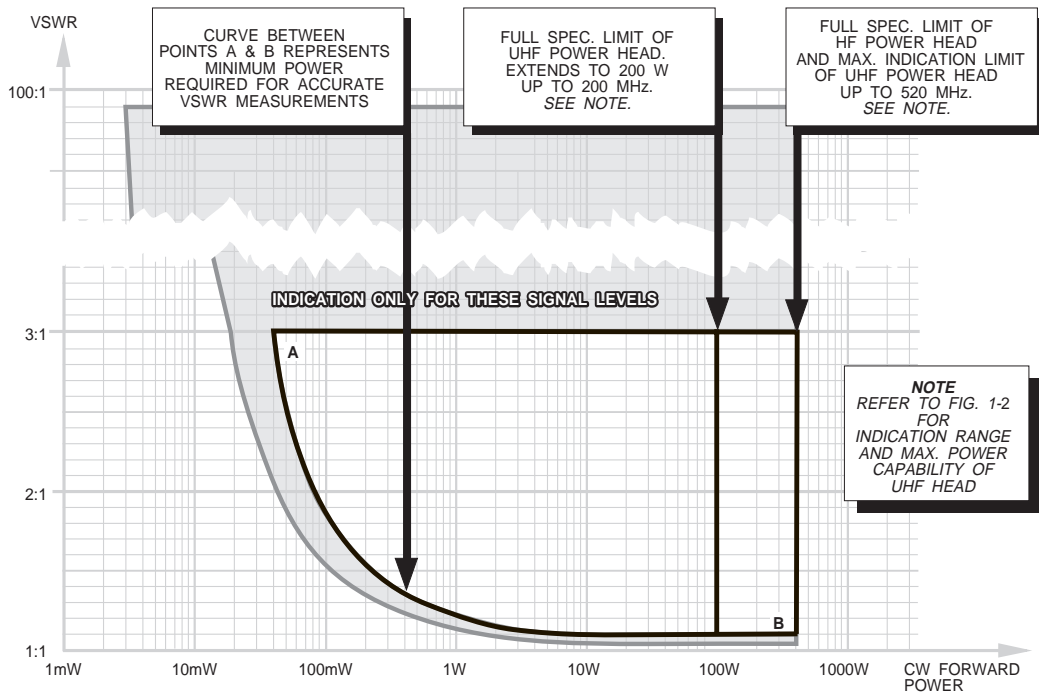


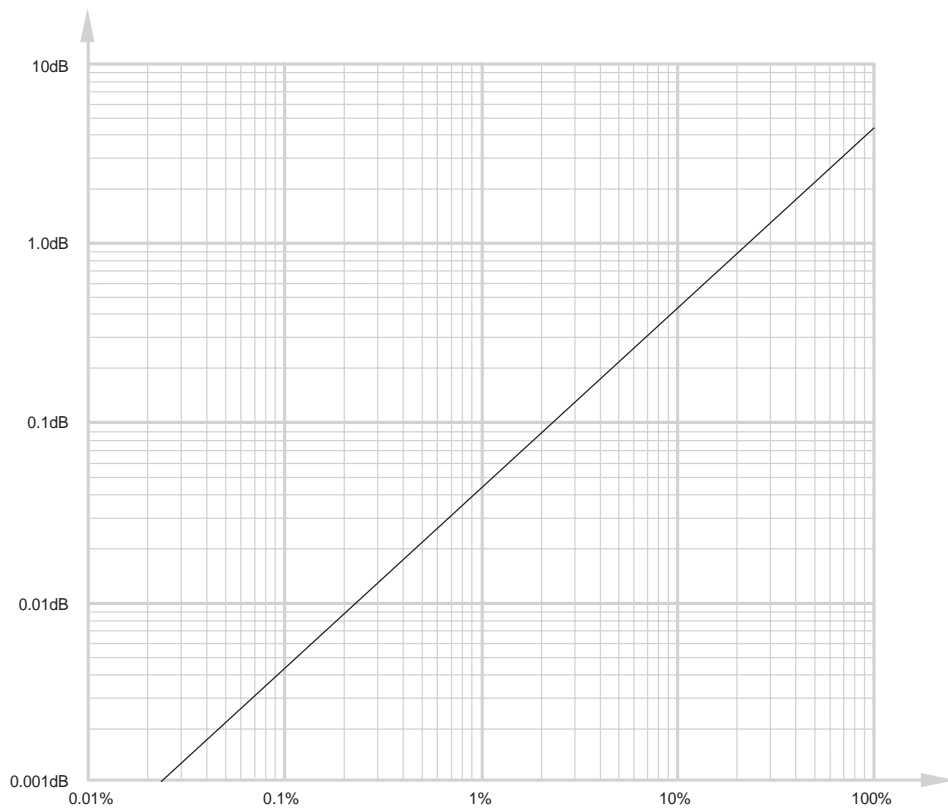
Fig. A-2 Power range of UHF directional power head

DIRECTIONAL POWER HEADS



C1379

Fig. A-3 VSWR range for HF and UHF directional power heads



C1380

Fig. A-4 Percentage to dB error conversion

Table A-1 Conversion of VSWR to return loss

VSWR	Return loss (dB)	VSWR	Return loss (dB)	VSWR	Return loss (dB)	VSWR	Return loss (dB)
1.00	∞	1.21	20.4	1.54	13.4	1.96	9.8
1.01	46.1	1.22	20.1	1.56	13.2	1.98	9.7
1.02	40.1	1.23	19.7	1.58	13.0	2.00	9.5
1.03	36.6	1.24	19.4	1.60	12.7	2.50	7.4
1.04	34.2	1.25	19.1	1.62	12.5	3.00	6.0
1.05	32.3	1.26	18.8	1.64	12.3	3.50	5.1
1.06	30.7	1.27	18.5	1.66	12.1	4.00	4.4
1.07	29.4	1.28	18.2	1.68	11.9	4.50	3.9
1.08	28.3	1.29	17.9	1.70	11.7	5.00	3.5
1.09	27.3	1.30	17.7	1.72	11.5	5.50	3.2
1.10	26.4	1.32	17.2	1.74	11.4	6.00	2.9
1.11	25.7	1.34	16.8	1.76	11.2	6.50	2.7
1.12	24.9	1.36	16.3	1.78	11.0	7.00	2.5
1.13	24.3	1.38	15.9	1.80	10.9	7.50	2.3
1.14	23.7	1.40	15.6	1.82	10.7	8.00	2.2
1.15	23.1	1.42	15.2	1.84	10.6	8.50	2.1
1.16	22.6	1.44	14.9	1.86	10.4	9.00	1.9
1.17	22.1	1.46	14.6	1.88	10.3	9.50	1.8
1.18	21.7	1.48	14.3	1.90	10.2	10.00	1.7
1.19	21.2	1.50	14.0	1.92	10.0	11.00	1.6
1.20	20.8	1.52	13.7	1.94	9.9		

Additional parts associated with directional power head

Supplied

	Part no.
Lead Assembly with DIN plugs, 3 m	43130-591B
Carrying Case HF version	46662-190V
Carrying Case UHF version	46662-189W

Optional

Lead Assembly with DIN plugs, 1 m	43130-590R
Dual DIN Connector Assembly	44990-814K

Using the directional power head accessory

General

The supplied accessory consists of the Power Head together with the 3 metre Cable Assembly.

Power supply

No additional power supply is required. 12 V DC is supplied to the Power Head from the Service Monitor, through the cable assembly.

Procedure

WARNING

RF HAZARD. No attempt should be made to connect the Directional Power Head to an RF line until the "Operating Precautions" on page v have been noted.

Connect the accessory cable between the seven pin ACCESSORY IN/OUT socket on the Service Monitor front panel, and the seven pin DIN socket on the Power Head. These connections can be made with the instrument powered up.

Select either the Tx or Dx operating mode by pressing the appropriate mode key.

Press the *[Tx Freq]* key which will display the screen shown in fold out diagram (2.1) or (4.8).

Press the *[Dir Power]* key. The screen shown in Fig. A-5 will be displayed.

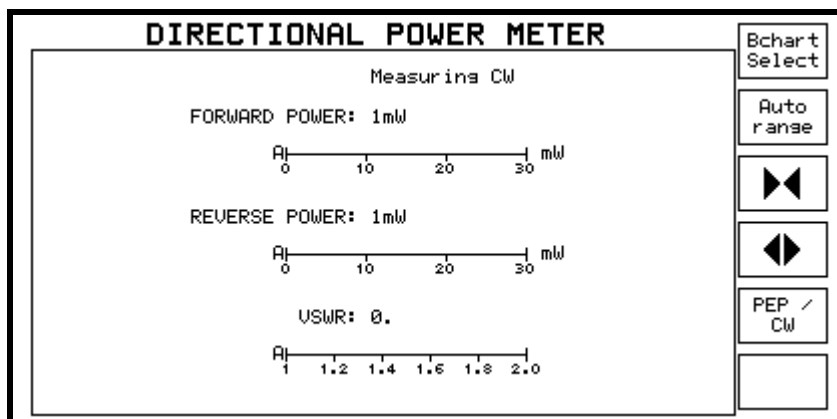


Fig. A-5 Directional power head screen

The power head is now installed and the Service Monitor ready to make directional power measurements.

Ensure that transmitter power is OFF and an antenna or load is connected to the transmitter.

Connect the Power Head in series with the transmitter output using either of the N sockets for input or output.

The Directional Power Head is able to operate in two modes, CW and PEP (when using AM or SSB). When the DIRECTIONAL POWER METER display first appears, it is in CW mode. Select CW or PEP as appropriate, using the *[CW/PEP]* key.

Switch on the transmitter under test. Readings appear for forward power, reverse power and VSWR. The values appear on three horizontal bar charts.

The forward and reverse power levels and the VSWR level, are each displayed as digital readouts with a maximum resolution of three figures. Below 10 mW the power readings are reduced to a single figure, with two digits resolution up to 99 mW.

The bar charts can be set for auto-ranging or manual range selection. Repeated presses of the *[Bchart Select]* key selects each bar chart in turn. The selected bar chart is indicated by an **A** or **H** being shown in inverse video at the left end.

Pressing the *[Autorange]* key will switch the selected bar chart to auto-ranging, indicated by an inverse video **A**.

To change a bar chart from auto-ranging to a specific range, first select the bar chart using the *[Bchart Select]* key, then press the *[◀▶]* key or *[▶◀]* key, until the required range is selected. If the bar chart was in auto-range mode, the first press of a range change key will place the bar chart in 'Hold' mode without changing the range.

The bar chart indications of the power measurement range is covered in 10 ranges. The lowest range has a maximum indication of 30 mW, with 10 mW and 20 mW divisions. The highest range has a maximum indication of 1 kW, with 0.2, 0.4, 0.6 and 0.8 kW divisions. Between these, the ranges continue in a 1, 3, 10 sequence.

The directional power head is able to measure RF powers over a large dynamic range, from 5 mW to 400 W. The measuring circuits integrate readings over a finite period and therefore the accuracy of the readings obtained from amplitude modulated signals would depend on the content of the signal being measured.

For making measurements on CW, FM and phase modulated signals the CW measuring system is selected.

When it is required to make power measurements on amplitude modulated or single side band signals the PEP (Peak Envelope Power) system is selected. The range of measurement covered by the PEP system is from 1 W to 400 W.

The selection of CW or PEP measurements is made using the *[CW/PEP]* key. The selection is indicated by the legend *Measuring CW* or *Measuring PEP* displayed above the forward power measurement.

VSWR is shown digitally and also on a bar chart at the bottom of the display. The VSWR range is covered in two steps as shown below:-

- 1.0 (:1) to 2.0 (:1) with 1.2, 1.4, 1.6, 1.8 (:1) divisions.
- 1.0 (:1) to 4.0 (:1) with 2, 3 (:1) divisions.

Technical description

Directional coupler assembly

The directional coupler is connected in series with the RF line under test and senses forward and reverse RF power. The coupler has two outputs, one for forward power and the other for reverse power. Because the coupler can be connected in either direction on the RF line, either output could represent forward or reverse power. Each output from the coupler is routed to an RF detector.

Channel circuit

There are two channel circuits, each comprising an integrator, AGC circuit and a peak buffer. Both channel circuits are identical to each other, therefore only channel 1 is described below.

CW operation

With reference to Fig. A-6 the RF detector output is connected to one input of the integrator. The output from an LF detector is connected to the other input of the integrator. The integrator output controls the gain of the AGC circuit which controls the level of a 1 kHz signal to the LF detector.

When RF power is detected, an increased offset voltage exists at the integrator input which causes the AGC to compensate by increasing the level of LF voltage to the LF detector. The increase in LF level at the AGC circuit is routed to the Service Monitor, and is directly proportional to the increase in RF sensed by the directional coupler.

The error correcting action of the AGC/LF detector loop circuit corrects for law variations in the RF detector, thereby extending its linear output range.

The RF and LF detector diodes for each channel have matched characteristics and are mounted close together to ensure thermal equilibrium. However, DC level differences due to temperature are compensated by a unique auto-nulling scheme (patent applied for) which further extends the detector dynamic range.

PEP operation

The integrator and AGC/LF loop circuit is not suitable for AM signals, therefore for PEP operation it is switched out of circuit. The RF detector output is routed to a peak buffer which in channel 1 outputs a positive voltage and in channel 2 outputs a negative voltage proportional to the forward and reverse peak envelope voltage on the RF line under test.

Control circuit

Signal switching for CW/PEP signal paths is controlled by the Service Monitor through a control circuit hybrid in the power head. The control circuit directly controls the operation of the zero-loop circuit.

Power supply and oscillator

A power supply and oscillator circuit hybrid in the Power Head is powered by +12 V DC from the Service Monitor. It provides the nominal 1 kHz signal to each channel AGC circuit, and also ± 6.5 V DC supplies to the Power Head circuits.

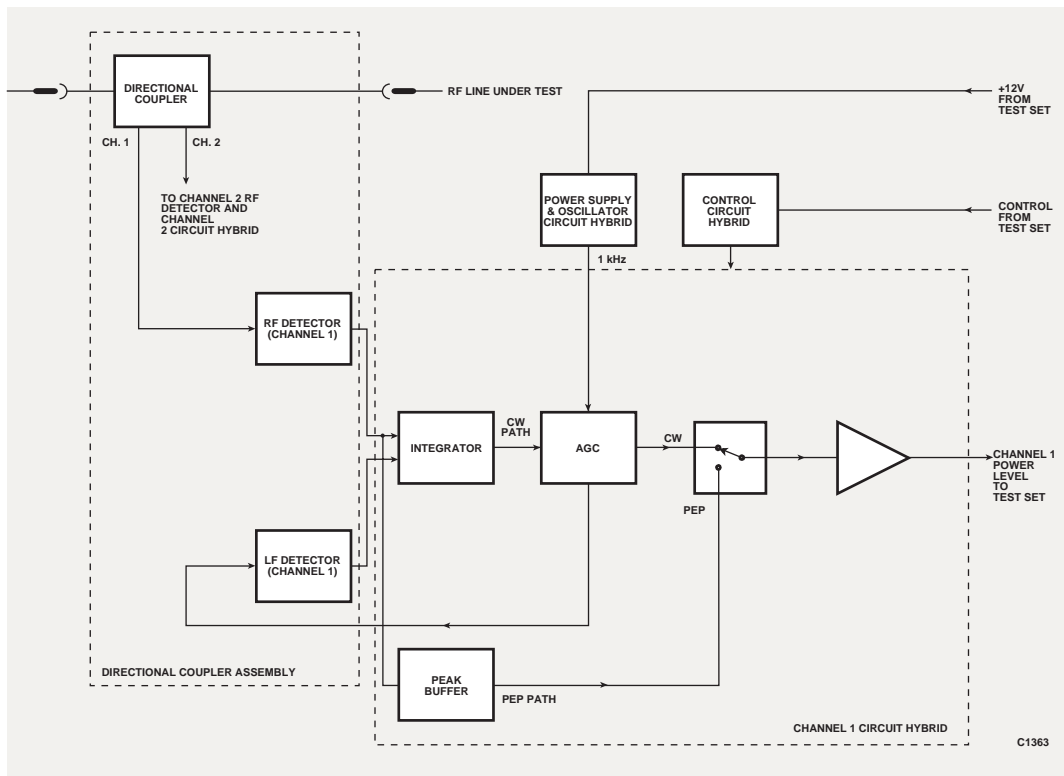


Fig. A-6 Simplified block diagram of HF or UHF power head

Appendix B

LIGHT-WEIGHT DIRECTIONAL POWER HEADS

Contents

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Performance data	B-7
Using the Light-weight Directional Power Head accessory.....	B-9
General	B-9
Power supply	B-9
Procedure.....	B-9

List of figures

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Fig. B-2 Directional Power meter screen (Light-weight DPH).....	B-10

Precautions

WARNING

These terms have specific meanings in this manual:

WARNING

Information to prevent personal injury.

Safety

This product has been designed and tested in accordance with IEC1010-1 (BS EN61010-1) 'Safety requirements for electrical equipment for measurement, control and laboratory use.'

WARNING



RF hazard

When measuring high VSWR ratios, hazardous voltages may be present on the line due to standing waves. Under these conditions, it is dangerous to operate the equipment with the covers removed.

WARNING



Toxic hazards

Some of the components used in this equipment may include resins and other materials which give off toxic fumes if incinerated. Take appropriate precautions, therefore, in the disposal of these items.

Précautions

WARNING

Les termes suivants ont, dans ce manuel, des significations particulières:

WARNING

contient des informations pour éviter toute blessure au personnel.

Sécurité

Ce produit a été conçu et testé conformément à la norme IEC 1010-1 (BS EN 61010-1) recommandations de sécurité des équipements électriques pour la mesure, le contrôle et l'utilisation en laboratoire.

WARNING



Danger RF

Lors de la mesure de T.O.S. de valeur importante, des tensions dangereuses dues aux ondes stationnaires peuvent apparaître sur l'alimentation. Dans ces conditions il est dangereux de faire fonctionner l'appareil sans ses capots de protection.

WARNING



Danger produits toxiques

Certains composants utilisés dans cet appareil peuvent contenir des résines et d'autres matières qui dégagent des fumées toxiques lors de leur incinération. Les précautions d'usages doivent donc être prises lorsqu'on se débarrasse de ce type de composant.

Vorsichtsmaßnahmen

WARNING

Diese Hinweise haben eine bestimmte Bedeutung in diesem Handbuch:

WARNING

dienen zur Vermeidung von Verletzungsrisiken.

Sicherheit

Dieses Produkt wurde in Übereinstimmung mit der IEC 1010-1 Norm (BS EN 61010-1) für "Sicherheitsanforderungen an elektrische Geräte in der Meßtechnik, für Steuerungen oder im Laboreinsatz" entwickelt und geprüft.

WARNING



Hochfrequenz

Bei Messung von hohen Stehwellenverhältnissen können sich auf der Leitung gefährliche Spannungen aufbauen. In solchen Fällen darf das Gerät nicht bei geöffnetem Gehäuse betrieben werden.

WARNING



Warnung vor giftigen Substanzen

In einigen Bauelementen dieses Geräts können Epoxyharze oder andere Materialien enthalten sein, die im Brandfall giftige Gase erzeugen. Bei der Entsorgung müssen deshalb entsprechende Vorsichtsmaßnahmen getroffen werden.

Precauzioni

WARNING

Questi termini vengono utilizzati in questo manuale con significati specifici:

WARNING riportano informazioni atte ad evitare possibili pericoli alla persona.

Sicurezza

Questo prodotto è stato progettato e collaudato in accordo con le norme IEC1010-1 (BS EN61010-1) "Safety requirements for electrical equipment for measurement, control and laboratory use" (Requisiti di sicurezza per apparati elettrici di misura, controllo e di laboratorio).

WARNING



Rischio a RF

Durante la misura di ROS di valori elevati, la presenza di onde stazionarie può causare tensioni pericolose. In queste condizioni è quindi rischioso usare lo strumento coi coperchi rimossi.

WARNING



Pericolo sostanze tossiche

Alcuni dei componenti usati in questo strumento possono contenere resine o altri materiali che, se bruciati, possono emettere fumi tossici. Prendere quindi le opportune precauzioni nell'uso di tali parti.

Precauciones

WARNING

Estos términos tienen significados específicos en este manual:

WARNING contienen información referente a prevención de daños personales.

Seguridad

Este producto ha sido diseñado y comprobado de acuerdo con la norma IEC 1010-1 (BS EN61010-1) sobre "Necesidades de seguridad para equipos eléctricos de medida, control y laboratorio.

WARNING



Riesgo de RF

Cuando se miden valores elevados de ROE, pueden existir tensiones elevadas debido a ondas estacionarias. Bajo estas condiciones resulta peligroso operar con el equipo sin las tapas puestas.

WARNING



Aviso de toxicidad

Alguno de los componentes utilizados en este equipo pudieran incluir resinas u otro tipo de materiales que al arder produjeran sustancias tóxicas, Por tanto, tome las debidas precauciones en la manipulación de esas piezas.

Features

This accessory is used to measure forward power, reverse power and VSWR in coaxial RF transmission lines and antenna systems. There are two versions as follows:-

70 MHz to 1 GHz	54421-016
400 MHz to 1 GHz	54421-018

There are no controls fitted to the Light-weight Directional Power Head. RF line input and output connections are by 'N type' connectors. A multicore lead with an 8way DIN connector at the end supplies the connection to the service monitor.

The Light-weight Directional Power Head is not unique to the Communications Service Monitor 2945A, therefore an active adaptor is supplied. This connects between the ACCESSORY socket on the service monitor and the connecting lead from the power head.

Performance data

RF frequency range

70 MHz to 1 GHz	(54421/016)
400 MHz to 1 GHz	(54421/018)

RF power measurement

Display resolution	0.1 dB
Input power	
400 MHz to 1 GHz	20 mW to 50 W; CW, PEP
Accuracy	<±1 dB (P = 1 W) typically 0.5 dB (P = 1 W)
Input power	
70 MHz to 400 MHz	(54421/016 only)
70 to 88 MHz	0.5 W to 50 W
88 to 180 MHz	0.25 W to 50 W
180 to 400 MHz	0.1 W to 50 W
Accuracy	
70 to 88 MHz	<±1.5 dB (P = 10 W)
88 to 180 MHz	<±1.5 dB (P = 5 W)
180 to 400 MHz	<±1.5 dB (P = 2.5 W)
Display	Watts Barchart

VSWR measurement

Range	1.2 : 1 to 10 : 1
Resolution	0.1 : 1 (VSWR 1 : 1 to 3 : 1) 0.2 : 1 (VSWR 3 : 1 to 5 : 1) 0.5 : 1 (VSWR 5 : 1 to 10 : 1)
Display	Numerical Barchart

Indication of antenna short circuit

Red LED on the power head

Dimensions and weight

Dimensions	Height 30 mm Width 75 mm (body only), 110 mm (inc. connectors) Depth 120 mm
Weight	<600 g

Part numbers

The IFR part numbers for the power heads and adaptor combinations are:-

400 MHz to 1 GHz power head	59999/173
400 MHz to 1 GHz power head and adaptor	54421/018
70 MHz to 1 GHz power head	59999/174
70 MHz to 1 GHz power head and adaptor	54421/016
Adaptor only	46884/789

Using the Light-weight Directional Power Head accessory

General

The Light-weight Directional Power Head can only be used with the Communications Service Monitor 2945A if the adaptor 46884/789 is used. This is either supplied with the Light-weight Directional Power Head as an accessory kit or can be obtained as a separate item. See the performance data section of this appendix.

Power supply

No additional power supply is required. 12 V DC is supplied from the accessory socket to the adaptor, which in turn provides the supply for the power head.

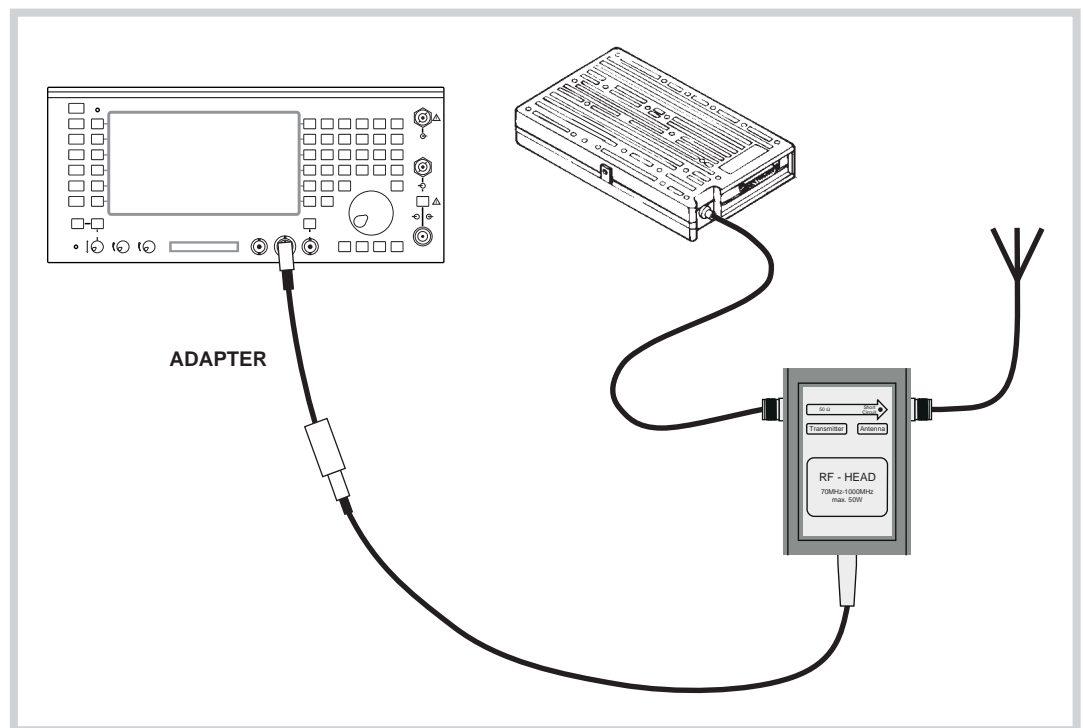
Procedure

Connections

WARNING

RF HAZARD. No attempt should be made to connect the Light-weight Directional Power Head to an RF line until the "Precautions, RF Hazard" have been noted.

Connect the multicore cable from the power head to the adaptor 46884/789, and connect the DIN plug from the adaptor to the ACCESSORY socket of the service monitor. See Fig. B-1.



C2557

Fig. B-1 Connecting the Light-weight Directional Power Head

Select either the Tx or Dx operating mode by pressing the appropriate mode key.

Press the [Tx Power] key, which will display the screen shown in fold out diagram (2.1) or (4.8).

Press the [Dir Power] key. The screen shown in Fig. B-2.

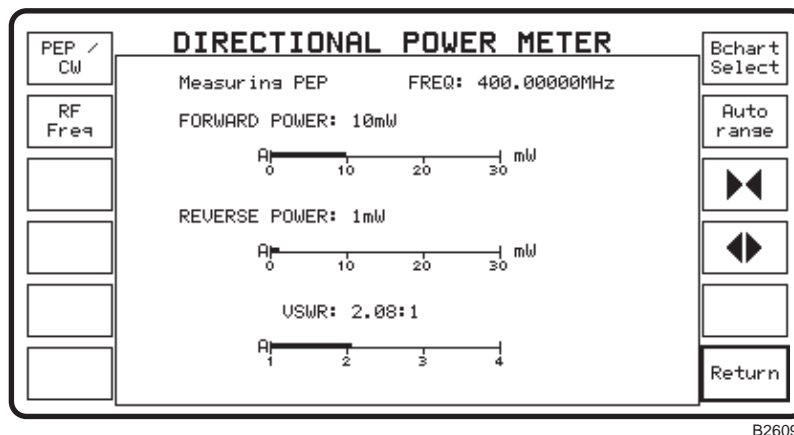


Fig. B-2 Directional Power meter screen (Light-weight DPH)

The power head is now installed and the service monitor ready to make directional power measurements.

Ensure that the transmitter power is OFF and an antenna or load is connected to the transmitter.

The RF connections should be made so that the signal path from the transmitter to the antenna is in series, through the power head, in the direction of the arrow on the front panel.

The power head is able to operate in two modes, CW mode for measuring Carrier Wave, Frequency Modulation or Phase Modulation signals; PEP mode for measuring amplitude modulation or Single Side Band signals.

Press the [PEP/CW] key to switch between the two modes. The current selection is shown near the top of the screen.

Set the frequency of the signal to be measured, using the [RF Freq] key and the data keys.

Switch on the transmitter under test. Readings appear on the screen for forward and reverse power levels and of VSWR. The values appear on the three horizontal barcharts.

Digital readings are also displayed for each of the three values, with a maximum resolution of three figures. Below 10 mW the power readings are reduced to a single figure, with two figure resolution up to 99 mW.

The barcharts can be set for autoranging or manual range selection. Repeated presses of the [Bchart Select] key selects each barchart in turn. The selected barchart is indicated by an **A** or **B** at the left end.

Pressing the [Autorange] key will switch the selected barchart to autoranging, indicated by an **A**.

To change a barchart from autoranging to a specific range, first select the barchart using the [Bchart Select] key, then press the [◀▶] key or [▶▶] key, until the required range is selected. If the barchart was in autorange mode, the first press of a range change key will place the barchart in 'Hold' mode without changing the range.

The barchart indications of the service monitors power measurement range is covered in 10 ranges. The lowest range has a maximum indication of 30 mW, with 10 mW and 20 mW divisions. The highest range has a maximum indication of 1 kW, with 0.2, 0.4, 0.6 and 0.8 kW divisions. Between these, the ranges continue in a 1, 3, 10 sequence.

The RF power range covered by the Light-weight Directional Power Head depends upon the frequency of the signal being measured. Refer to the performance data relating to the specific power head type, for the usable power range.

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