

Precautions

Contents

COMMUNICATIONS SERVICE MONITOR 2945



Safety

PROVISIONAL

WARNING

Electrical hazards

AC supply voltage

This equipment conforms with IEC safety class II 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. The supply must be a grounded circuit.

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Chapter 2 INSTALLATION

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

The latter situation could well apply where an instrument is used by several users for differing tasks.

Initial visual inspection of new instruments

After unpacking the instrument 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.

3. Insulation Tests

A 500 VDC 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 instrument 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. Marconi Instruments products employ reinforced insulation in their construction and hence a minimum pass limit of 7 MΩ should be achieved during this test.

Where a DC power adapter is provided with the instrument the adapter must pass the 7 MΩ 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.

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 instrument 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 Marconi Instruments Ltd.

The above information is provided for guidance only. Marconi Instruments products are designed and constructed in accordance with International Safety Standards such that in normal use they represent no hazard to the operator. Marconi Instruments Ltd reserve the right to amend the above information in the course of continuing its commitment to product safety.

WARNING

NOTE

Ventilation

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

CAUTION

The instrument requires an unrestricted airflow to ensure that its performance meets the specification. Before switching on the instrument 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 instrument. Ensure that these are not obstructed.

Power requirements

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

AC supplies must be within the range 94 V to 264 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 instrument is designed to handle this wide spread of input variations.

For DC operation, the instrument 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 instrument, 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.

Fitting AC supply connections

The three core AC power lead supplied with the instrument is fitted with a female connector at one end which mates with the male connector on the rear of the instrument. The other end of the lead is supplied with trimmed and tinned tails.

When fitting a mains connector that uses screw connections, it is recommended that the tinned portion of each conductor is removed and the tails re-made and left un-tinned.

The conductors must be connected as follows:-

Yellow/green to earth.

Blue to neutral.

Brown to live.

Connecting to a DC supply and fitting batteries

If the instrument is to be used from a DC voltage source it should be connected using the supplied DC connecting lead. 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 instrument and therefore to all screen connections of input and output connectors. Note however, that the AF ports are isolated under some operating conditions.

The instrument 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 instrument.

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

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

When the DC supply powering the instrument 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 instrument 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 instrument.

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, MI Part No 43137-052Y and a 1 metre, 'N type' male to 'N type' male, connector lead 54311-095C are both available from MI 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.

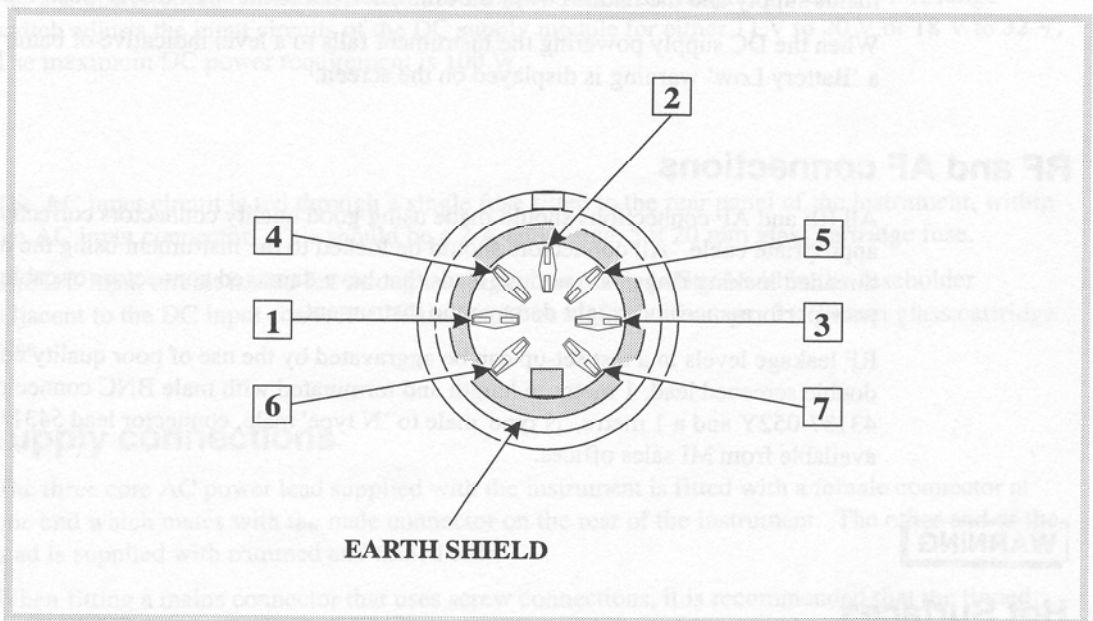
Accessory socket connections

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. 2-1, Accessory in/out socket pin numbers, and is as viewed from the front of the instrument.

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 instrument, is shown in Fig. 2-1 'Accessory in/out socket pin numbers'.



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Fig. 2-1 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 on pins 1,3 and 6 enable the instrument 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. 2-2 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		

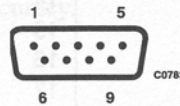
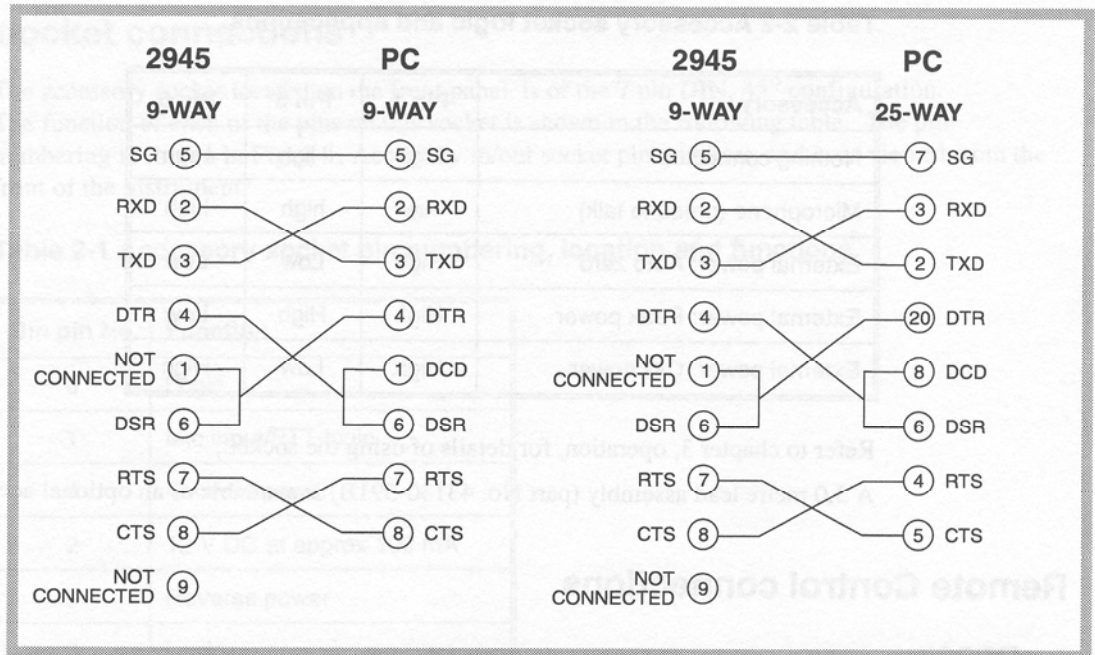


Fig. 2-2 RS232 serial port connections (as seen facing panel)

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. 2-3.



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Fig. 2-3 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 instrument connector will result.

The pin connections are listed below and the pin locations shown in Fig. 2-4 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

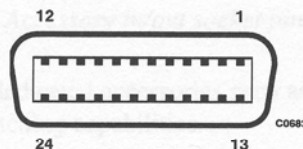


Fig. 2-4 IEEE488 parallel port connections (as seen facing panel)

Acceptance tests (inc Self tests)

Acceptance tests applicable only to any 'SYSTEMS' testing options, which may have been installed in this instrument, are not described here. Details of these tests will be found in the operating instructions of that test system.

Self Tests

The 2945 has a built in 'Self Test' program which 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 is comprised of 17 tests, which are listed on the display when the [Self Test] key is pressed.

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 band width 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. 1kHz.

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 band width 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 instrument

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 instrument is fitted with a filter to prevent the ingress of foreign matter into the instrument. This should be inspected and cleaned at regular intervals. The procedure for this is as follows:-

Disconnect the instrument from the mains supply and from any DC supply.

WARNING

Remove any other connections to the instrument.

Note

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

Stand the instrument face down on a firm, non-scratch flat surface so that the front handles are supporting the instrument. The rear of the instrument, with the fan housing, should be at a safe and accessible working height.

Remove the two M4 screws holding the fan cover to the rear of the instrument and lift the cover away. The dust filter can now be removed.

Lift the filter from the fan taking care not to tilt any foreign matter into the fan.

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.

Replace in the instrument in the reverse manner.

If the filter is damaged or blocked, a replacement is available as MI part No. 37491-440N.

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 instruments must be disconnected from the mains supply and all external signal connections removed. All tests should include the instrument'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 dependant 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 instrument 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 instrument 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 (Class I Equipment only)

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 0.1 Ω 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.

Chapter 3

LOCAL OPERATION

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About this section

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 set-up procedure is explained.

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

The internal set-up 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 two of this manual (Installation).

Conventions

The following conventions apply throughout this manual:-

RF IN/OUT Titles shown on the instrument panel are shown in capital letters.

[SELECT] Hard key titles are indicated by normal lettering in square brackets.

[RF Gen] Soft key titles are shown in Italic lettering in square brackets.

Front panel layout

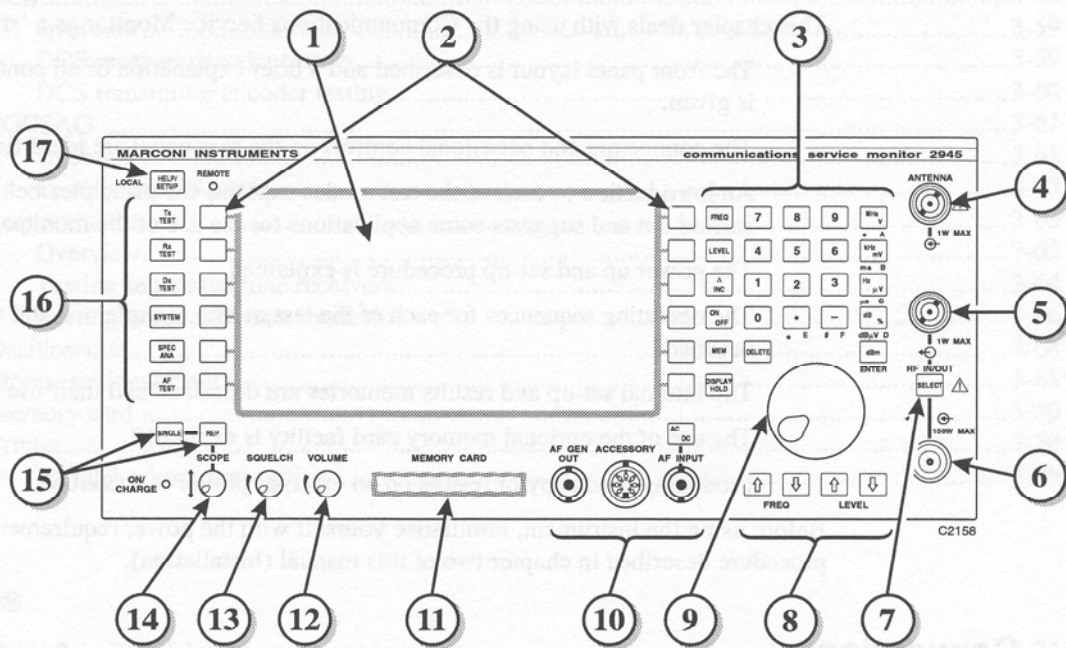


Fig. 3-1 Front panel

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 on page 3-5

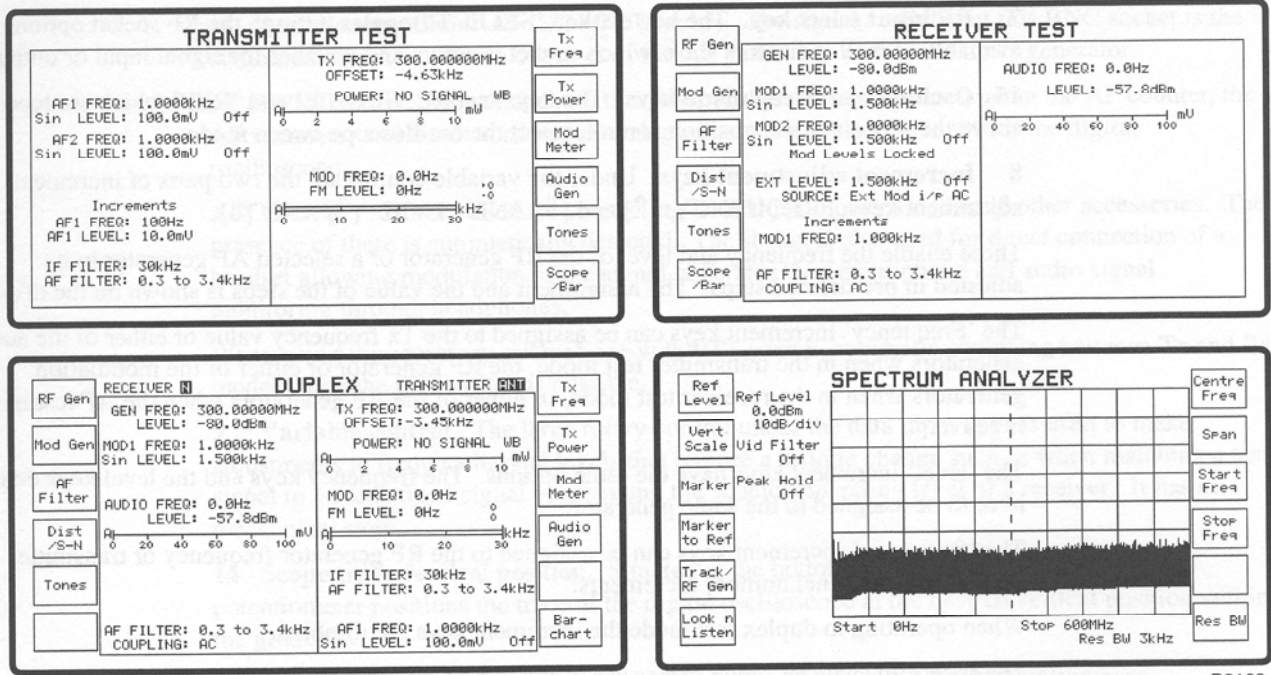
The screen is divided into four main areas. They are:-

The information display area, which shows the parameters relating to the test, together with settings and results, including bar graphs. When the oscilloscope function is called up, all bar graphs are removed from the display and the oscilloscope screen inserted in the lower right quarter.

The standard display is replaced with the spectrum analyzer screen when this mode is called into use.

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 'duplex' 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 transmitter test mode and the audio test mode both display and use only the right hand soft keys, the receiver test mode only the left hand soft keys. Duplex testing uses the right hand soft keys for transmitter test functions and the left hand soft keys for receiver functions.



B2168

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.

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 at any time, when the instrument is under local control, will cause the HELP/SETUP ACCESS screen to be displayed. The action of calling up the set-up screen does not interrupt any on-going function of the monitor.

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.

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.

7 RF input select key. The key marked 'SELECT' toggles through the RF socket options available. Small indicators show which socket is active and whether for signal input or output.

15 Oscilloscope sweep mode keys. The keys marked 'SINGLE' and 'REP' which are located above the scope vertical position control, select the oscilloscope sweep mode.

8 Increment adjustment keys. Under the variable control are the two pairs of increment adjustment keys, FREQUENCY: [↑] and [↓] AND LEVEL: [↑] AND [↓].

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 'Frequency' increment keys can be assigned to the Tx frequency value or either of the audio generators when in the transmitter test mode, the RF generator or either of the modulation generators when in the receiver test mode, or either of the AF generators when the AF test mode is active.

The 'level' increment keys have the same options. The frequency keys and the level keys do not have to be assigned to the same generator.

The 'frequency' increment keys can be assigned to the RF generator frequency or transmitter frequency as channel number increments.

When operating in duplex test mode the increment keys are disabled.

The spectrum analyzer mode makes use of the increment frequency adjustment keys for span range 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.

The level increment 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.

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. Pressing this key also gives access to the 'Store/Print' menu. This allows current instrument settings and results of tests to be stored within the instrument memory for later retrieval or for the results of the current test screen to be printed on a suitable printer.

AF input coupling option key AC/DC. 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.

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.

The nominal impedance of all RF input and output circuits is 50 Ω.

4 The female BNC Antenna socket is the low level RF input socket with a maximum handling capability of 1 Watt. Primarily intended for 'Off Air' measurements and monitoring.

5 The BNC RF output socket is used only for RF signal output. The maximum reverse power that can be applied to it is 1 Watt.

6 The 'N type' female connector is dual function, input and/or output. A 20dB bi-directional attenuator is in series with this connector. This permits the maximum power input to the connector to be 50 W continuous or 150 W for 1 min.

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.

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.

9 Variable control. The large rotary control under the data input keys is used to make adjustments to frequencies and levels that require an infinite 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.

14 Scope trace vertical position. Situated at the bottom left of the front panel, this potentiometer positions the trace of the digital oscilloscope at the desired vertical position within the graticule.

13 RF receiver squelch level control. This is the centre of the three potentiometers.

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.

12 Volume. The right-hand of the three, this control varies the level of the AF signal fed to the loudspeaker.

11 Memory card slot (Optional). Instruments with the 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' and 'Memory Card'.

Rear panel controls and connectors

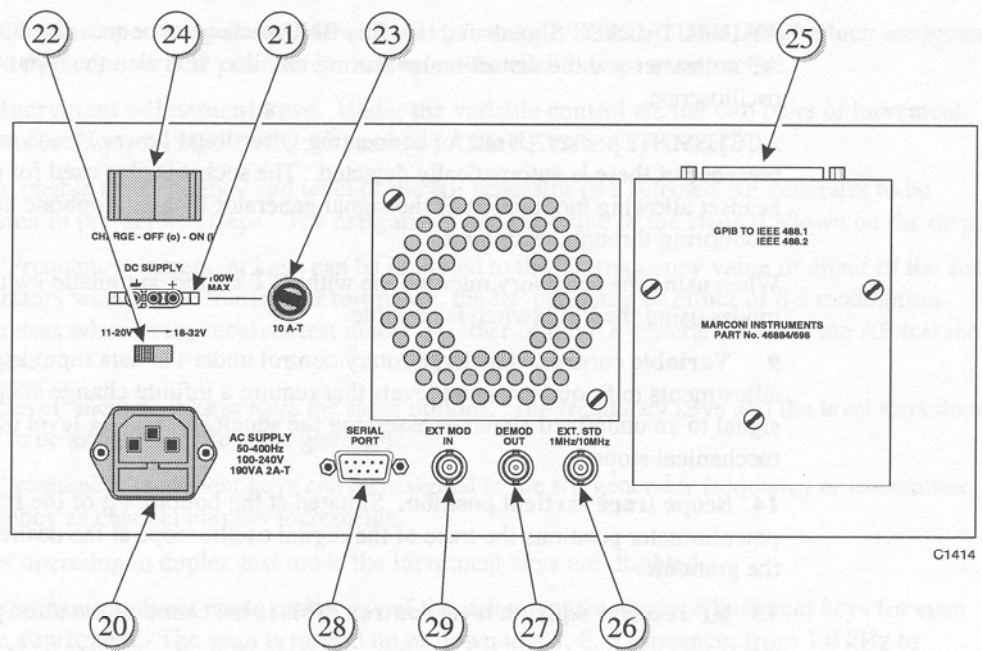


Fig. 3-3 Rear panel layout, (with optional GPIB fitted)

On the rear panel of the instrument are:-

- 20 AC power supply input connector.** One range for all mains voltages. See performance specification. The AC supply fuse is contained within this connector.
- 21 DC supply input voltage connector.** For direct connection of optional accessory battery pack and for powering the instrument from other DC supplies. See performance specification.
- 22 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.
- 23 DC supply fuse.**
- 24 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 2945 power supply to recharge the accessory battery pack (if connected) from the AC mains supply. See 'Getting Started; (Applying Power and Selecting Test Modes)' on Page 3-9.
- 25 GPIB interface.**
- 26 External frequency standard input.** This may be 1MHz or 10MHz, as the instrument will automatically adjust to suit either frequency. In the event of external standard failure control will revert to the internal standard.
- 27 Demodulated signal output.** The demodulated signal removed from the input RF signal is brought to this connector for feeding to external equipment.
- 28 Serial output socket.**
- 29 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).

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 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. The choice of screen displayed on power up is selectable by the user from the set-up screens and menus accessible using the 'HELP/SETUP' key.

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

The following explanation of keys and menus used with the menu illustrations as a reference will assist in this. The figures in brackets e.g.: (1.2.) cross-refer to the screen/menu illustrations.

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, **17** at any time will display the screen shown in (1.0)

This action does not interrupt any on-going operations of the monitor.

Help

The help facility is accessed by using the [HELP] soft 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 tests

Pressing this key gives access to the instrument 'Self Test' function. Refer to Chapter 2, 'Acceptance tests, Self tests.' for details.

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.

Set-up pages

The set-up facilities allow selection of options of user preference and system compatibility. There are two pages of set-up options accessed by soft keys.

Page 1, Menu (1.10), allows option selection of RF generator facilities.

Page 2, Menu (1.10.6), allows selection of the AF level measurement units, the allocating of a GPIB address, the selection of remote control options, serial port set-up options and memory card set-up.

Brightness and contrast of the display can be adjusted without leaving the HELP/SETUP screen and then returning to the previous or on-going operation by using the RETURN key.

Set-up page 1 (1.10) (RF parameters)

RF Counter Resolution 1Hz/10Hz

The choice of 1 Hz or 10 Hz resolution for the RF counter is selectable. 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 choice 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 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 press the dB terminator key.

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

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

Rx=Tx Offset Freq: Hz

A set-up option within the transmitter 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/Set-up Menu.

Set-up page 2 (1.10, 6) [AF parameters, GPIB address]**Audio Level Measured in volts/dBm/dBV**

The level of a signal applied to the AF input socket is measured in terms of the selected option.

Repeated presses of the adjacent soft key will toggle through the options. The highlighted choice will then apply to all subsequent measurements.

The presentation of 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 this soft 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 serial (RS232) port can be configured as a printer output port or as a remote control port. When the GPIB (IEEE 488) interface option is fitted it is made active whenever the serial port is configured as a printer output port. The *[Remote Control]* key toggles between the two options and causes the legends of the active functions to be shown in reverse video.

Serial Set-up

This soft key gives access to the serial port set-up 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 later under the headings of 'Printer connections' in Chapter 2, 'Printer Output' in Chapter 3 and in Chapter 4, (Remote Control).

Printer Set-up

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.

Power Up From

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

'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.

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

'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.

Memory card set-up

A 'Memory Card' placed in the memory card slot can be formatted and electronically titled from the screen and menu available after pressing the [Card Set-up] key. Details of this procedure is given later under the heading 'Memory Cards'.

Return

Returns to the last screen displayed prior to the pressing of the Help/Set-up mode key.

Test mode screens and menus

The six test modes are selected by pressing one of the blue keys. 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 illustrations of the screens displayed when each of the mode keys is pressed, together with a branching diagram of the second level screens and menus, are given at the end of this chapter. An illustration of the screens accessed from the HELP/SETUP key is also included.

These illustrations are numbered to correlate with the activating key position. The top level screens are numbered 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

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

Spectrum analyzer

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

Data relating to the set-up and to measurements of the signals being analysed are 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 oscilloscope, available from the Tx, Rx and AF test modes, uses a graphical presentation within the right-hand half of the display screen. See the oscilloscope section of this chapter.

Using the testing modes

Note

The transmitter test mode, (Tx TEST) the receiver test mode (Rx TEST) and duplex test mode, (Dx TEST), are interdependent, rather than isolated, functions. Selecting a particular test mode should be considered as an alternative view of the on-going test procedure.

When the transmitter test mode is selected, the receiver test mode is not disabled. Therefore the RF generator remains active unless it has been disabled by selecting the 'OFF' option within the receiver test mode or duplex test mode. Similarly, a set-up from within the duplex test mode will remain active and unchanged if the Tx or Rx mode is selected.

Use of the press to talk facility on the optional accessory, 'microphone with PTT switch', Part No 44991-145 gives a mode switching capability to the Tx test mode. 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 Rx or Dx test mode, pressing the PTT switch will allow voice modulation of the RF signal but no mode switching will take place.

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 duplex test mode. References are made to duplex mode to clarify this or to identify a difference in presentation. These references are headed *DUPLEX*

References are also made to the oscilloscope function under the heading *OSCILLOSCOPE*.

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

Pressing this key will display the menu shown in either (2.5), (3.5), (4.5) or (7.5) and give access to the 'Calling 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.

The duplex 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 term radio transmitter is used to describe a piece of electronic equipment which produces a defined frequency of electromagnetic oscillation and radiates the oscillations outside of its own confines, either directly or by means of an external antenna.

The scope of this definition embraces high power installations radiating thousands of watts of energy to carry entertainment, commercial or diplomatic information over thousands of miles; medium power equipment providing local area broadcasts for radio and television, radio telephone systems both private and of the cellular type; and also extremely low power devices used for personal communications, 'toy walkie-talkies' and information gathering from inaccessible locations.

The transmission frequency of a transmitter will depend on many factors such as the distance that the transmission is required to carry, the size of antenna system available and conformity with international and national frequency allocations.

In general, transmitters will be found using frequencies from as low as 50 kHz up to several GHz.

The transmitter may be the only radiating device of its system, such as a broadcast transmitter, or it can be one of many similar units coupled to suitable receivers, employed to form a network for

intercommunication between several locations. A common type of network uses a medium power transmitter as a base station, with low power units communicating with it.

With a few exceptions such as frequency standard transmitters, all transmitters have the intelligence that they are to convey superimposed onto the basic electromagnetic oscillation. This superimposition process is known as modulation. The three basic methods of modulation are by starting and stopping the transmission to form pulses, by varying the level of the transmission, or by varying the frequency of the transmission.

There are many systems of modulation, each with its own descriptive title, but all are variations and combinations of these three basic methods.

The 2945 Communications Service Monitor is primarily designed to monitor the performance of mobile communication equipment, therefore the specification of the instrument and the interconnections and controls are configured to meet the requirements of this type of equipment. It follows that the interconnections, set-ups and test examples given in the following procedures will reflect this .

Transmitter testing is required for a variety of reasons; Performance checking following manufacture, as a routine quality assurance procedure, for fault diagnosis or location 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:-

a	Transmitter power
b	Transmitter frequency
c	RF distortion
d	Spurious outputs
e	Modulation characteristics
f	Modulation frequency response
g	Companding/limiting
h	Modulation distortion

The 2945 communications service monitor will perform all of the above tests.

With the transmitter test mode selected, the screen and menu shown in menu diagram (3.0) is displayed.

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

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. Single sideband modulation can be demodulated if the option has been implemented.

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

As well as setting up the major sections of the monitor, the selection of the following parameters is undertaken from the transmitter test screen:-

IF filter bandwidth.

AF filter pass-band.

Inclusion of de-emphasis filtering.

Selection of distortion measurement methods.

Connections

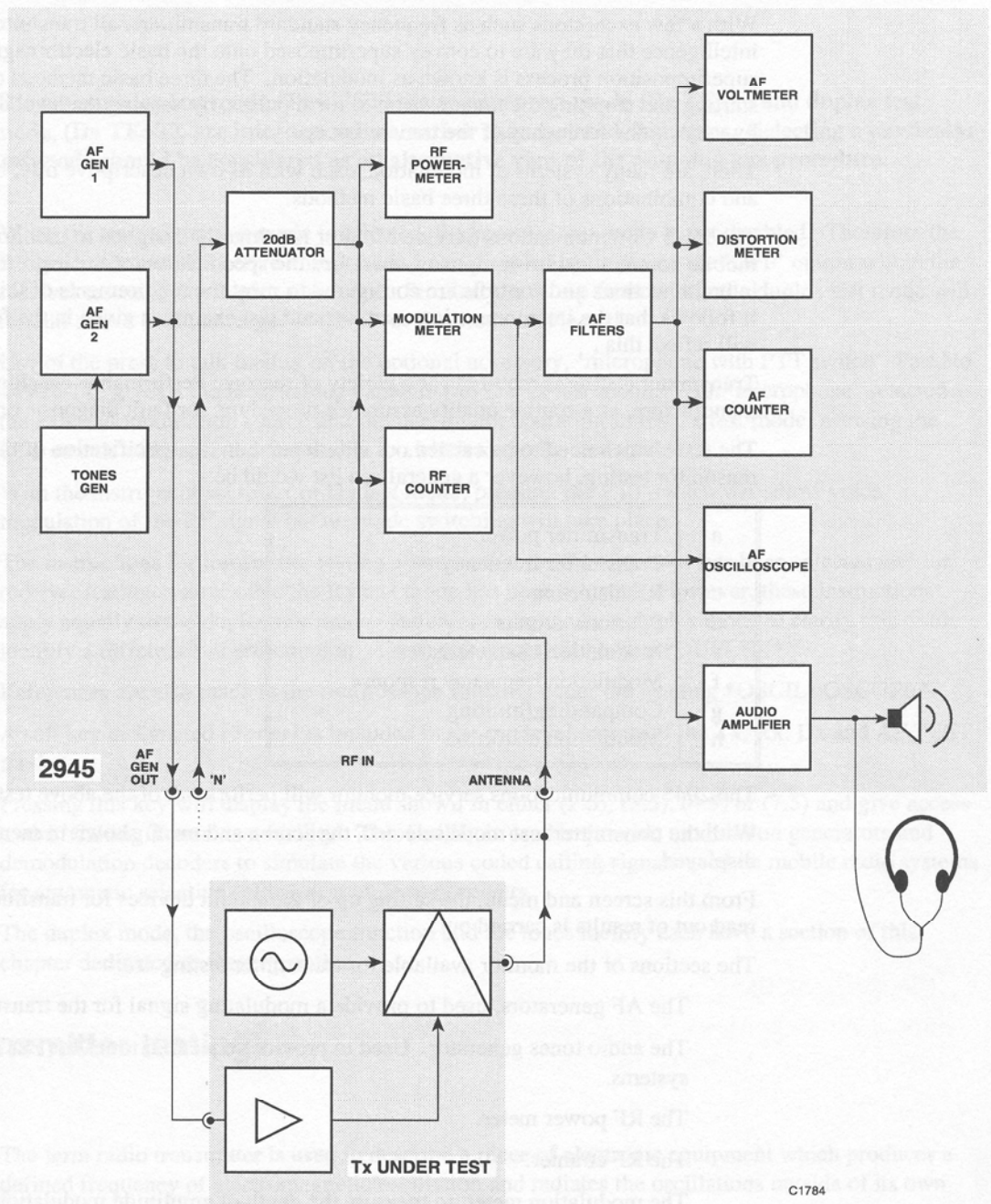


Fig. 3-4 Transmitter test connections

The transmitter and the monitor are connected as shown in the diagram. Fig. 3-4 on page 3-16 Diagram of transmitter test set-up (including block diagram of monitor modules).

The Audio frequency input connection must be to the audio input of the transmitter 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 effect the performance of the set-up.

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 of 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 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.

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 power source for the transmitter should be reliable and stable. A battery 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.

Setting up

When all the required connections have been made, select the transmitter test mode to display the screen (2.0).

Work through the transmitter test menus, setting the parameters or options to the test requirements.

The set-up can be stored for future recall by making use of the internal set-up/results memories or the optional memory card facility. Both of these features are described under 'stores' later in the chapter.

Tx frequency

Press the [Tx Freq] key.

The soft key options change to those shown in (2.1)

The frequency of the transmitter to be tested can either be entered manually or be established automatically.

Manual frequency setting

Range; 100 kHz to 1.05 GHz

The Tx FREQ legend in the main display is shown in inverse video to indicate that data may 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. Pressing one of these for MHz, kHz or Hz entries causes the entered frequency to be displayed according to normal convention. The following examples explain further:-

Pressing:-

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

Frequency increment

An incremental change can be made available to transmitter frequency adjustment. The **FREQ** [\uparrow] and **FREQ** [\downarrow] keys, adjacent to the variable control effect these changes. Refer to the section on incremental adjustments which starts on page 3-54.

Automatic frequency setting

Pressing the autotune key causes the instrument to lock onto the strongest signal fed into the instrument at one of the RF input sockets, measure the mean frequency of the signal and display it as the Tx frequency with the legend 'AUTOTUNE'.

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 2945 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 receiver 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. ($Rx=Tx \pm \text{offset}$) See the option selections within set-up page one for more information.

After setting the transmitter frequency and any associated adjustments use the **RETURN** key to revert to the original Transmitter Test menu.

Tx power

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

Broad Band, or In Band, power

The **[Broad/In Pwr]** key selects which of the RF power measurement methods is operative. The selected method is indicated on the display by the letters **WB** or **NB** to the right of the digital power reading. The use of this facility is explained under 'Making measurements' later in this chapter.

Directional Power

The **[Dir Power]** key displays the screen required for making directional power and **VSWR** measurements using the optional 'Directional Power Head' accessory. The use of this accessory is described in appendix A of this manual. 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 bargraphs. The upper bargraph shows the power meter reading and is the same as that shown on the other Tx test screens.

The four bargraphs under the HARMONICS heading 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. 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, thereby allowing the instrument 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.

Pressing the return key will display the previously used Tx test screen with the top level Tx menu.

Modulation meter, demodulation options set-up

Set up the DEMODULATION OPTIONS to be compatible with the transmission from the unit under test.

Select [*MODMETER*] key. The soft key options change to those shown in (2.2) demod soft keys.

Modulation Type

Options; AM. FM. SSB

[*AM/FM/SSB*] selects modulation type by sequential key presses. The MOD LEVEL indication within the main display becomes suffixed by % for AM, MHz or kHz for FM. When 'SSB' has been selected, no modulation level is shown, either digitally or as a bargraph. The demodulated signal is made available at the 'DEMOD OUT' connector on the rear of the instrument.

SSB Input sensitivity

When testing SSB transmitters, no RF carrier signal is transmitted. This would result in the automatic gain control circuits of the 2945 setting the input attenuators to maximum sensitivity.

Therefore when 'SSB' demodulation has been selected, the RF level sensitivity of the 2945 can be optimised. Three sensitivity options are given as soft key choices; high, medium and low. The approximate sensitivities of these are;

[<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 monitor receiver circuits can be selected.

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

Press *[IF Filter]* key. This changes the designation of the right hand soft keys to offer the choice of IF bandwidth filters as shown above.

The action of selecting a filter, by pressing the appropriate soft key, causes the selection to be shown on the main display and the menu to revert to the previous indication of demodulation options.

Audio frequency filtering

The demodulated signal can be filtered using standard passband audio filtering. To select the required AF filter press the AF filter soft key which will bring the AF filter menu into the display.

Options	0.3 - 3.4 kHz	50 kHz low pass	15 kHz low pass	300 Hz low pass
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The selected filter appears on the main display and the soft key menu reverts to the DEMOD options.

De-emphasis filtering, on-off, is toggled by alternate presses of the *[DEEMPH]* key. The de-emphasis filtering uses a 750 μ s time constant to give a 6dB/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.

After setting the modulation meter options return to the main transmitter test menu using the return key.

Audio distortion measurement

Options	Signal to noise ratio	SINAD level	Percentage distortion.
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The last screen to be set up for basic transmitter testing controls the distortion measuring options and is accessed by pressing the MOD DIST'N soft key to display the screen/menu (2.4.)

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 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 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% and 0 to 30%. The distortion percentage level is displayed as a digital readout above the bar chart. The Tx test 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 graph 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.

Audio generator set-up

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 set-up menu. (2.3)

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]

Incremental changes can be designated to the AF generator frequency and level. When the incremental keys have been assigned, these changes are made by repeated presses of the FREQ [\uparrow] and FREQ [\downarrow] and the LEVEL [\uparrow] and LEVEL [\downarrow]. See the section on incremental adjustments for instruction on setting increments, which starts on page 3-54.

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 receiver test mode will show both modulation generators in the 'OFF' condition. Either or both generators can be set up and turned on within the receiver test mode.

The frequency, level and shape settings of their last use in the receiver test mode will be retained within the receiver test mode set-up. 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 mode will then be disabled.

Pressing the LOCK soft 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 transmitter 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 set-up/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.

a. Transmitter power

Broad-band and In-band power measurements

The monitor has both broad-band and in-band power measurement facilities. The broad-band power meter measures the total average power of all signals present at either RF input, while the in-band power meter measures only the average power of the signal contained within the IF pass band selected for the transmitter test mode.

The facilities of the 2945 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 Generator OFF condition from the Rx TEST mode or the Dx TEST mode.

In-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.

A power overload condition is indicated by an audible and visual warning. Should this condition be indicated, immediately remove the source of the power into the monitor by keying down the transmitter.

DO NOT DISCONNECT THE RF CONNECTOR AS THIS CAN DAMAGE THE TRANSMITTER AND DO NOT SWITCH OFF THE MONITOR AS THIS WILL SILENCE THE WARNING BUT WILL LEAVE THE EXCESSIVE POWER CONNECTED TO THE LOAD WITHIN THE MONITOR!!!

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 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. The option is set from the scope/bar menu. Auto ranging is indicated by 'A' at the left of the bar chart, 'H' indicates that the range is held and that any changes must be made by the user.

The full scale ranges available for selection are:-

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

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

Directional power measurements

Directional power and VSWR measurements can be made using the directional power head optional accessories. The display and menu 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.

RF harmonic analysis

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

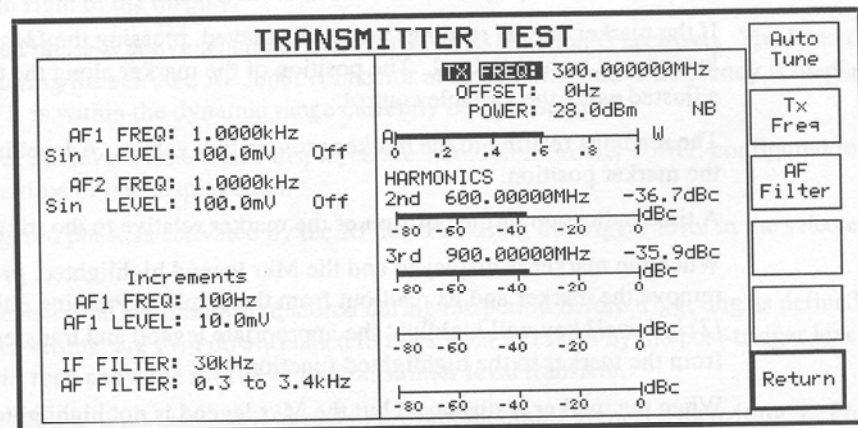


Fig. 3-5 Tx power, harmonic analysis screen

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. 3-15 is displayed. The power level bargraph shows the power output of the transmitter as before. The harmonic content of the signal is shown on the HARMONICS bargraphs. These four bargraphs 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 bargraph, 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 bargraphs which would be given to these frequencies remain inactive.

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

If the Tx TEST mode is exited with the harmonic analysis function selected, when the Tx TEST mode is again selected, the harmonic analysis screen will be displayed.

RF transient power analysis

This facility provides the 2945, with the ability to capture and display changes to the RF levels of signals. The display used to control the transient power analysis function is accessed from the Tx TEST mode by the key sequence [*Tx Power*], [*Trans Analys*].

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 level/time graph showing the transition.

Ref level

The gradicule of the transient analysis screen is calibrated in 10 db/division vertically with the reference level at the top.

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 spectrum analyser 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.

If the marker and its readings are not displayed, pressing the [*Marker*] key will do so. The Mkr legend will be highlighted. The position of the marker along the time axis of the display can be adjusted using the variable control.

The readings relating to the marker provide two values. A level indication of the signal level at the marker position.

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

When the marker is displayed and the Mkr legend highlighted, pressing the [*Marker*] key will remove the marker and its read-out from the display. 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 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 initiated by the signal passing through the set trigger level. The set level is relative to the reference 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 current setting is shown by either a +ve edge legend or -ve edge legend.

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 spectrum analyser 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 [><] key will progressively increase the time/division in a 1, 2, 5 sequence. Using the [>] 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.

The Triggered phase is activated by the RF level crossing the trigger level in the selected direction.

The contents of the circular buffer, stored during the period before triggering as defined by the pre-trigger setting, are then down-loaded to the screen followed by the post-trigger levels. The screen will then show the profile of the transmitter level transient.

Once the display is complete it is stored to prevent incoming signals overwriting it. From this condition a permanent record can be made on a suitable printer by using the display hold, print, function.

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

Whenever a reference level setting, a transmitter frequency setting a display time scale setting or a pre-trigger setting is changed, the function re-arms.

SSB power measurement

The power level bargraph and digital readout are not displayed when SSB demodulation is selected.

When the transmitter being tested is producing a single sideband transmission, the carrier signal and one sideband is filtered out, leaving only one sideband. As this is a product of the original carrier signal and the modulating signal, it will only exist when a modulating signal is present.

It follows from this that steady power levels will only be obtained if the transmitter is modulated with a constant level tone or tones.

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 external attenuator field of set-up page one. 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 mode and in Dx mode.

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

OSCILLOSCOPE

With the oscilloscope facility functional, 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 duplex mode the bar chart and digital display remains in the same location and the indications are identical to those given in the transmitter test mode.

b. Transmitter frequency

The digits adjacent to the 'Tx Freq' legend on the Tx TEST display refer to the frequency to which the 2945 receiver circuits are tuned.

If the frequency of the transmitter is known, this figure can be entered as 'Tx Freq'. This is done by firstly pressing the [Tx Freq] key in the transmitter test 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 close to it 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 2945 receiver circuits in this way in order to successfully decode the initial tones.

If the transmitter frequency is unknown, or it is required to make a direct measurement of it, key up the transmitter and press the [Autotune] key within the Tx freq menu.

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 adjacent to the 'Tx freq' legend.

DUPLEX

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

c. RF distortion, and

d. 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 will produce harmonics or other spurious outputs.

These can be located using the spectrum analyzer mode of operation.

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

The use of the spectrum analyzer mode is explained fully under that heading.

e. Modulation characteristics**f. Modulation frequency response and****g. 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 2945 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 2945 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.

OSCILLOSCOPE

The digital oscilloscope facility can be used for modulation testing. When this facility is active within the transmitter test mode, the monitor demodulator output is applied to the input of the oscilloscope.

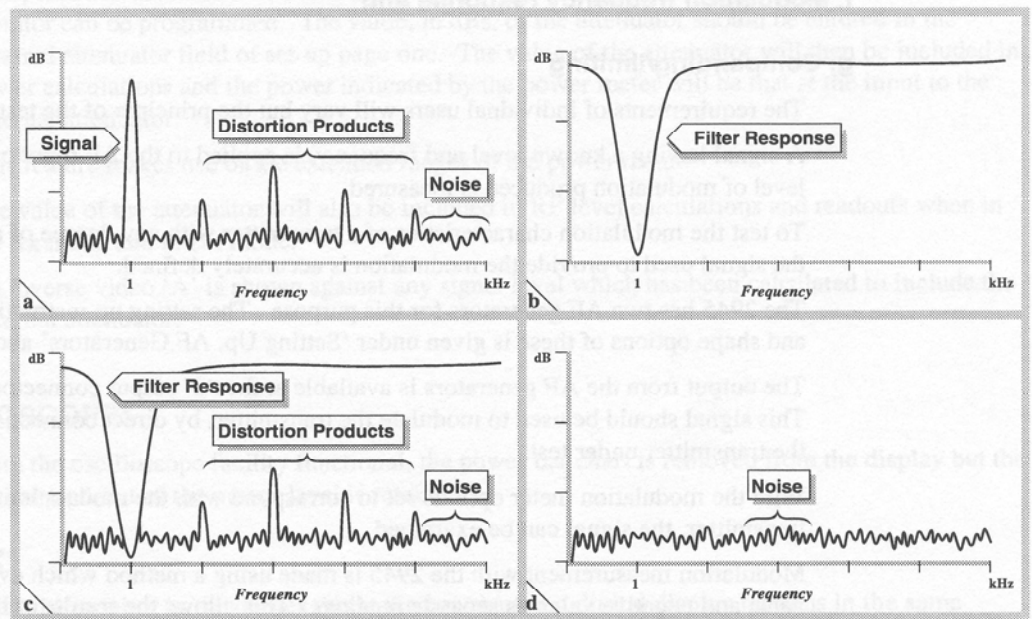
The Y ranges of the oscilloscope are directly calibrated in deviation frequency when FM demodulation is selected and in percent modulation when AM demodulation is selected. The ranges are from 200Hz/ Div. to 10 kHz/Div. in a 1, 2, 5, sequence and 25 kHz/ Div FM and 5%, 10% and 20%/ Div. AM.

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

DUPLEX

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

h. Modulation distortion



C1640

Fig. 3-6 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 unnoticed to the ear or it may be so severe as to cause the information to become un-intelligible.

The reasons for this distortion to the signal are the non-linearity of the amplifiers and modulators in the system and to 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 will comprise of 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 will comprise only of the values of any distortion products generated and the value of any noise present. See Fig. 3-6 on page 3-28 a, b, & c. Diagrams of distortion measuring procedure. 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 will comprise of 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 a second level reading taken. A notch filter is not included in the signal output path. The second measurement will only comprise of the value of any noise present on the demodulated signal. See Fig. 3-6 a, & d. on page 3-28 Diagrams of signal to noise level measuring procedure. 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 2945 Communications Service Monitor has the capability to make all three measurements. Pressing the [Mod Dist] soft key accesses the distortion measurement menu (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 option selected, the distortion level bar chart is not displayed. The distortion %, SINAD level or S/N level is given as a digital presentation.

DUPLEX

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

Rx test (receiver testing)

Overview

The term radio receiver is used to describe a piece of electronic equipment which has internal circuits designed to select one particular frequency within the radio frequency spectrum or that can be tuned over a range of such frequencies, for the purpose of detecting the radiations from a radio transmitter.

The designs of radio receivers are numerous and examples are the familiar domestic broadcast receivers, radio pagers which are activated by a remote radio transmitter, large fixed installations for receiving international communication signals and the receivers that are combined with the transmitters in personal radio telephones.

Fundamental principles of radio receiver design are that the transmission to be received must be able to induce a voltage into the antenna of the receiver, the frequency selective circuits must be tuneable to the frequency of those transmission, other frequencies must be rejected, the modulation on the transmission must be extracted, and finally the information contained within the modulation presented to the user or passed on electronically to other equipment.

The 2945 Communications Monitor is primarily designed to monitor the performance of mobile communication equipment, therefore the specification of the instrument and the interconnections and controls are configured to meet the requirements of this type of equipment. It follows that the interconnections, set-ups and test examples given in the following procedures will reflect this.

Receiver testing is required for a variety of reasons; Performance checking following manufacture, as a routine quality assurance procedure, for fault diagnosis or location 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:-

a	Sensitivity
b	AF Bandwidth
c	AF Distortion
d	Selectivity
e	Blocking (or desensitisation)
f	Spurious response
g	AGC response

With the receiver test mode selected, the screen and menu shown in menu 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 provide modulation of the RF generator.

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

Audio distortion meter

Digital oscilloscope

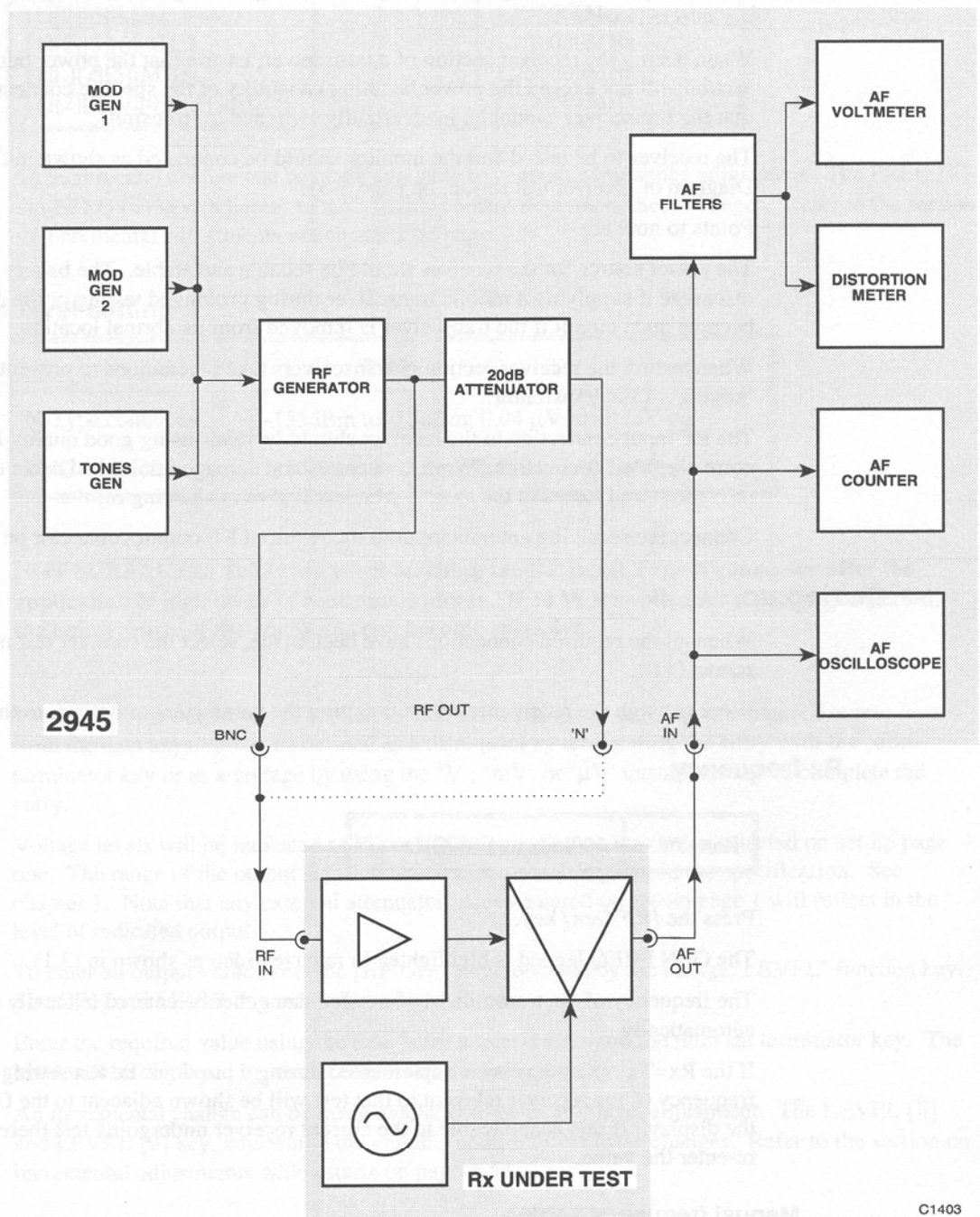
As well as setting up the major sections of the monitor, the selection of the following parameters is undertaken from the receiver test screen:-

Audio filters

Pre-emphasis filtering

Selection of distortion measuring methods.

Connections



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Fig. 3-7 Receiver test connections

Before making any connections between the monitor and the receiver ensure that the RF generator of the monitor is not enabled. To check this, select the Rx Test mode to display the screen and menu (3.0.)

Press [RF Gen] key and the GEN FREQ: legend will become highlighted.

Press the orange [ON/OFF] function key and a highlighted 'OFF' legend will appear adjacent to the indicated generator frequency value.

The RF generator output is now disabled although the settings may be preset ready for enabling at their new values.

To enable the generator output highlight the GEN legend by selecting RF GEN from the Rx Test menu and press the orange [ON/OFF] function key. The generator output will now be present at the selected output socket.

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 specific connector on the monitor and that the transceiver cannot be inadvertently switched to 'transmit'.

The receiver to be tested and the monitor should be connected as shown in the diagram Fig. 3-7 Diagram of receiver test set-up, on page 3-31.

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.

Connect the receiving antenna input to the required RF output connector on the monitor.

Setting up

When all the required connections have been made, select the receiver test mode to display the screen (3.0).

Work through the receiver test menus setting the parameters or options to the test requirements.

Rx frequency

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

Press the [RF Gen] key.

The GEN FREQ legend is highlighted in reverse video as shown in (3.1).

The frequency of the transmitter to be tested can either be entered manually or be established automatically.

If the Rx=Tx option has been implemented during a previous Tx test setting up procedure, the frequency of the receiver relevant to that test will be shown adjacent to the GEN FREQ: legend on the display. If this is applicable to the current receiver undergoing test there is no need to re-enter the value.

Manual frequency setting

With the GEN FREQ legend in the main display highlighted in reverse video, 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 GEN FREQ 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. Pressing one of these for MHz, kHz or Hz entries causes the entered frequency to be displayed according to normal convention. The following examples explain further. Pressing:-

[1][2][5][MHz]	will display	125.000000MHz
[1][2][5][kHz]	” “	125.000kHz
[1][2][5][0][kHz]	” “	1.250000MHz
[1][.][2][5][MHz]	” “	1.250000MHz
[1][2][5][0][0][0][1][MHz]	” “	1.250001MHz

An incremental change can be made available to generator frequency adjustment. The FREQ [↑] and FREQ [↓] keys adjacent to the variable control implement these changes. Refer to the section on incremental adjustments which starts on page 3-54.

Output level setting

Range	
N-Type connector,	-135dBm to -15dBm; 0.04 μV to 40 mV pd
BNC connector,	-115dBm to +5dBm; 0.4 μV to 400 mV pd

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 level of the output signal applied to the receiver is set by entering the required output level from the data keys. It can be defined as a dBm level by terminating the entry with the 'dBm' terminator key or as a voltage by using the 'V', 'mV' or 'μV' terminator key to complete the entry.

Voltage levels will be indicated as PD or EMF depending on the option selected on set-up page one. The range of the output signal from each connector is given in the specification. See chapter 1. Note that any external attenuator values entered on set-up page 1 will reflect in the level of indicated output.

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.

An incremental change can be made available to generator level adjustment. The LEVEL [↑] and LEVEL [↓] key, adjacent to the variable control effect these changes. Refer to the section on incremental adjustments which starts on page 3-54.

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 generators

Set up one or both of the modulation generators for the required frequency and modulation level by using the soft keys and data input keys.

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 (4.2.) will be displayed.

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 MOD1, then, *[FREQ][n]...[n][kHz/Hz]*

[LEVEL][n]...[n][kHz/Hz]

then *[Gen 1/Gen 2]* to select MOD2 if required,....*[.../Hz]*

Incremental changes can be designated to the modulation generator frequency and level. When the incremental keys have been assigned, these changes are made by repeated presses of the *FREQ* [\uparrow] and *FREQ* [\downarrow] and the *LEVEL* [\uparrow] and *LEVEL* [\downarrow]. See the section on incremental adjustments for instruction on setting increments which starts on page 3-54.

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 to the generator to be disabled. 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 modulation generator output waveform can be either sine or square wave. This is controlled by first selecting the modulation generator as for on/off control above, then pressing the *[SHAPE]* key to toggle between the options.

Note that the modulation generators are also used as AF generators to provide a modulation source in the Tx test mode. If both generators are set up as a modulation source in the Tx test mode, switching to receiver test mode will show both modulation generators in the 'OFF' condition. Either or both generators can be set up and turned on within the receiver test mode.

The frequency, level and shape settings of their last use in the receiver test mode will be retained within the receiver test mode set-up. 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 mode will then be disabled.

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 filtering is controlled from the Mod Gen menu.

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

The legend Pre-emph ON is displayed when the filtering is active. No indication is given when the filtering is inactive.

When the modulation generators and de-emphasis filter are set to the required settings press the *[return]* key to restore the receiver test menu.

External Modulation

An external modulation source may be used to modulate the generated RF signal. Pressing the *[Ext Mod]* key will display the external modulation input selection menu, to select AC or DC coupling of the 'EXT MOD IN' connector on the rear of the instrument or the microphone input option. 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 of this manual.

To retain correlation of the modulation level indicated on the display with that applied to the RF signal, the level of the external modulation signal should be 1 V rms.

The level of modulation applied to the RF signal is set from the front of the 2945. 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 bargraph, or by monitoring the modulation level of the RF generator using the Dx TEST mode.

If the [MIC] key is pressed, the microphone input option is selected. This uses the accessory connector on the front panel. A suitable microphone is available as an optional accessory. (See 'Options and accessories', in the Performance data section of Chapter 1 of this manual).

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 users 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 external modulation source can be disabled by pressing the orange [ON/OFF] key when the 'EXT LEVEL' legend is highlighted in reverse video. The Off condition is indicated next to the external modulation parameters on the display.

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 filters

Pressing the AF Filter soft key will cause the menu options shown in (3.3.) to be displayed, giving access to the following selection of AF passband filters:-

300 Hz low pass	300 Hz to 3.4 kHz bandpass	15 kHz low pass	50 kHz low pass.
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The function associated with the [Option] key is not implemented.

Audio distortion

Options	Signal to noise ratio	SINAD level	Percentage distortion.
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Distortion levels introduced into the audio signal path can be measured using the distortion measuring module.

Pressing the [Audio dist] soft key will display the screen and menu (3.4). The function of each soft key option from 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. 3-6 a, & d. Diagrams of distortion measuring procedure, on page 3-28. 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. 3-6 a, b, & c. Diagrams of distortion measuring procedure, on page 3-28. 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. 3-6 a, b, & c. Diagrams of distortion measuring procedure, on page 3-28. 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.

a. 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 (12dB SINAD) 0.25 μ V'

or

'Sensitivity (20dB SINAD) 1.0 μ V EMF'

or

'12dB (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 require 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 2945 proceed as follows:-

12dB 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 a 2945 to make a 12 dB SINAD sensitivity test, the 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 being firstly that the SINAD level specified is 20 dB and secondly that a psychometric 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 psophometric filter is connected between the AF output from the receiver and the AF input to the monitor.

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 a 2945 to make a 20 dB S/N sensitivity test, the monitor is set up to make signal to noise measurements through the distortion meter menu of the receiver test mode. The modulation frequency and level are set according to the receiver test specification requirements.

The RF level is adjusted until the S/N level indicated on the 2945 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 a 2945 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 off the RF signal by use of the orange 'ON OFF' 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 set-up operation if required, by pressing the orange 'ON OFF' 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 on the RF generator output by pressing the orange [ON OFF] 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 incremental keys or by precision adjustment using the variable control.

b. 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 1kHz, 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.

c. AF distortion

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

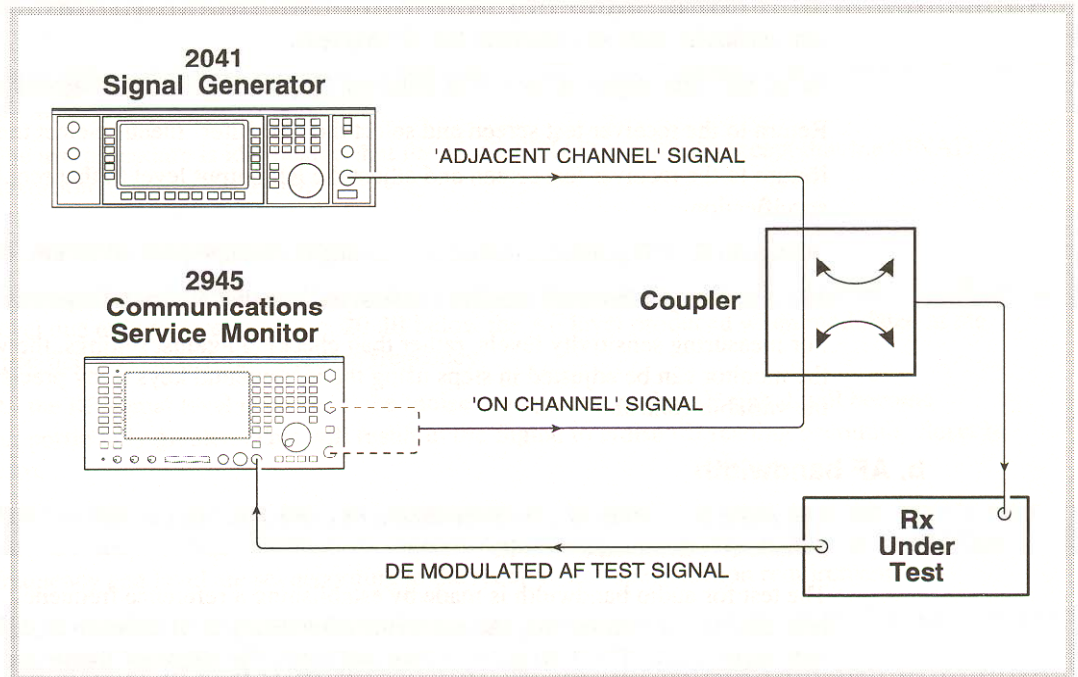
SINAD tests are usually made in conjunction with sensitivity testing (see above), while distortion test results are often quoted within the power output parameter. For example '3 Watts output with better than 10% THD' (total harmonic distortion).

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.

d. Selectivity



C2187

Fig. 3-8 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 2945 as for previous tests but with a second RF signal generator simulating the adjacent channel transmitter. See Fig. 3-8 Selectivity test setup, on page 3-40.

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 20dB 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. 3-8. 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 2945 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 20dB 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.

e. 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 set-up 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.

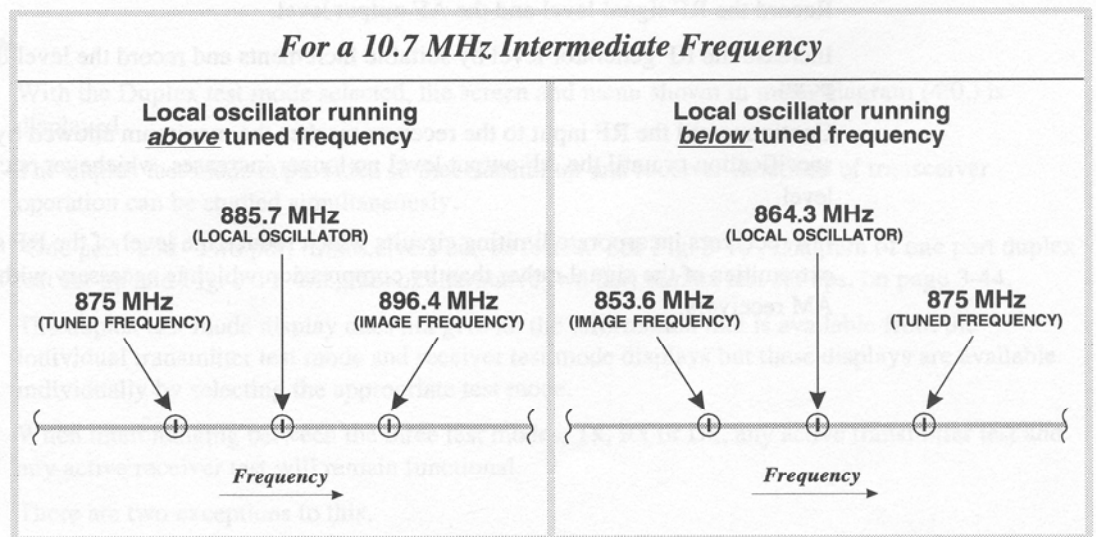
The generator providing the 'interfering' signal should be unmodulated and set to an RF level of between 80 and 90 dB above the level of the 'wanted' signal

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.

f. Spurious response

The two types of spurious response measurements normally carried out to 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. 3-9 Spurious response 'Image Frequency' location.



C1614

Fig. 3-9 Spurious response 'Image Frequency' location

With the receiver and 2945 set up as for sensitivity testing, establish a reference RF input level. Change the RF output frequency of the 2945 to the image frequency of receiver tuning point, without altering the receiver tuning. Increase the RF output level of the 2945 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 set-up. 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.

g. 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 2945 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 2945 display, either barchart or oscilloscope.

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

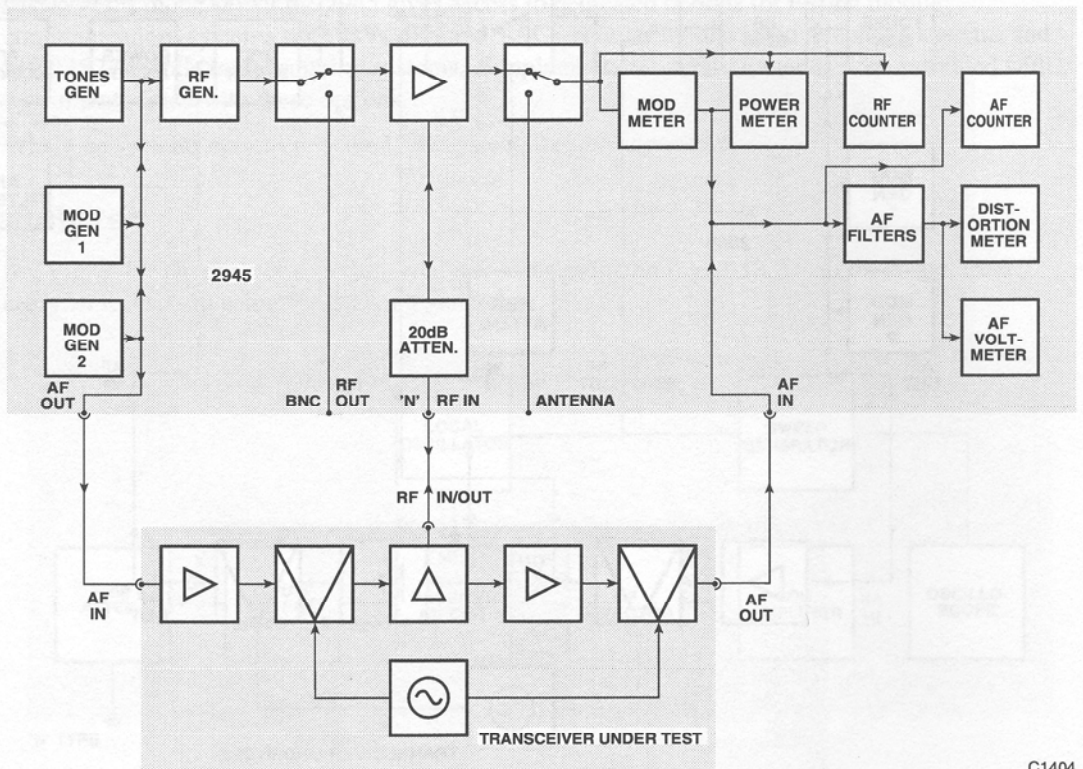
Record the RF signal level and the AF output level.

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)



C1404

Fig. 3-10 One port duplex test setup

Overview

With the Duplex test mode selected, the screen and menu shown in menu diagram (4.0.) is displayed.

The duplex 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. 3-10 . Diagram of one port duplex test set-up and Fig. 3-11 Diagram of alternative two port duplex test set-ups, on page 3-44.

The duplex test mode display does not give all the information that is available from the individual transmitter test mode and receiver test mode displays but these displays are available individually by selecting the appropriate test mode.

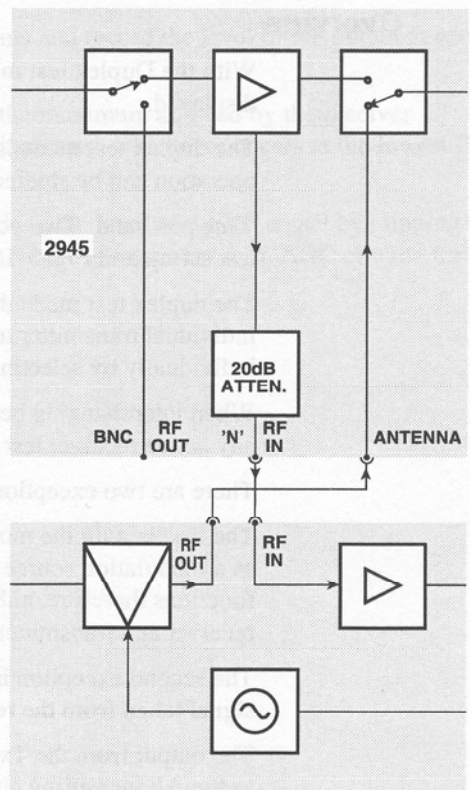
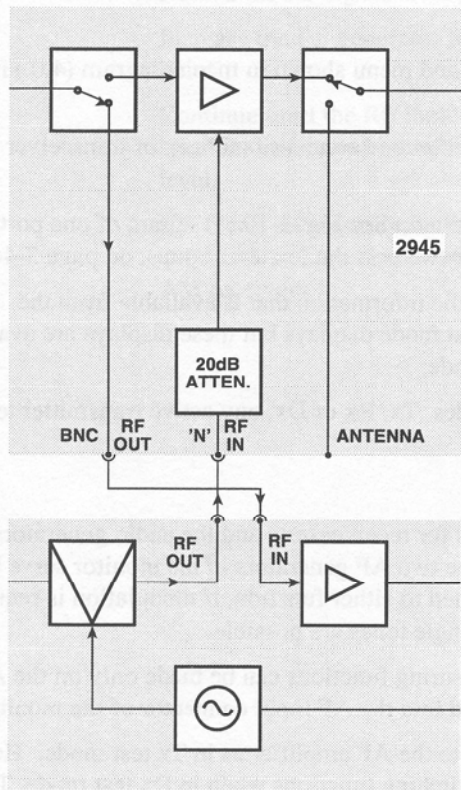
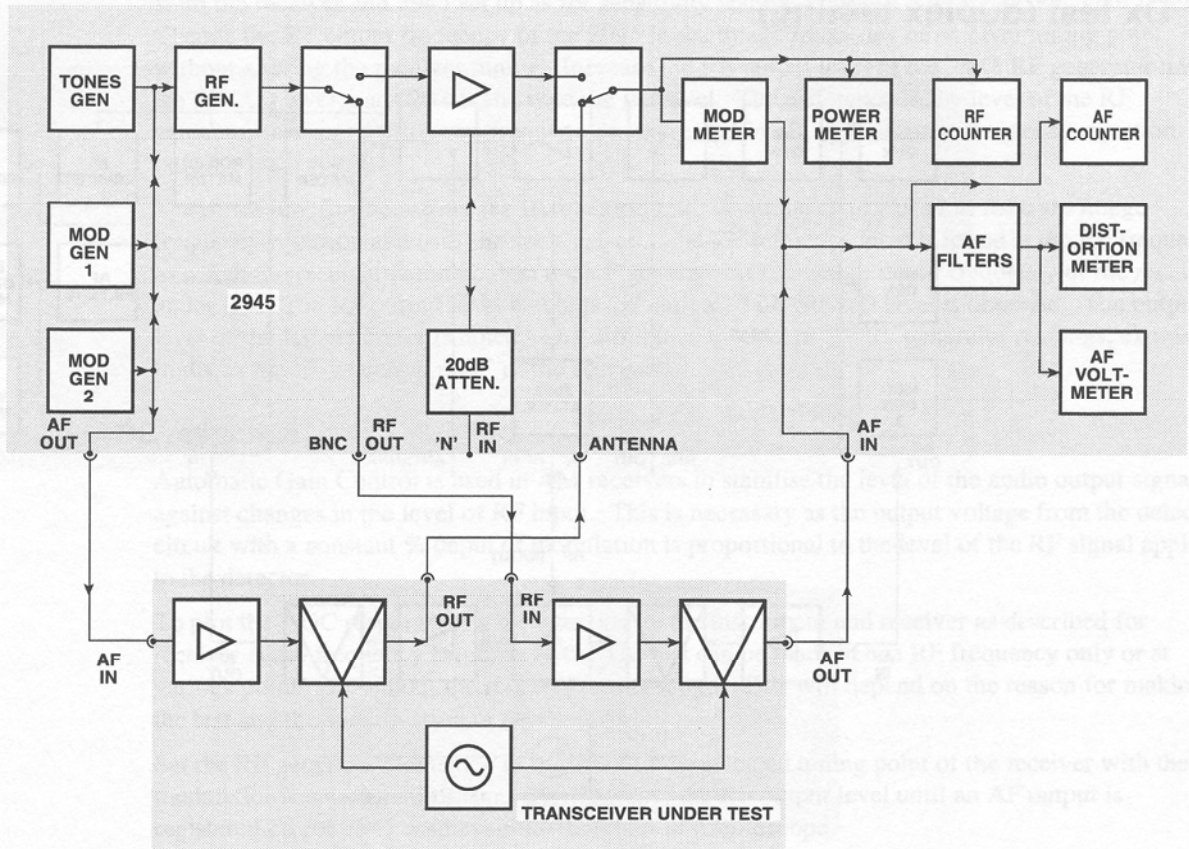
When interchanging between the three test modes, Tx, Rx or Dx, any active transmitter test and any active receiver test will remain functional.

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 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.



C1405

Fig. 3-11 Alternative two port duplex setups

Systems

The systems mode key of the 2945 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.

Where no systems options are fitted, the systems key is inoperative.

Spectrum analyzer

See Fig. 3-12 Diagram of spectrum analyzer test set-up and Fig. 3-13, Diagram of spectrum analyzer test set-up using the tracking generator.

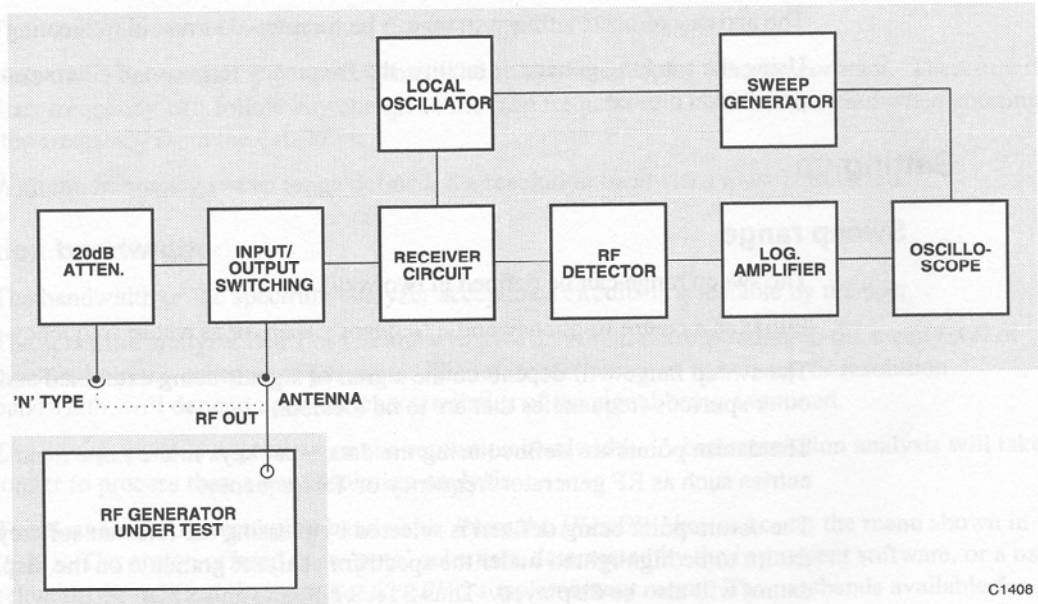


Fig. 3-12 Spectrum analyzer test setup

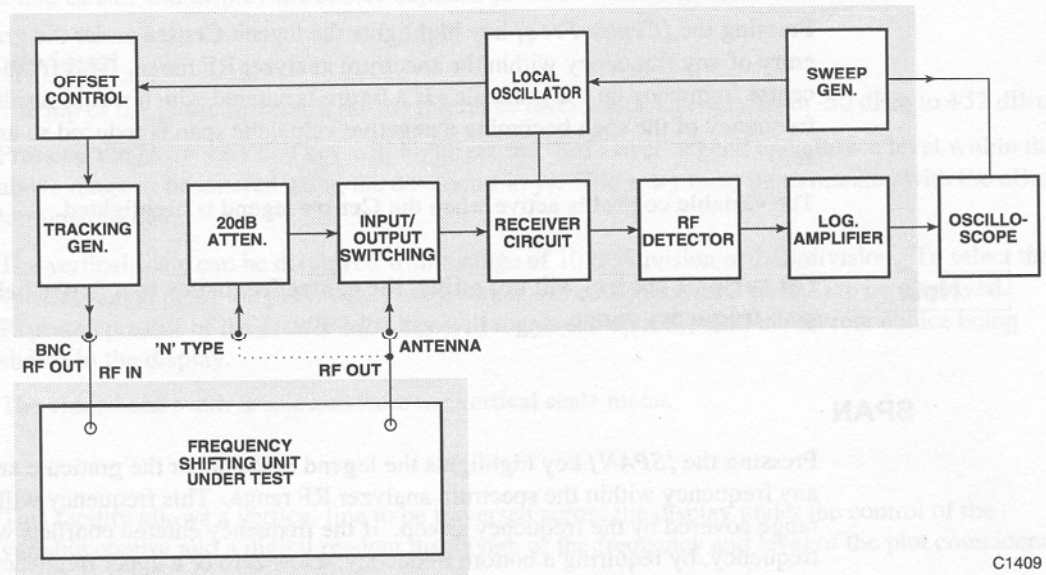


Fig. 3-13 Spectrum analyzer test setup using the tracking generator

Overview

With the spectrum analyzer test facility selected, the screen and menu shown in menu diagram (6.0.) is displayed.

In the spectrum analyzer 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 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.

Note

The variable control will not adjust the centre frequency to a figure below half of the set span frequency range.

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 of the spectrum analyzer RF range, the span will be restricted.

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 allow 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.

With the frequency sweep range defined, the resolution bandwidth must be selected.

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 dependant on the resolution bandwidth. A high resolution analysis will take longer to process than a low resolution analysis.

To select a suitable resolution bandwidth, Press the [*Res BW*] key to access the menu shown in (6.12). The option offered is an 'auto' selection, determined by the instrument software, or a user selection determined through the [*Res BW*] supplementary menu. The passbands available for selection are 300 Hz, 3 kHz, 30 kHz, 300 kHz and 3 MHz.

Selecting a passband, either by the [auto] soft key or by manual selection, will immediately bring it into circuit and display the choice adjacent to the Res BW legend in the display.

Reference level

The top of the graticule represents the reference level which can vary from -50 dBm to +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.

The vertical scale can be displayed with a range of 10 dB/division or 2dB/division. To select the vertical range, press the [*Vert Scale*] key which will cause the menu in (6.2) to be displayed.

Repeated presses of the [*10dB/2dB*] key will toggle the options, with the current choice being shown in the display.

The video bandwidth is selected from the vertical scale menu.

Marker

This facility allows a vertical line to be traversed across the display under the control of the variable control and a digital readout displayed, of the frequency and level of the plot coincident with the marker.

To activate the marker facility, the [*Marker*] key is pressed.

The legend '**MKR**' is displayed at the lower left of the display, together with the RF level in dBm and the RF frequency measurement.

Tracking generator facility

The tracking generator facility uses the RF generator of the 2945 to provide a tracking signal source.

This allows the spectrum analyzer to show the frequency response of frequency dependant 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 2945. (See performance specification).

The frequency offset facility adds to the above capability by allowing tests to be made to frequency shifting circuits. The difference frequency, between the tracking generator and the spectrum analyzer input, can be positive or negative. 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).

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 spectrum analyzer 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 (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.

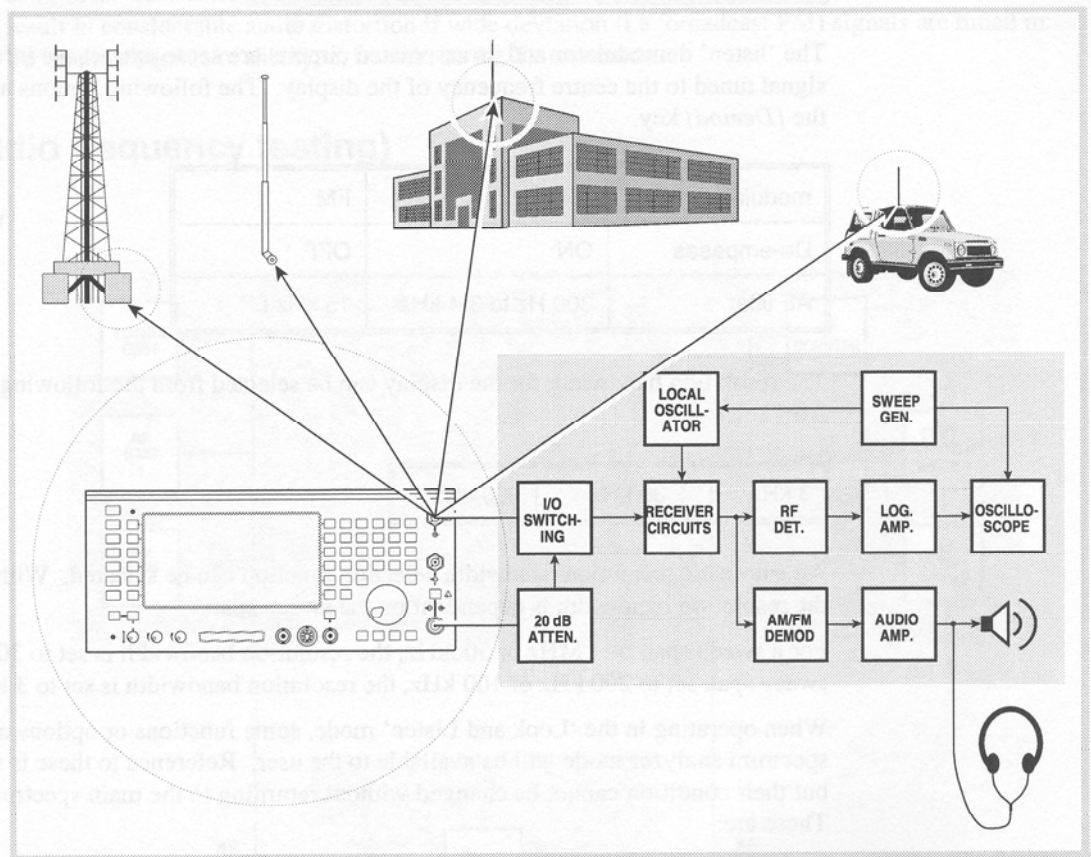
Tracking generator level. Pressing the *[Level]* key will highlight the 'Track Gen Level' legend and allow the level to be altered, either by the variable control or by entering a new value using the data entry keys.

Locking the Frequency of the tracking generator to the sweep oscillator of the spectrum analyzer. Pressing the *[Freq Locked]* key will do this. 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. 3-14 Spectrum Analyzer setup, look & 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 centered. 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 2945 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.3-14 Spectrum Analyzer set-up, Look & Listen function.

Setting up

Pressing the [Look & Listen] key from the SPEC ANA menu selects this option. The menu shown in (6.6) is displayed.

When operating in the 'Look and 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.

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
-------	---------	---------	---------

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-emphases	ON	OFF
AF filter	300 Hz to 3.4 kHz	15 kHz LP

The resolution bandwidth for the display can be selected from the following through the [Res BW] key:-

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

An automatic resolution bandwidth selection function can be selected. With this function active the resolution bandwidth is dependent on the sweep span.

For a sweep span of 1 MHz or 500kHz, the resolution bandwidth is set to 30 kHz. With the sweep span set to 200 kHz or 100 kHz, the resolution bandwidth is set to 3 kHz.

When operating in the 'Look and Listen' mode, some functions or options of the normal spectrum analyzer 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	2dB	10dB
Video filter option	OFF	ON
Peak hold option	OFF	ON

With an input signal displayed, adjusting the centre frequency will allow the listen detector to be tuned to an observed signal.

The input sensitivity of the test set in the 'Look and Listen' mode are the same as for the normal spectrum analyzer input. The reference level can be adjusted using the variable control, can be entered as data using the data input keys and terminator, or it can be set using the level increment keys. When using the latter the increment of each key press is one division of the display, either 10dB or 2dB. This selection is made in the main spectrum analyzer display through the [Vert Scale] key.

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.

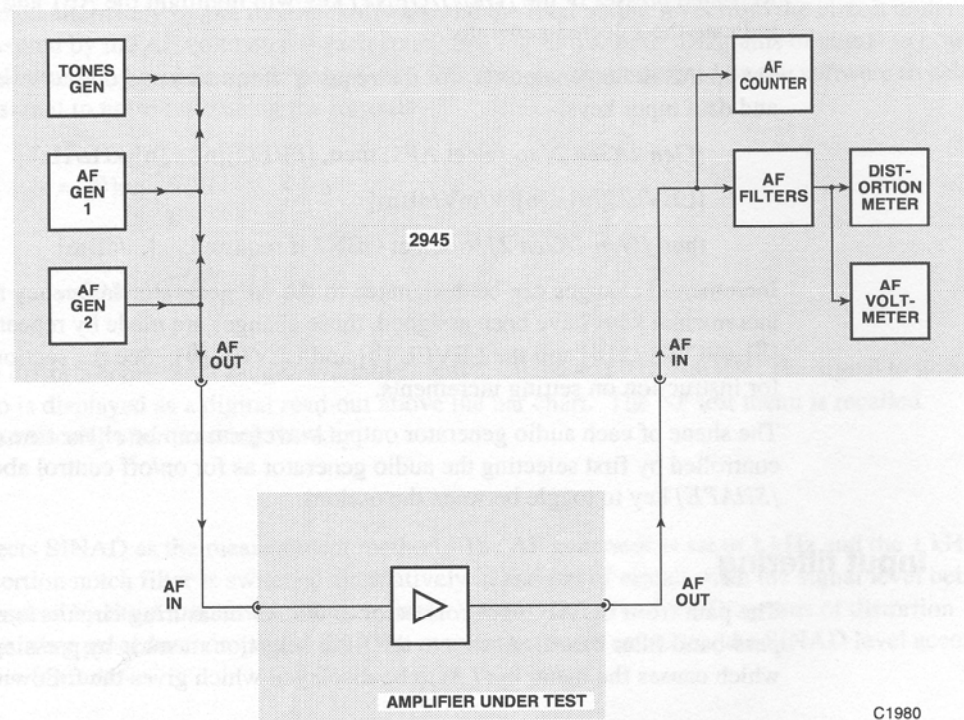
The peak level of the signal can be determined by reference to the RF level scale on the display.

The top of the gradicule represents the reference set on the display. Each division of the gradicule represents either 10 dB or 2dB, as set in the vertical scale set up menu of the main spectrum analyzer mode.

Note that when in 'Look and Listen' mode the IF bandwidth of the demodulation circuits is fixed at 15 kHz. This is irrespective of the spectrum analyzer resolution bandwidth selected. This will result in considerable audio distortion if wide deviation (i.e. broadcast FM) signals are tuned in. To monitor signals of this type, transfer to the Tx test mode.

AF test (audio frequency testing)

Overview



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Fig. 3-15 Audio test setup

To enter the audio frequency test mode press the blue [AF TEST] key. This will cause the menu and screen (7.0.) to be displayed.

When the audio frequency 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. 3-15 Audio test set up.

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

The AF signal can be used as a test signal for performance testing of passive and active AF circuits such as filters and amplifiers.

Measurements on the signal after passing through the circuit being tested can be carried out using the analytical circuits within the 2945 to establish Frequency, level distortion level, SINAD level and signal to noise level. The oscilloscope facility is available to observe and measure the waveform. 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] key to highlight the word OFF adjacent to each of the generators 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 soft key. This will display the audio set-up menu (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]

Incremental changes can be designated to the AF generator frequency and level. When the incremental keys have been assigned, these changes are made by repeated presses of the FREQ [↑] and FREQ [↓] and the LEVEL [↑] and LEVEL [↓]. See the section on incremental changes for instruction on setting increments.

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 filtering

The path from the AF input connector to the AF measuring circuits is routed through the AF pass-band filter board. Access to the filter selection menu is by pressing the AF Filter soft key which causes the menu in (7.3) to be displayed which gives the following filtering options:-

0.3 - 3.4 kHz	Band-pass
50 kHz	low-pass
15 kHz	low-pass
300 Hz	low-pass

Pressing the relevant soft key causes the selected filter to appear on the main display and the soft key menu to revert to the AF Filter menu, (7.3).

To change a filter selection, select the [AF filter] key and again select from the menu. The 50 kHz LP filter can be considered to be the 'unfiltered' selection as this represents the normal full bandwidth of the audio circuits.

The function associated with the [Option] key is not implemented.

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 (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. 3-6 a, & d. Diagrams of signal to noise level measuring procedure, on page 3-28. 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. 3-6 a, b, & c. Diagrams of distortion measuring procedure, on page 3-28. 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. 3-6 a, b, & c. Diagrams of distortion measuring procedure, on page 3-28. 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 produce a graphic representation of 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.

A section on the use of the oscilloscope facility will be found later in this chapter.

Incremental adjustments

General

This section covers the use of the incremental controls. Most of the information given is contained within other sections of this chapter but is repeated here collectively.

The incremental controls are the four keys situated under the variable control with one pair designated 'FREQ' [↑] and FREQ [↓], the other pair designated 'LEVEL' [↑] and LEVEL [↓]. Each pair can be assigned to a selected parameter within a test mode which allows the parameter to be adjusted in steps. The parameters that can be selected are:-

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 frequency	Spec ana.
RF level	Spec ana.

Hint

The 'frequency' increment keys can be assigned to the RF generator frequency for channel spacing number increments.

The frequency keys and the level keys do not have to be assigned to the same generator.

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** incremental keys to **AF generator 1** in the **Tx test mode** to step up or down by 500 Hz steps, follow this procedure:-

From the **Tx test menu** press the [**Audio Gen**] soft key.

From the **AF Generator menu** select '1'.

The '**AF GEN 1**' legend will be highlighted.

Press the orange '**LEVEL**' key.

The '**LEVEL**' legend following '**AF GEN 1**' 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 frequency increment key will increase or decrease the output frequency of **AF generator 1** by 500 Hz.

Points to note are:-

Each press of an incremental 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 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 set-up 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 receiver test mode and the **AF generators** within the **AF Test mode**.

The incremental keys cannot be used when in the duplex test mode.

Use within spectrum analyzer mode

The spectrum analyzer mode makes use of the incremental frequency adjustment 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.

The level incremental 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.

Tones

Tones sub-mode

Audio tones and digital code signals are used for many purposes within radio communication systems. The 2945 includes within the **Tx Test**, **Rx Test**, **Dx Test** and **AF test modes** a **TONES** test mode.

This gives facilities for testing tone calling and control systems of the following types.

CTCSS (Continuous Tone coded Squelch System).

DTMF (Dual Tone, multi-Frequency).

DCS (Digitally Coded Squelch).

POCSAG (Post Office Code Standardisation Advisory Group). A paging system using digital signalling.

Sequential Tones. A selective calling system using audio tones.

Signal routing

The tones sub-mode can be entered from either Tx test, Rx test, Dx test or audio modes. The functionality is different in each case:

- 1) When entering tones from Tx test, encoded tones are generated from the AF out socket and the tones decoder operates on the demodulation RF input.
- 2) When entering tones from the Rx test, encoded tones are modulated onto the RF output, and the tones decoder operates on the audio input on the AF input socket.
- 3) When entering tones from the Dx test, encoded tones are modulated onto the outgoing RF signal, and the tones decoder operates on the incoming RF signal.
- 4) When entering tones from the AF test, encoding and decoding are performed on the AF output and AF input signals respectively.

It is important to note that if the top level mode is changed whilst any tones encoding is running continuously (e.g. CTCSS, DCS, DTMF or continuous sequential tones), the functionality will not change. To disable the tones encoding, it is necessary to turn the tones "off" before changing mode.

RF input attenuators

The RF input circuits of the test set are autoranging under most operating conditions. When operating in some of the tones modes this can be a disadvantage as the decoders need to receive the leading burst of any transmission. Therefore when 'TONES' mode is selected, the autoranging function is disabled. An intermediate menu allows the sensitivity of the RF input attenuators to be manually set.

[↑] and [↓] keys will change the sensitivity in 10 dBm steps. The level set should relate to the level of the transmitter signal measured in the Tx test mode.

CTCSS

The CTCSS tones system requires a precise frequency, continuous tone to be transmitted below the audio pass band to un-squelch the receiver.

The 2945 CTCSS function will generate a single AF tone selected from a 32 tone table. These are within the range 67 Hz to 250.3 Hz. The level of the tones can be set within the range 100 μ V to 4 V AF output, 0 - 75 kHz deviation and 0 - 99% AM depth, depending on the application. The selected tone can be frequency shifted by up to $\pm 10\%$ for decoder testing.

DTMF

Overview

Dual Tone, Multi-Frequency

The DTMF tones function will generate and decode sequences of dual tones corresponding to the standard DTMF frequencies. The user can create a 'key' sequence of up to 40 digits which can be transmitted from the encoder as modulation for receiver testing or as AF from the AF GEN OUTPUT connector.

The decoder will accept up to 40 tone pairs either from the modulation meter output for transmitter testing or as AF signals into the AF INPUT connector.

Observe notes relating to signal routing and RF input attenuators at beginning of this section. See page 3-56.

Tx test DTMF tones function

In the Tx test mode DTMF tones are generated within the mobile under test from keypad instructions and used to modulate the transmitter. The test set recovers the tones from the RF signal and feeds them to the DTMF decoder. The decoder measures the frequencies of each tone in each pair and displays the digit or symbol that corresponds to those frequencies. The test set is set-up in the Tx test mode with RF frequency and modulation type set as appropriate.

Pressing the [Tones] key will display the screen shown in (2.5). The [DTMF] key will then give access to the RF DTMF DECODER screen shown in Fig. 3-16.

RF DTMF DECODER						Clear Sequ			
Encode	1234567890**1234567890**1234567890**123								
	1	697.0Hz	0.0%	1.2090kHz	0.0%	49ms	▲		
	2	697.0Hz	0.0%	1.3360kHz	0.0%	50ms	▼		
	3	697.0Hz	0.0%	1.4771kHz	0.0%	50ms			
	4	770.1Hz	0.0%	1.2092kHz	0.0%	50ms			
	5	769.8Hz	0.0%	1.3363kHz	0.0%	50ms			
	6	769.9Hz	0.0%	1.4770kHz	0.0%	50ms			
	7	852.0Hz	0.0%	1.2092kHz	0.0%	49ms			
	8	852.3Hz	0.0%	1.3363kHz	0.0%	50ms			
	9	851.6Hz	0.0%	1.4770kHz	0.0%	50ms			
	0	941.0Hz	0.0%	1.3360kHz	0.0%	50ms			
	Tone Frequencies			HI1	HI2	HI3	HI4		
	LO1	697.0Hz	HI1	1.2090kHz	LO1	1	2	3	A
	LO2	770.0Hz	HI2	1.3360kHz	LO2	4	5	6	B
	LO3	852.0Hz	HI3	1.4770kHz	LO3	7	8	9	C
	LO4	941.0Hz	HI4	1.6330kHz	LO4	*	0	#	D
									Return

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Fig. 3-16 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 underline in the decoded symbol panel of the display indicates which symbols 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 bring decoded results into the display or to change the selection of symbols listed in the tones analysis list, use the [↑↑↑] key or the [↓↓↓] key. These keys will page up or page down the list of decoded tones and move the underline to the displayed symbols.

The contents of the decoder memory can be cleared by pressing the [Clear Sequ] key.

Rx test DTMF tones function

In the Rx test mode, the encoder output is fed to the modulation circuits of the RF generators and the tones used to modulate the RF signal. The receiver response to the transmitted tones can then be observed.

When setting up to make tests to the DTMF decoder of a receiver, first set-up the test set as for standard 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.

Pressing the [Tones] key will display the screen shown in (3.5). The [DTMF] key will then give access to the RF DTMF ENCODER screen.

To format a tones sequence, first press the [Edit Sequ] key. The screen shown in Fig. 3-17 will be displayed. If an existing sequence is to be deleted, press the [Clear Sequ] key. A new sequence can then be formatted. Any of the 16 available characters of the DTMF keypad can be used in a sequence. 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.

A maximum of 40 characters can be included in a sequence, any further entries will over-write the existing sequence.

An existing sequence can be edited as required. Using the [LEFT ARROW] or [RIGHT ARROW] key, move the cursor over the character to be changed. Press the data key corresponding to the required character. The unwanted character will be replaced.

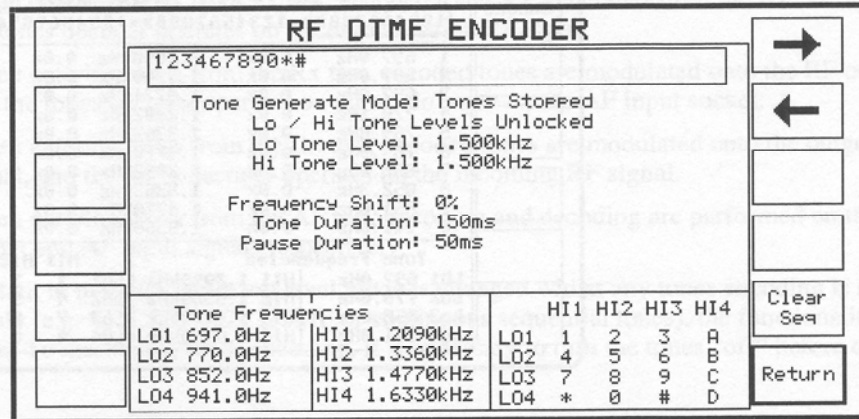


Fig. 3-17 RF DTMF ENCODER screen and menu, edit mode

The modulation level of 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. Attempted entries outside of the values will be ignored. The default level is 1.5 kHz.

The modulation level 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 [Stop Tones] 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 until either the [Stop Tones] key is pressed or until the [Step Tones] key is pressed again, which will step to the next tone in the sequence.

[Single Tone] After pressing this key, pressing any data entry key pressed will cause the corresponding tone to be generated. This tone can either be stopped by pressing the [Stop Tones] key or changed to a different tone by pressing another data key.

[Stop Tones] Stops any on-going tone generation.

[Return] Returns to the main DTMF menu.

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 test set 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 test set is through the AF input connector. The decoder will respond to signal levels above approximately 150 mV rms.

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.

Observe notes relating to signal routing and RF input attenuators at beginning of this section. See page 3-56.

DCS receiver decoder testing

To test the DCS decoder function of a mobile transceiver, set up and connect the 2945 (2946) 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. 3-18.

RF DCS ENCODER		
Decode	Tone Generate Mode: Tone On	Bit Rate
Tone Level	Tone Level: 1.500kHz	Invert
	Polarity: Normal	Code
	Bit Rate: 134.0Hz	Tone On/Off
	DCS Code: 0	
		Return

Fig. 3-18 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 'Inverse'.

The *[Invert]* key toggles between the two options.

Enter the DCS code for the transceiver to be tested by pressing the *[Code]* key and entering the three digits using the data entry keys. Complete the entry by pressing the [Enter] key. A three digit code which starts with a zero will be displayed as a two figure number.

Return to the Rx test mode and check that the RF generator is active, then return to the Tones, DCS mode.

Press the *[Tone On/Off]* key and the legend 'Tone Off' will change to 'Tone On'. The transceiver voice channel will open. *Note. If the receiver test set-up included a modulating tone, this will be passed through the voice channel when opened by the DCS signal.*

To stop the DCS signal, press the *[Tone On/Off]* key.

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 2945 DCS RF decoder function 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 pattern 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 200bits/s. The modulation level of the data signal is shown on the display.

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 2945 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.

To access the POCSAG test facility use the following key sequence:-

[Rx TEST], [Tones], [POCSAG].

The screen and menu shown in Fig. 3-19, POCSAG radio pager test screen and menu, will be displayed.

RF POCSAG ENCODER	
	GEN FREQ: 153.12500MHz
	LEVEL: -10.0dBm
	Bit Rate: 512.0Hz
	Tone Level: 1.500kHz
	Polarity: Normal
	RIC: 0
	Addr/Alert Type: ***** (00)
	Message Type: Numeric Message
	Mess 1
RF Gen	Bit Rate
Tone Level	Invert
Alert Type	RIC
Select Message	Call Pager
	Return

Fig. 3-19 POCSAG radio pager test screen and menu

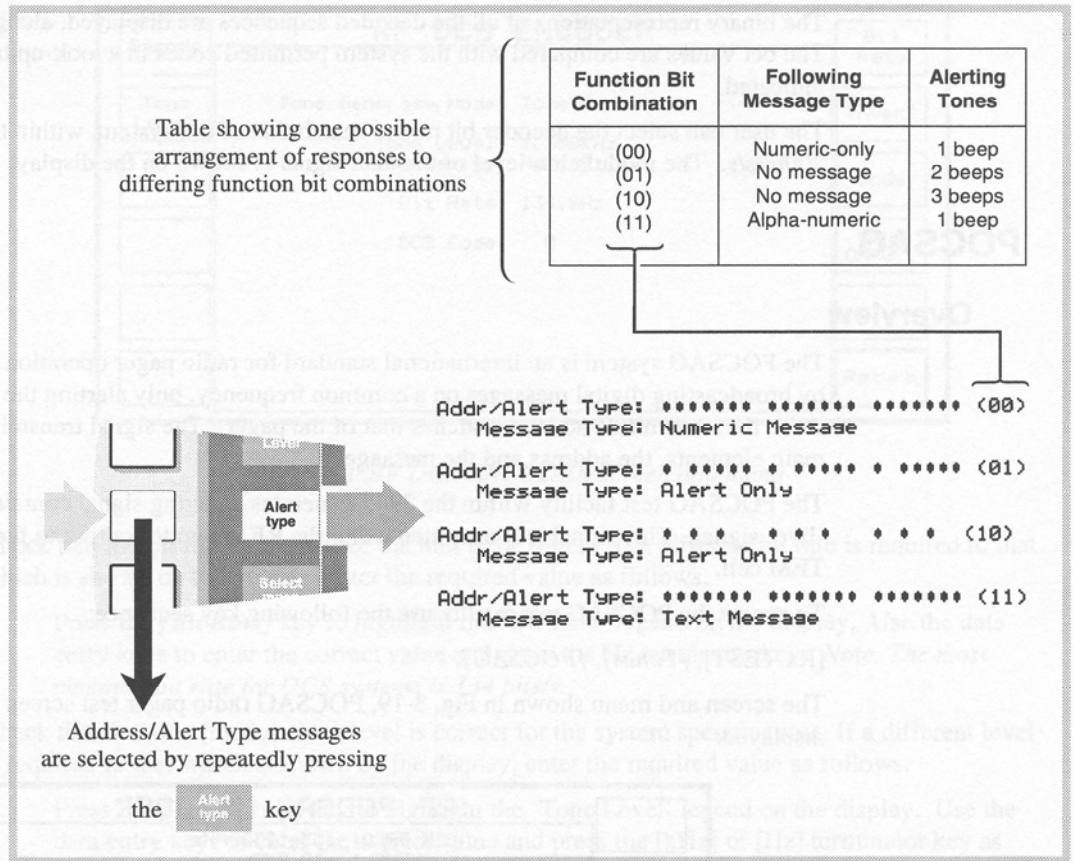
The facilities offered by the 2945 for testing radio pagers are:-

The RF generator of the test set can be set to any frequency within the specified range of the test set. The default frequency is 153.125 MHz.

The RF level can be set to any level within the normal operating level of the test set.

The modulation level of the signal can be to any level within the normal operating level of the test set. 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 which depend on the state of the two function bits within the transmitted address codeword. The test set 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. 3-20 Alternative address/warning messages.



C1883

Fig. 3-20 Alternative address/warning messages

A selection of 7 different messages 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 test set 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 may be omitted from the entry of RIC to save time.

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 test set and the pager. The test set output can be taken from the BNC RF output connector using the telescopic antenna accessory (MI part No 54421-001N) or similar, where suitable screening is available. Alternatively, a TEM cell may be preferable.

To configure the test set to make operational tests to a radio pager proceed as follows:-

Select the POCSAG option from within 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 Bite 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 RIC: on the display and enter the required number using the data entry keys. An attempt to enter a number which exceeds the range of the system maximum will not be accepted. The previously displayed RIC will be retained.

The test set 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. 3-1, POCSAG 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.

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 test set are:-

CCIR, ZVEI, DZVEI, EEA, EIA, plus two 'User' tables, to which frequencies and tone durations can be programmed by the user.

The 2945 has encoding facilities with variable parameters which allow signals to be produced for the testing of 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 3-56.

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:-

Select the receiver test mode by pressing the [Rx TEST] key.

Set the RF output frequency of the test set to that set on the receiver .

Ensure that the RF generator within the test set is in the OFF condition.

Make a suitable RF connection between one of the test set RF output connectors and the RF input connector of the receiver.

Set the RF output level from the test set to an appropriate setting.

Select the 'RF SEQUENTIAL TONES' function by using the key sequence, [Tones], [Sequential]. The screen and menu shown in Fig. 3-21 RF Sequential tones encoder display, main menu.

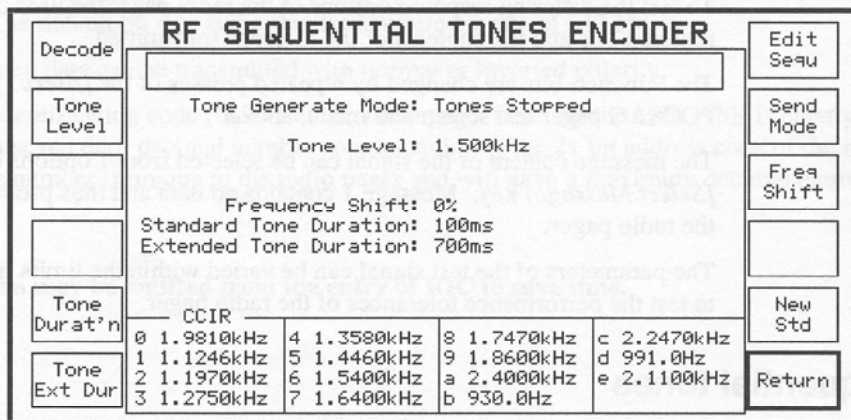


Fig. 3-21 RF Sequential tones encoder display, main menu

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 *[New Std]* key to display the 'SELECT TONES STANDARD' screen and menu as shown in Fig. 3-22.

EIA		RF SEQUENTIAL TONES ENCODER				CCIR	
USER 1		SELECT TONE STANDARD				ZUEI	
USER 2		Frequency Shift: 0%				DZUEI	
		Standard Tone Duration: 100ms				EEA	
		Extended Tone Duration: 700ms					
		CCIR					
	0	1.9810kHz	4 1.3580kHz	8 1.7470kHz	c 2.2470kHz		
	1	1.1246kHz	5 1.4460kHz	9 1.8600kHz	d 991.0Hz		
	2	1.1970kHz	6 1.5400kHz	a 2.4000kHz	e 2.1100kHz		
	3	1.2750kHz	7 1.6400kHz	b 930.0Hz		Return	

Fig. 3-22 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 system, check that the other parameters are correctly set. The tone modulation level has a default setting 1.5 kHz but can be set by the user to any level up to the instrument maximum of 75 kHz.

The standard and extended tone duration times are set to the system standard when the system is selected. They can be altered by the user by pressing either the *[Tone Durat'n]* key or the *[Tone Ext Dur]* key and entering the required duration using the data entry keys and the *[ms]* terminator key.

The frequency of all the tones in the table can be collectively altered by up to $\pm 10\%$ for tolerance checking.

Create the required tone sequence. Press the *[Edit Sequ]* key to display the 'Sequence Editing' menu. If the tone sequence panel is not empty press the *[Clear Seq]* key to clear the sequence.

Enter the required sequence by using any of the data entry keys 1 to 9, zero and the Hex digits A to E. The *[Null Tone]* key and the *[Extend Tone]* key can also be used as required.

Access the Rx test mode and activate the RF generator. Return to the SEQUENTIAL tones mode and press the *[Send Mode]* key. This will display the menu options shown below:-

[Cont Tones] Generates the tone sequence repeatedly until the *[Stop Tones]* 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 until either the *[Stop Tones]* key is pressed or until the *[Step Tones]* key is pressed again, which will step to the next tone in the sequence.

[Single Tone] After pressing this key, pressing any data entry key pressed will cause the corresponding tone to be generated. This tone can either be stopped by pressing the *[Stop Tones]* key or changed to a different tone by pressing another data key.

[Stop Tones] Stops any on-going tone generation.

[Return] Returns to the main Sequential Tones menu.

Press the key relevant to the test procedure being carried out.

Testing sequential tone transmitters

To test the operation of transmitters sending sequential tones calling signals, proceed as follows:-

Select the Tx test mode and 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 test set input to that of the transmitter output.

Key the transmitter and check that the test set is obtaining a signal from the transmitter.

Select tones mode. The attenuators in the receive path of the test set will be held at their current setting. Press the *[Sequential]* key. The RF SEQUENTIAL TONES DECODER screen and menu is displayed. See Fig. 3-23, if the encoder screen is displayed, press the *[Decode]* key.

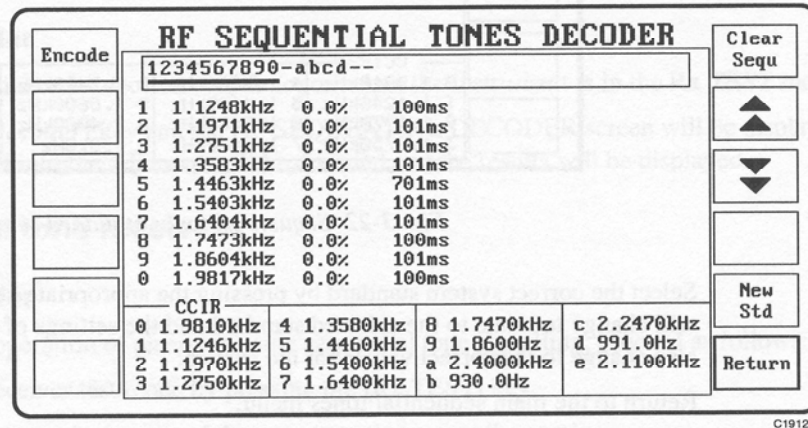


Fig. 3-23 Sequential tones decoder screen.

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. The decoder within the test set will decode the tones sequence obtained from the modulation meter within the test set. The decoded sequence will be displayed in the sequence panel at the top of the display and ten of the tones received are listed in the centre of the display. The measured frequency of each tone, the percentage error from the true tone frequency and the duration of each tone is shown. The block of ten tones listed is indicated in the sequence panel by an underline. the listed tones can be replaced by others from the sequence by use of the *[▲]* or *[▼]*. Those listed will be replaced by the next ten and the underline will move as appropriate.

The sequence decoder store can hold up to 40 decoded characters. Any received in excess of this will be lost. 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 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 revertive tones feature within the sequential tones function of the 2945 has four operating options, tailored to the operating modes of the 2945. This gives versatility for the testing of all of the above variations.

The revertive tones operation is configured by pressing the *[Revertv Tones]* key. To send a tone burst, first 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 2945 will change to decode mode ready to decode the revertive tones.

Tx TEST (Transmitter test mode)

With the 2945 in the transmitter test mode, the tones sequence, assembled in the tone sequence panel, is routed to the AF OUTPUT connector on the front panel of the 2945.

The device under test accepts the original tone sequence as an AF signal and produces the revertive tones as modulation on an RF signal.

The input to the sequential tones decoder within the 2945 is obtained by demodulating the RF signal fed into either of the RF input connectors.

After decoding, the results are displayed on the RF SEQUENTIAL TONES DECODER screen.

Rx TEST (Receiver test mode)

With the 2945 in the receiver test mode, the tones sequence, assembled in the tone sequence panel, modulates the RF signal generated in the 2945. This is fed to the RF input of the mobile under test.

The device under test accepts the original tone sequence as modulation on an RF signal and produces the revertive tones as an AF signal.

The input to the sequential tones decoder within the 2945 is obtained from the AF input connector on the front panel.

After decoding the results are displayed on the RF SEQUENTIAL TONES DECODER screen.

Dx TEST (Duplex test mode)

With the 2945 in the duplex test mode, the tones sequence, assembled in the tones sequence panel, modulates the RF signal generated in the 2945. This is fed to the RF input of the mobile under test.

The device under test accepts the original tone sequence as modulation on an RF signal and produces the revertive tones also as modulation on an RF signal.

The input to the sequential tones decoder within the 2945 is obtained by demodulating the RF signal fed into either of the RF input connectors.

After decoding the results are displayed on the RF SEQUENTIAL TONES DECODER screen.

AF TEST (Audio test mode)

With the 2945 in the audio test mode, the tones sequence, assembled in the tones sequence panel, is routed to the AF OUTPUT connector on the front panel of the 2945. This is fed to the AF input of the mobile under test.

The device under test accepts the original tone sequence as an AF signal and produces the revertive tones as an AF signal.

The input to the sequential tones decoder within the 2945 is obtained from the AF input connector on the front panel.

After decoding the results are displayed on the RF SEQUENTIAL TONES DECODER screen.

Oscilloscope

The digital oscilloscope option is available from within the Tx TEST, Rx TEST and AF TEST modes.

The vertical input is by the AF input connector when in the Rx TEST and AF TEST modes, with a sensitivity of from 10 mV/division to 20 V/division in a 1, 2, 5 sequence.

The [AC/DC] key selects the method of coupling the AF input signal to the input amplifier and will therefore provide AC or DC coupling into the oscilloscope.

When in the Tx TEST mode the input to the oscilloscope is taken directly from the modulation meter output. The calibration is in 'Frequency Deviation' for FM measurements with a range of from 1.5 kHz full scale to 75 kHz full scale and '% Modulation' for AM measurements with ranges of 5%, 10% and 20% per division.

The horizontal timebase has ranges of 100 μ S/division to 5 S/division in a 1, 2, 5 sequence.

The oscilloscope function is accessed from the menus of the three test modes mentioned above. Pressing the [Scope/bar] soft key will present the Scope/Bar menu and the [Scope] soft key will display the oscilloscope graticule with the control soft key legends in the right hand menu area.

The control soft keys have the following functions, (top to bottom):-

- Increase Y sensitivity by one range per key press.

- Decrease Y sensitivity by one range per key press.

- Increase time/division by one range per key press.

- Decrease time/division by one range per key press.

- Return to bar chart presentation with Scope/Bar menu

- Return display and menu to Tx, Rx or AF Test display and menu.

The scope trace vertical position can be adjusted using the rotary control situated at the bottom left of the instrument.

The horizontal sweep triggering can either be repetitive or single sweep. The required function is selected by pressing the appropriate key, located at the bottom left of the front panel. The single sweep trigger is re-armed by pressing the single sweep key.

Stores, settings/results

A section of the non-volatile RAM in the 2945 is made available for the storage of user instrument settings and the results of tests.

The internal memory provides 10 locations, each capable of holding the set-up parameters of the instrument or the results displayed on one screen.

This memory is accessed as follows:-

Press the [MEM] key. The store recall screen and menu is displayed. This gives direct access to the recall option, hence shortcutting the need for selection of this function.

The options available are:-

- [Store Setting]

- [Store Results]

- [Recall]

- [Delete Store]

- [Protect Store]

Pressing any of the soft keys will display a description of the action to be implemented and requesting a 'Store No' on which to act. The software requires a two digit number to be keyed in using the data entry keys therefore a zero must be entered before accessing the internal memory stores. The zero will appear on the screen to the right of the 'Screen No' legend. The second digit will not be displayed but the action will be performed on the memory store addressed as soon as the second digit is entered. If the action requested is not compatible with the contents or state of the store addressed, the action is not implemented and a message shown briefly to advise of this.

The action implemented by pressing each soft key is as follows:-

[Store Setting]

The description of the proposed action reads 'Store Settings to Store No.'

Entering the two digit address of the destination store will save all the parameter settings of the current 'Held' screen to the designated memory store and also cause the legend 'Settings' to be shown adjacent to the store No. in the 'INTERNAL STORE' list on the display.

[Store Results]

The description of the proposed action reads 'Store Results to Store No.'

Entering the two digit address of the destination store will save all the parameter readings of the current 'Held' screen to the designated memory store and also cause the legend 'Results' to be shown adjacent to the store No. in the 'INTERNAL STORE' list on the display.

[Recall]

The description of the proposed action reads 'Recall from Store No.'

The action of entering the two digit address of the destination store will differ according to the contents of the store.

If 'Results' are stored, then the recall action will cause the results stored to be displayed on a 'RESULTS SCREEN' and menu.

If 'Settings' are stored, then the recall action will cause the instrument to change to the mode appropriate to the stored settings with the parameters selected and levels set as at the time of saving. The Screen and menu will be in the 'HOLD' state and must be reactivated by pressing the [DISPLAY HOLD] key to commence measurement.

[Delete Store]

The description of the proposed action reads 'Delete Store No.'

Entering the two digit address of the destination store will delete the contents of the store and also cause the legend adjacent to the store No. in the 'INTERNAL STORE' list on the display to change to 'Empty'. This action is immediate, therefore ensure that the contents of the addressed store are no longer required before deleting. The exception to this action is that a store address may be 'Protected' as explained in the next soft key description. A protected store cannot be deleted. Store locations 00 and 01 cannot be made 'Unprotected'.

[Protect Store]

The description of the proposed action reads 'Protect Store No.'

The action of entering the two digit address of the destination store will differ according to the protection state of the addressed store.

If the contents are not 'protected', as indicated by a 'P' adjacent to the address in the 'INTERNAL STORE' listing on the 'STORE/RECALL' screen, then addressing the store will protect the contents from deletion and indicate this by displaying the letter 'P' as above.

If the contents are 'protected', then addressing the store will remove the protection and delete the 'P' from the store list.

Stores 00 and 01 contain settings of the 'Last Power-down' and the 'Factory Preset' settings respectively. These stores cannot have their protection removed or be deleted.

Memory card

The optional memory card facility extends the scope of the memory facility by the use of a SRAM card containing non-volatile memory with battery back-up. Information loaded onto a card is not unique to the source instrument. This allows users to interchange set-ups between operators and to establish a databank of cards for a complexity of tasks. Memory cards can be used by technicians to report results of tests to a service centre or to print out results after leaving the test site.

A memory card is loaded into the memory card port located on the front panel of the 2945. (If fitted) by sliding it 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.

Each memory card has capacity for 50 store locations.

Therefore with a memory card in place the number of store locations accessible through the STORE/RECALL screen is increased to 60. Locations 00 to 09 in the internal memory, with locations 10 to 59 on the memory card.

The memory store address list is headed 'INTERNAL STORE' and the locations are numbered 00 to 09. By pressing the [\downarrow] soft key the memory store address list heading changes to 'MEMORY CARD' and the locations are numbered 10 to 19. successive operations of this key will increment the numbering by 10 until the list is numbered from 50 to 59. Further operation of the key will have no effect. To access the lower numbered stores use the [\uparrow] soft key to increment down.

The procedure for storing, recalling and titling the memory stores on the memory card is the same as the procedure described above for using the internal memories.

Note

The memory card may be inserted or removed with the instrument powered up, provided that no instruction is displayed saying that the card is being read or written to.

Printer

An RS232 printer can be driven by the 2945 to obtain hard copy of test results. This is connected to the 'serial' port.

The serial port must be set to the printer option through 'Set-up Page 2' and [*Remote Control*] key. The port must be configured to match the requirements of the printer using the port configuration menu also accessible through 'set up page 2', and the [*serial port*] key.

Parallel printer port option

Parallel output

The parallel printer port option provides an output suitable for direct connection to a parallel drive printer. Fig. 3-24 shows the pin numbering of the socket and Table 3-1 shows the function of the socket connections.

Pin connections

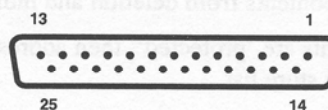


Fig. 3-24 Parallel printer port socket contacts. (as seen facing panel)

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. 3-25 shows the pin numbering of the socket and Table 3-2 shows the function of the socket connections. Fig. 3-26 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

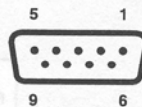


Fig. 3-25 Rear accessory port socket connections (as seen facing panel)

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)

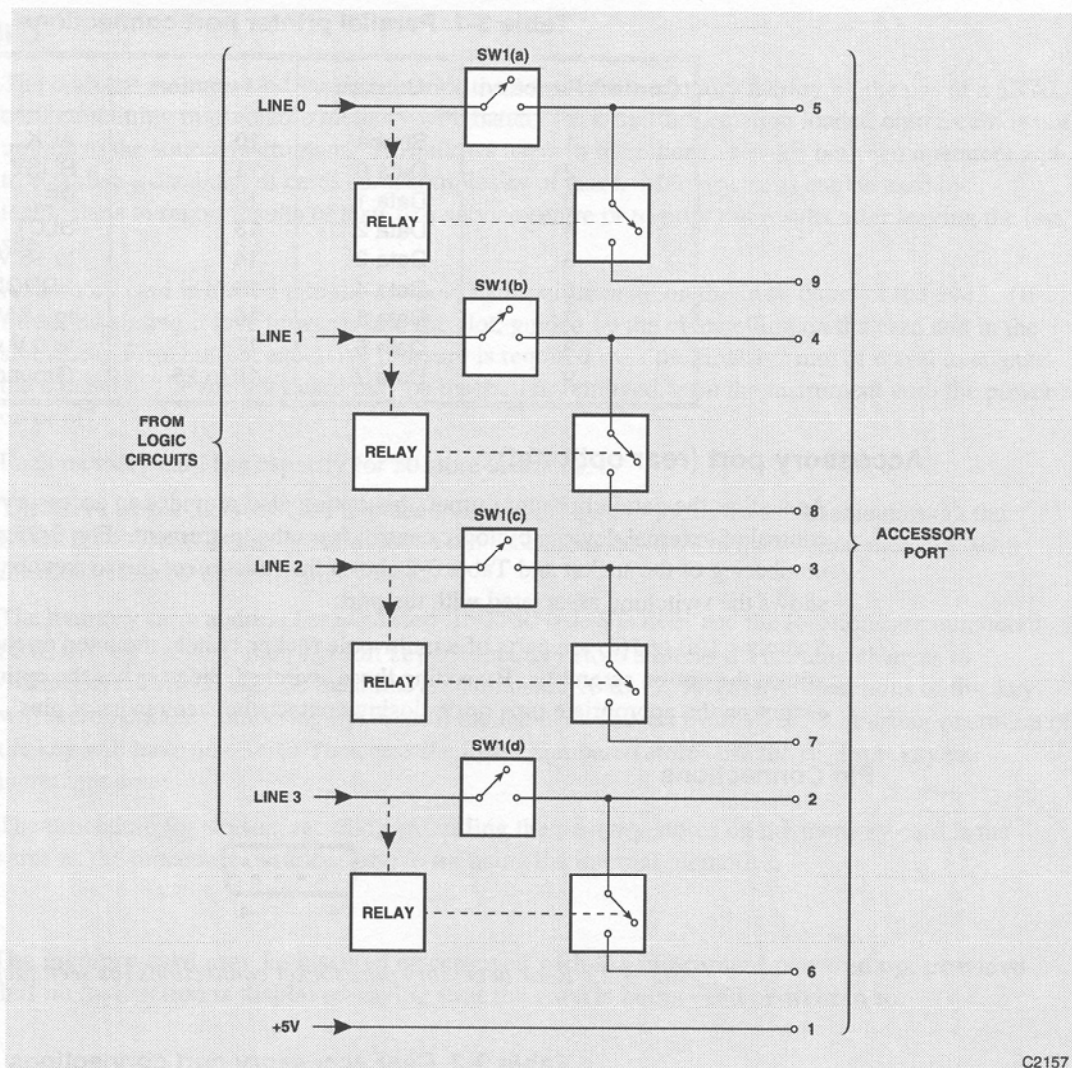


Fig. 3-26 Simplified diagram of rear accessory port switching

Setting up

Logic line state

The state of the logic lines outputs can be set from the logic lines set-up 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. 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 mode

Additional control is provided to logic lines 0 and 1, from the two top soft keys on the left of the logic line set-up 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', Line 0 will take up the 'Closed/Logic low' state when the instrument is in Tx test mode and the 'Open/Logic Low' state for all other test modes.

When the 'Line 1 Mode' is set to 'Close on Squelch', Line 1 will take up the 'Closed/Logic low' state when the instrument is in a squelched condition and the 'Open/Logic Low' state when the squelch circuits are open.

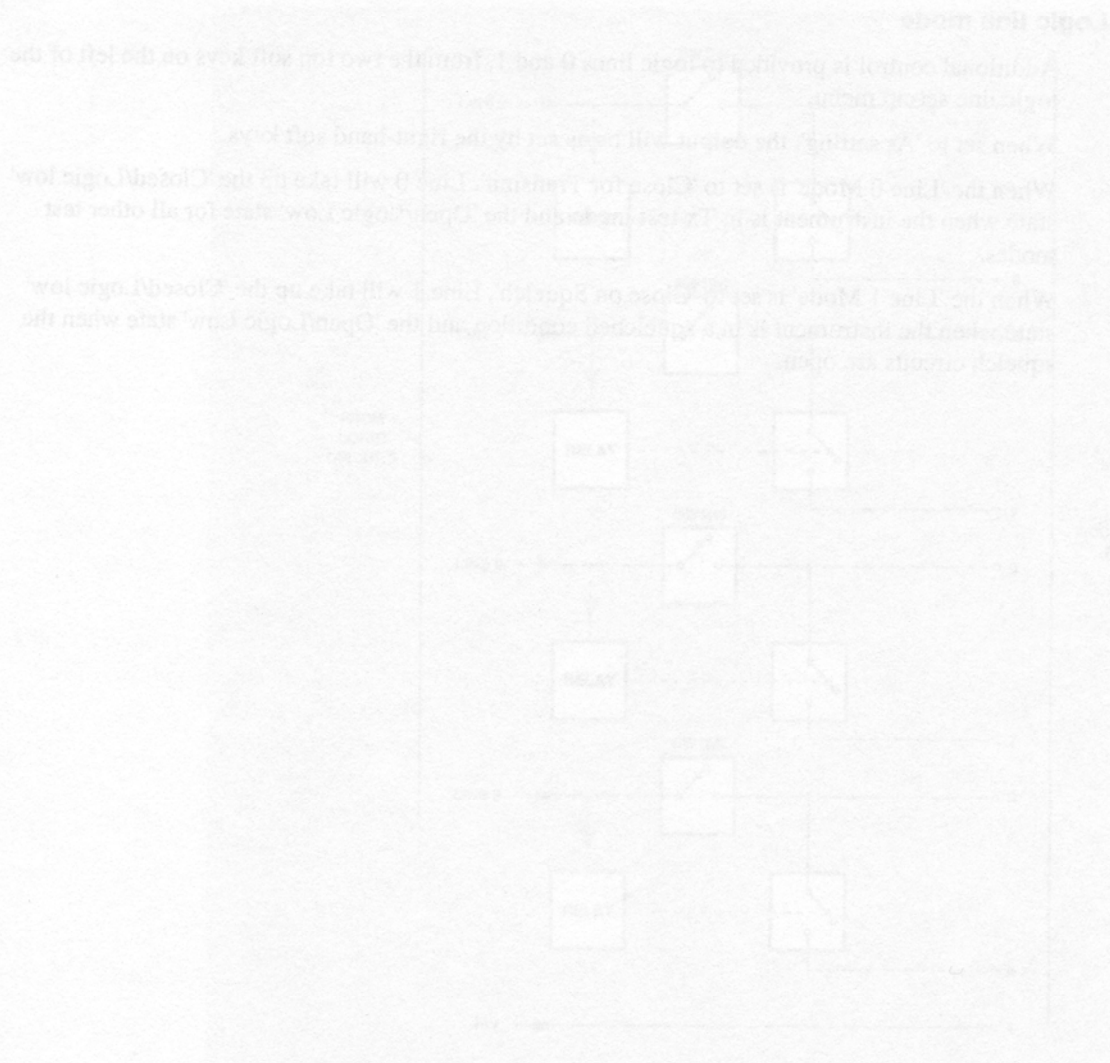


Fig. 3-26 Simplified diagram of four sections of port switching

Setting up

Logic line state

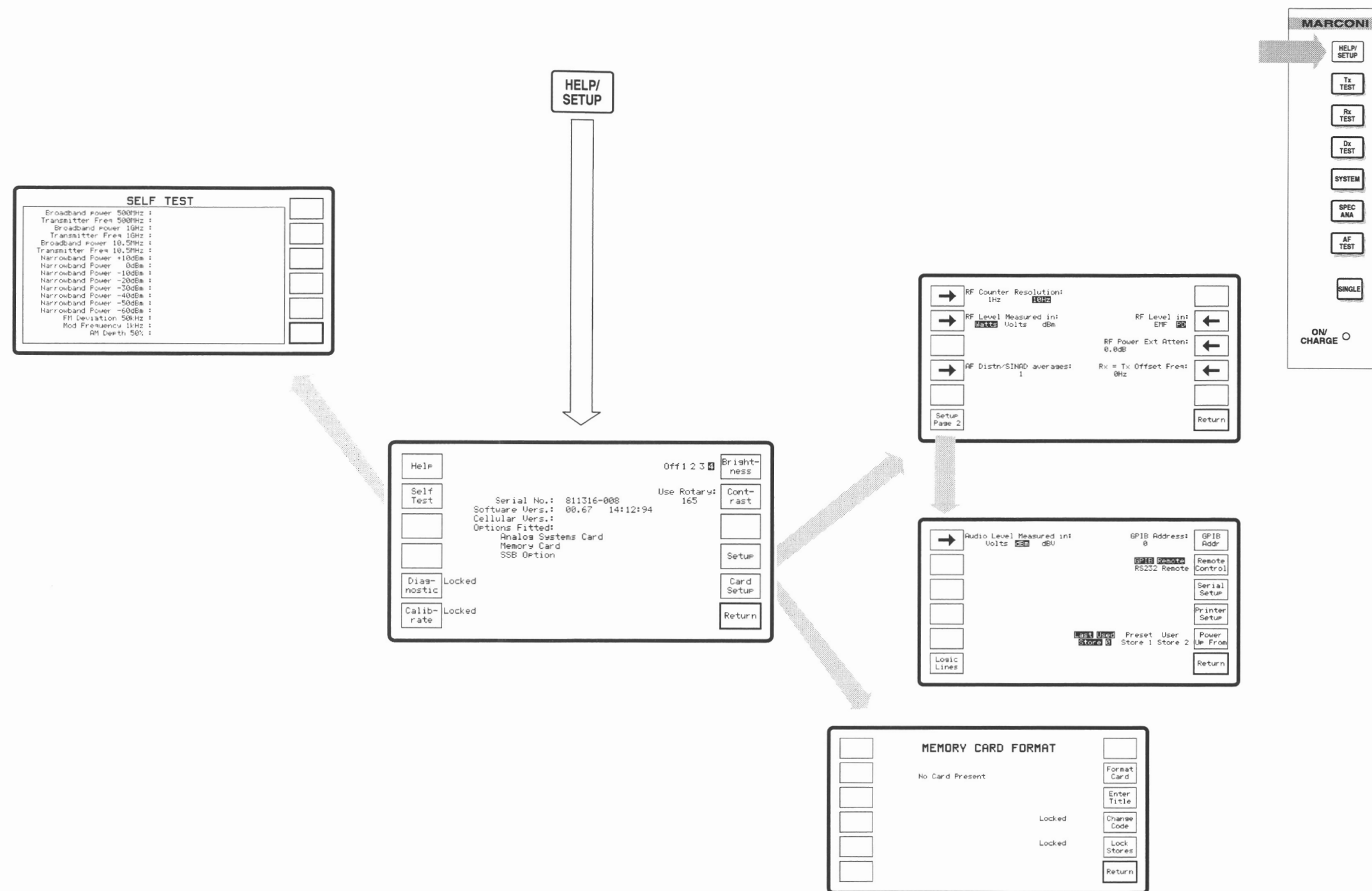
The state of the logic line outputs can be set from the logic lines set-up menu, accessible by the key sequence, [HOLD] P/[SETUP], [Setup] (Setup Page 2), [Logic Lines].

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.

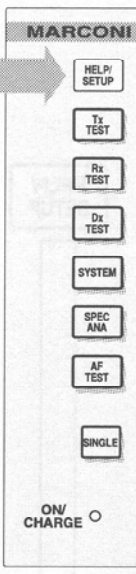
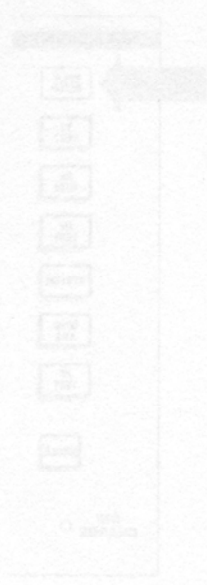
If the appropriate section of S1 is closed, the output can be set to either logic high or logic low. If the appropriate section of S1 is open, the circuit between pin pairs can be set to opened or closed. Each of the four lines can be set individually.

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.



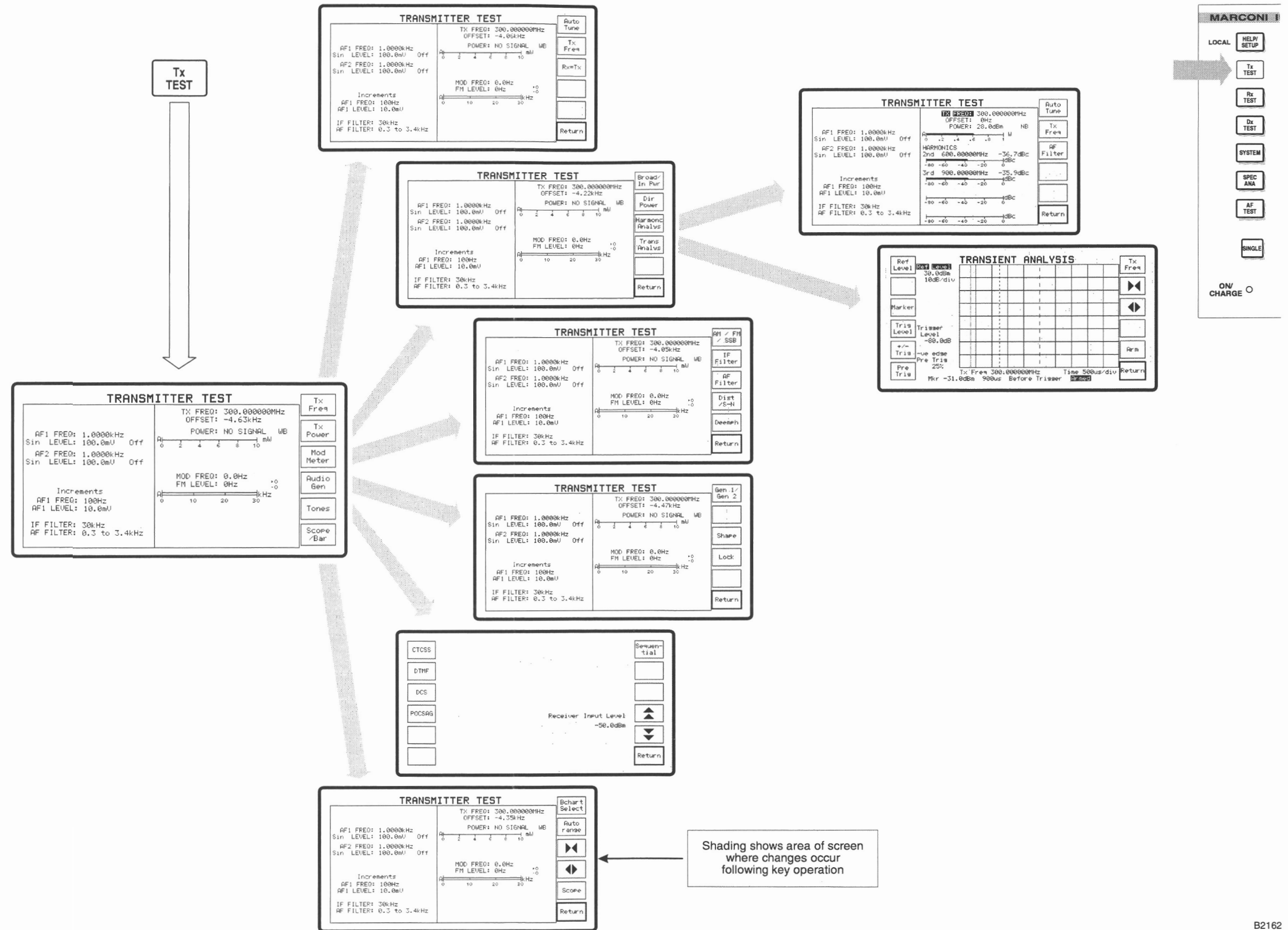
Test mode screen and menu (1.0). HELP/SETUP with lower levels.



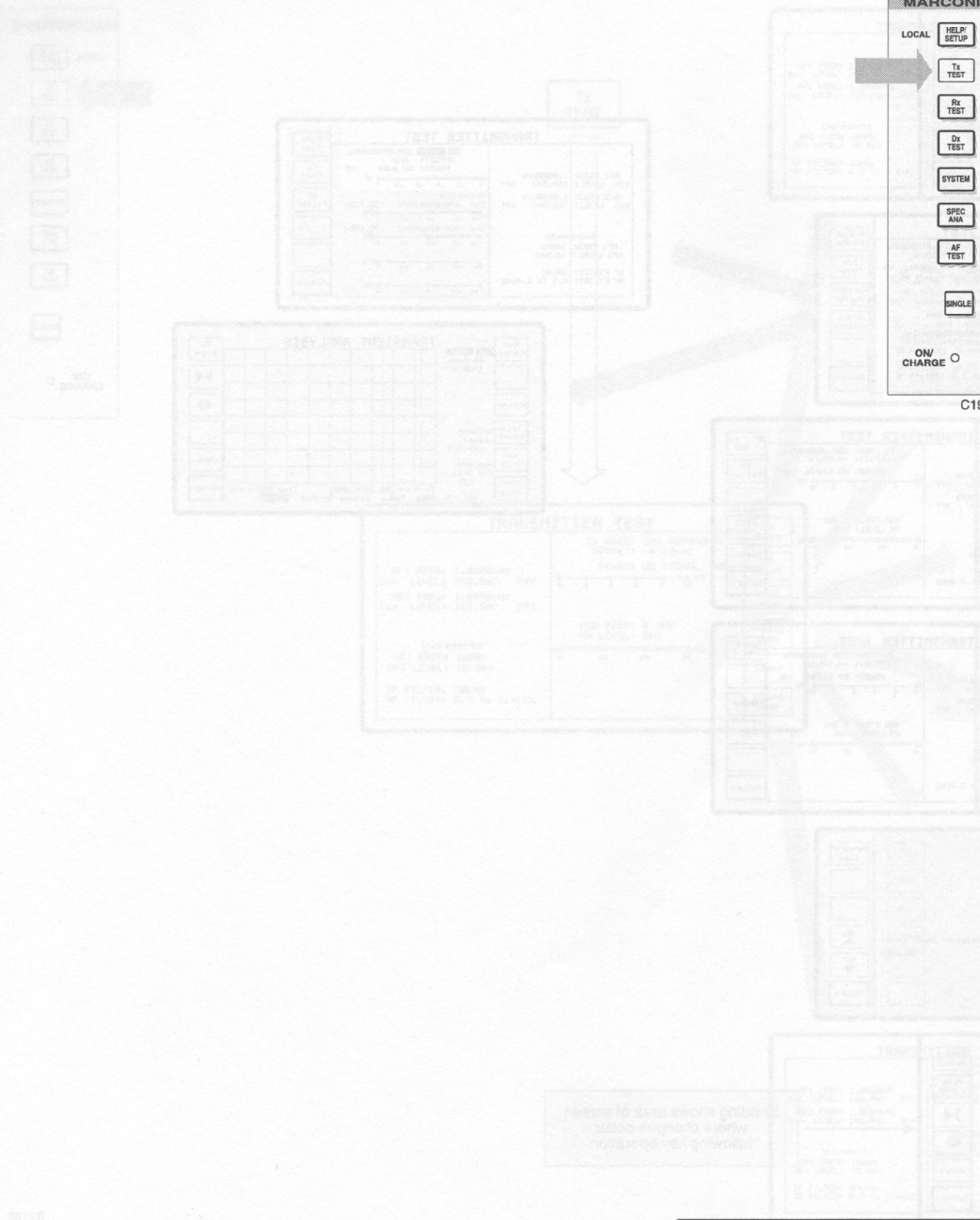
13122

Test mode screen and menu (1.0)
HELP/SETUP with lower levels.

4522 254

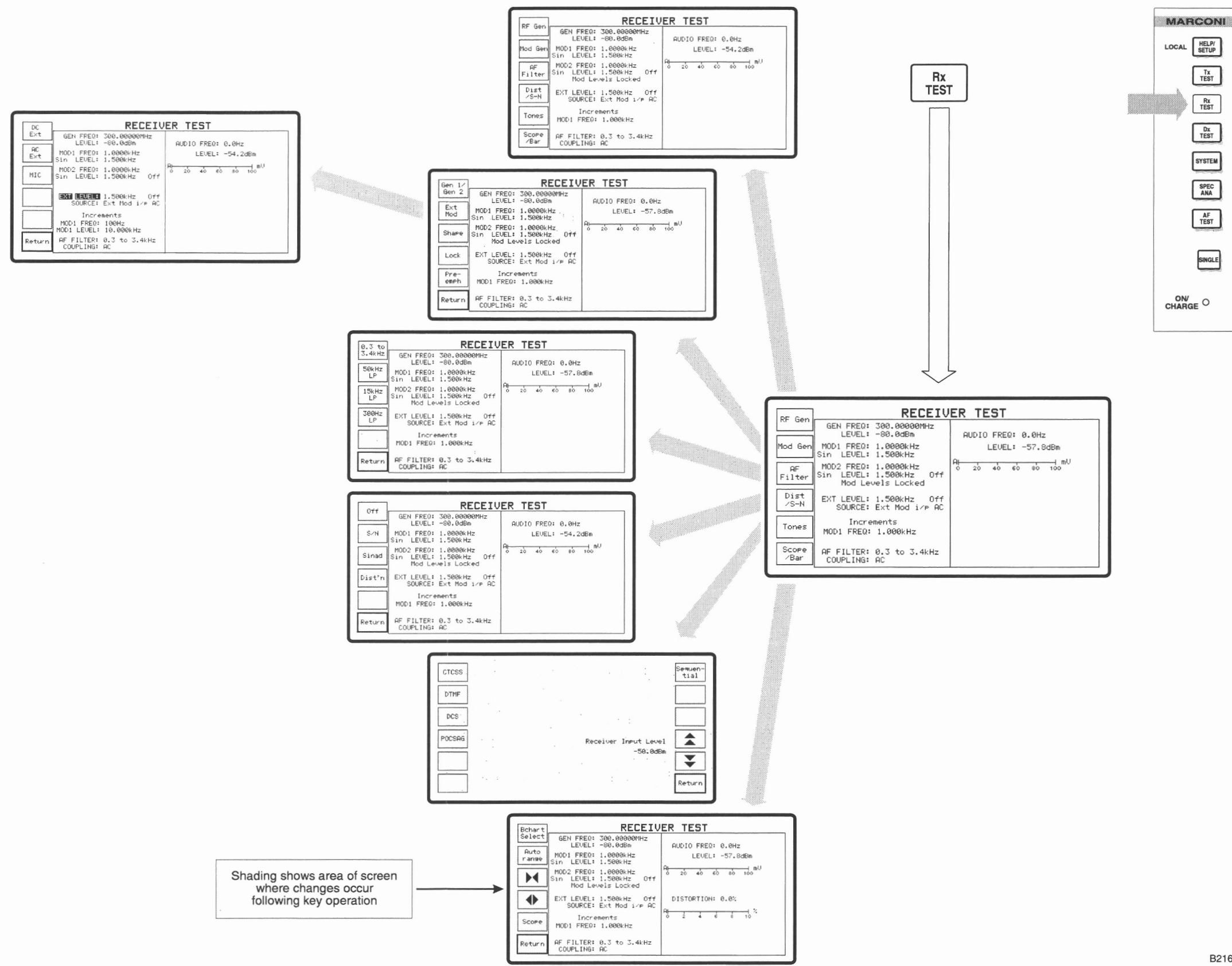


Test mode screen and menu (2.0). Tx TEST with next levels.



- LOCAL
- HELP/SETUP
- Tx TEST
- Rx TEST
- Dx TEST
- SYSTEM
- SPEC ANA
- AF TEST
- SINGLE
- ON/CHARGE

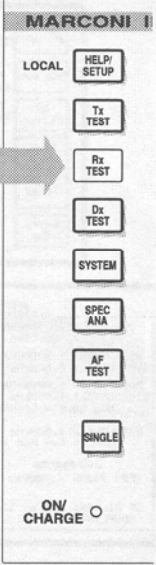
Test mode screen and menu (2.0)
Tx TEST with next levels.



Test mode screen and menu (3.0). Rx TEST with next levels.

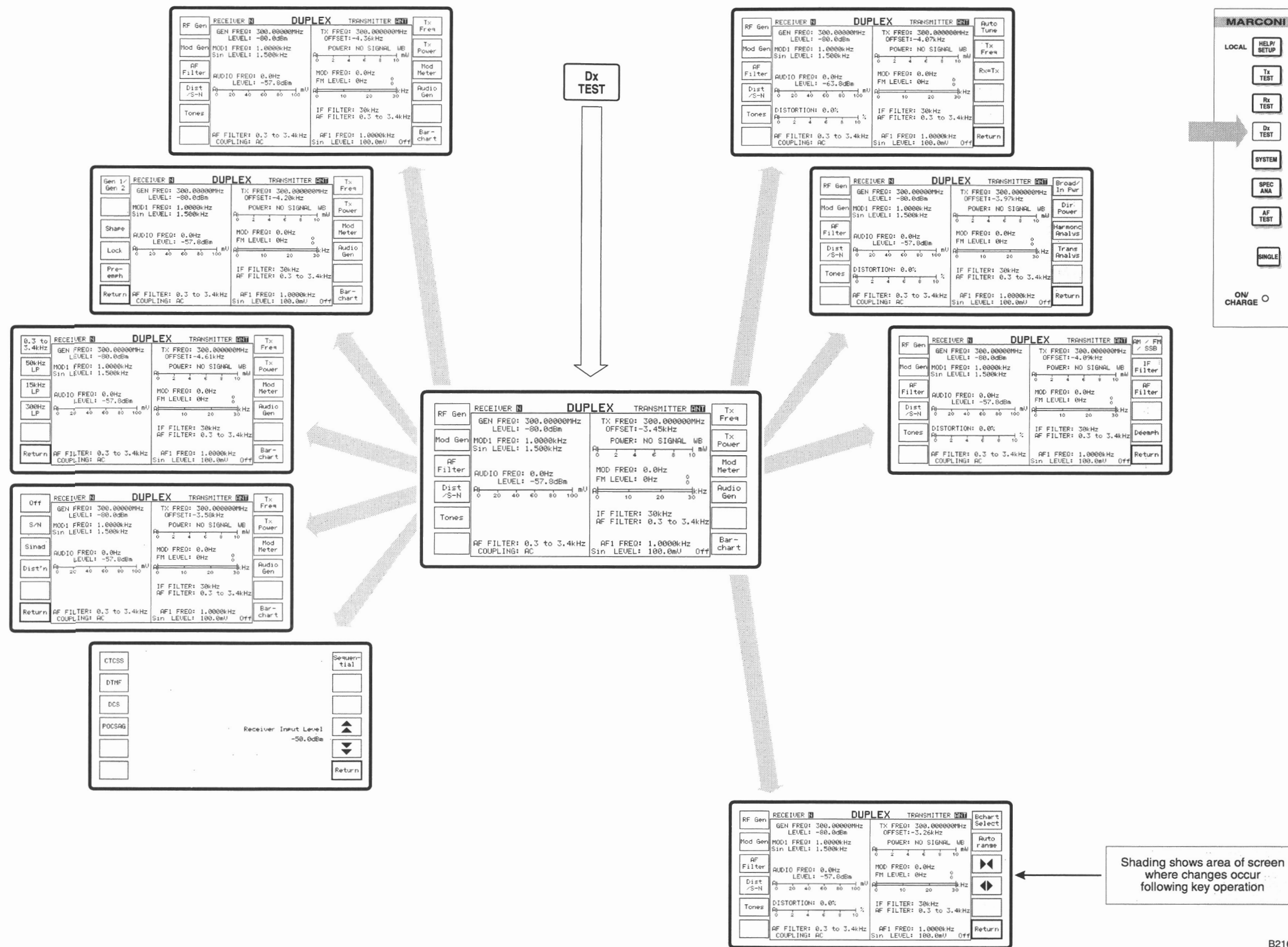


Rx
TEST

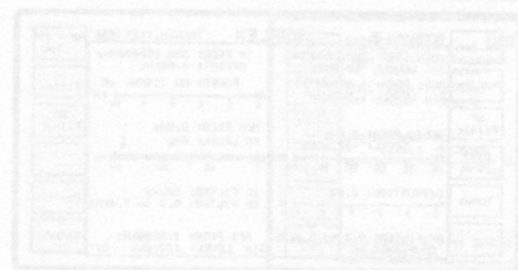
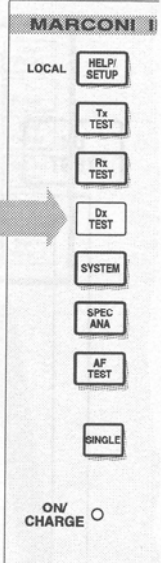


C1945

Test mode screen and menu (3.0)
Rx TEST with next levels.



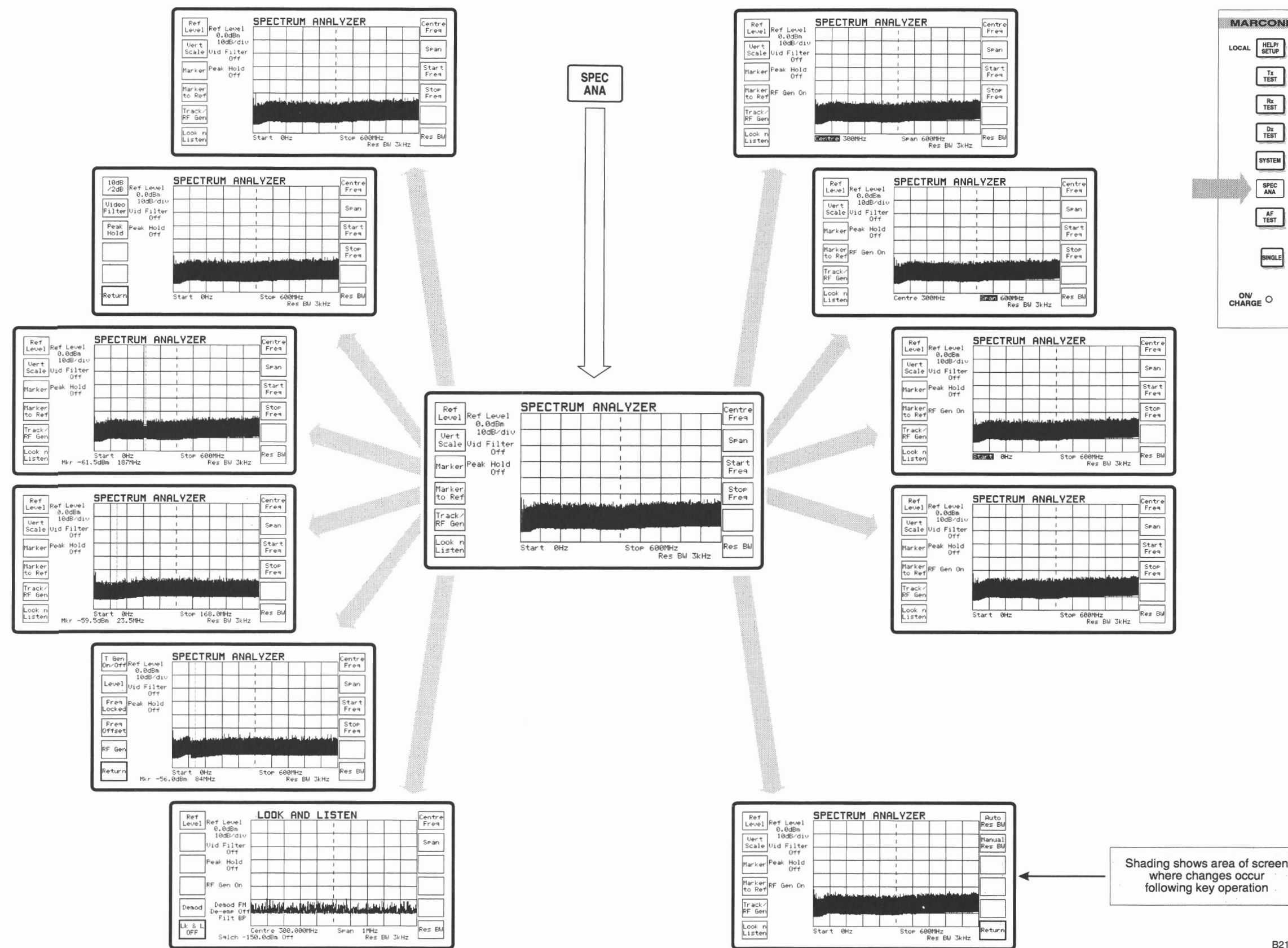
Test mode screen and menu (4.0). Dx TEST with next levels.



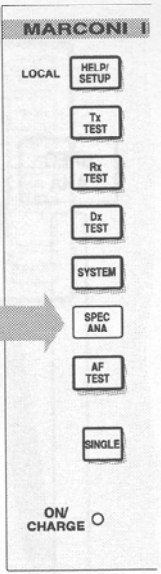
Pressing shows step of screen
when changed menu
following key operation

Test mode screen and menu (4.0).
Dx TEST with next levels.

C1944

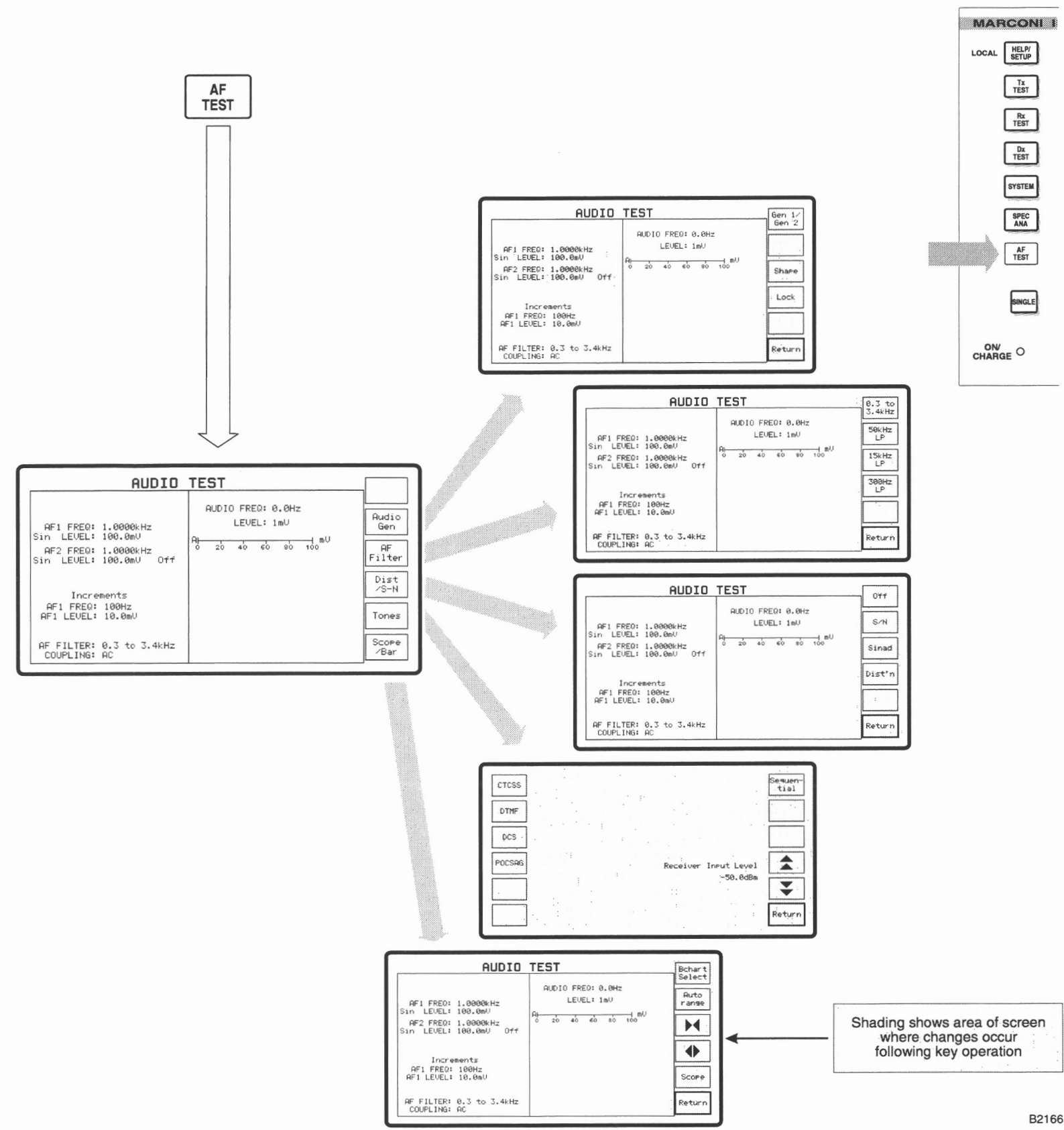


Test mode screen and menu (6.0). SPEC ANA with next levels.

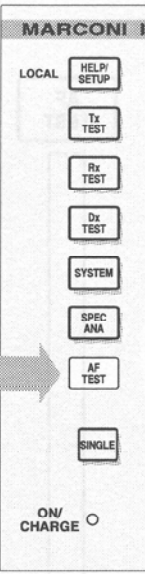


Check if shows error
when change data
following key operation

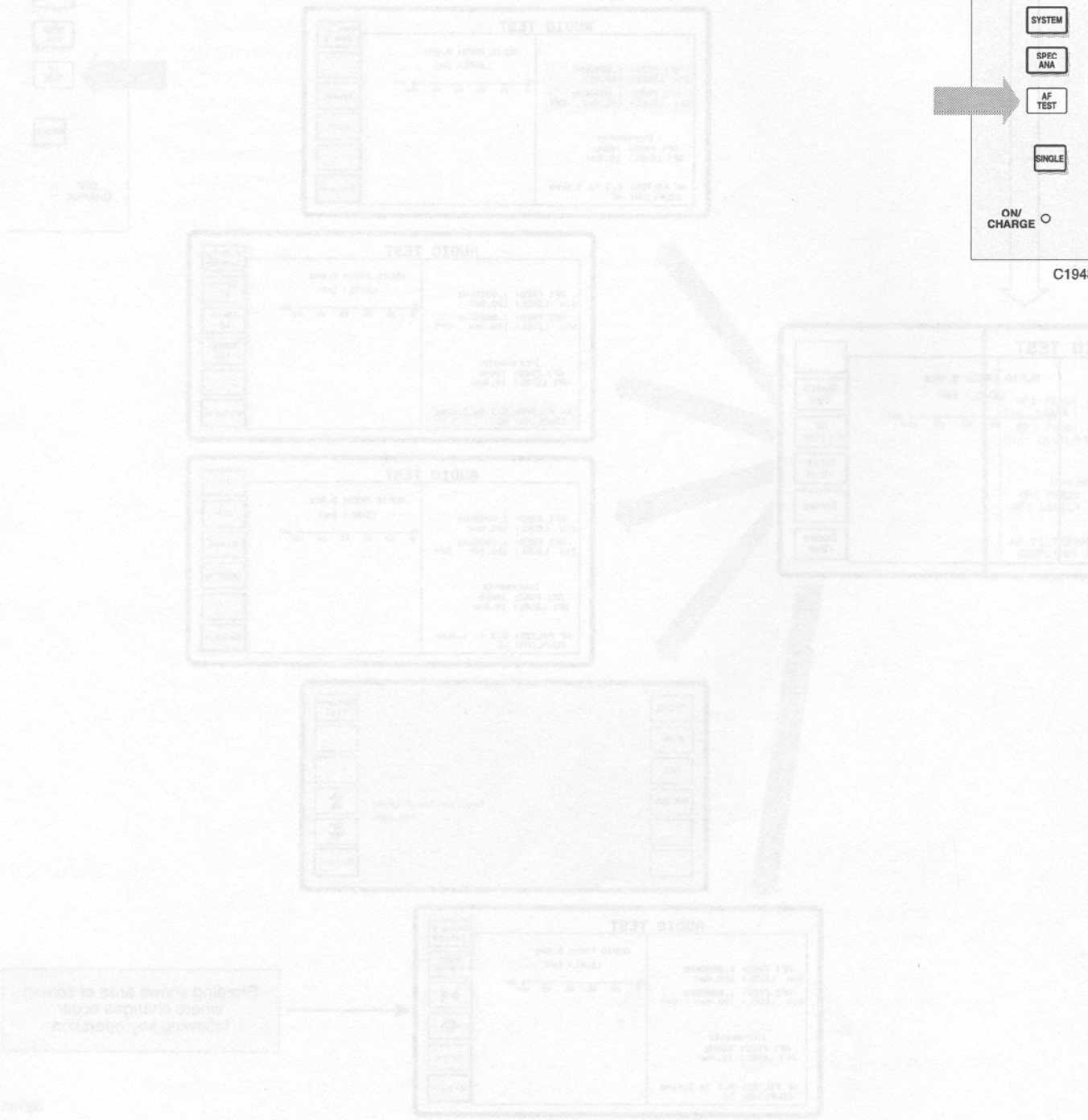
Test mode screen and menu (6.0).
SPEC ANA with next levels.



Test mode screen and menu (7.0). AF TEST with next levels.



C1948



Pressing down will of course
allow you to go to
the next level.

Test mode screen and menu (7.0).
AF TEST with next levels.