application note

Getting started with EDACS radio testing using the IFR 2945A

By N Trasler

Testing of EDACS radios is made quick and easy using the 2945A Communications Service Monitor. A step by step guide to testing EDACS radios is given.

INTRODUCTION

The 2945A Communications Service Monitor is ideally suited to the testing of trunking radios. It has an extensive array of built-in tests, allowing verification of radio performance, and rapid fault diagnosis.

This application note helps the user with little experience of either EDACS or the 2945A Communications Service Monitor. It will guide the user through the necessary steps involved in setting up and using the Communications Service Monitor to test EDACS radios.

TRUNKED RADIO

Traditional two-way radio systems such as PMR (Private Mobile Radio) have used a system where a group of users have one channel allocated, with this channel possibly in use by other groups. With several groups of users on one system, this leads to inefficient use of available channels, with the likelihood of one user waiting for his channel to become free while several other channels are unused.

Trunked radio systems make use of a central controller to assign channels as and when they are required. This involves signalling between the controller and the radios, but like a trunked telephone system, this trunking process is transparent to users - the typical operation of the radios appears the same with a trunked system as with a PMR system.

WHAT IS EDACS

EDACS, developed by Ericsson Inc., stands for Enhanced Digital Access Communications System. It is a computer-controlled trunked radio system which is typically used for one person to contact members of his or her own group In addition, it has a number of other features, including the ability to allow users to place individual, emergency or system-wide calls.

EDACS uses two channel types: control and working channels. The control channel is used to send digital signalling between the computer controlling the system and the radios. The working channel is used to transmit voice and data communications. A site may consist of one control channel and at least one working channel.

The 2945A Communications Service Monitor tests EDACS radios by simulating the signalling of a repeater, both on control and working channels. It has two testing modes, automatic test, where a test program runs through a selection of tests and compares the radio's performance to stored limits, and manual test, which is used as a trouble shooting tool where the user can control more closely what the radio does.

SETTING UP THE SYSTEM

What you need to know

Each EDACS system is a custom installation and will have a different set of parameters from any other EDACS system. To test an EDACS radio, you will need to know a little about the system it is programmed to work on.

Firstly, you will need to know the frequency set (or frequency plan) of the system, that is, the number of channels and the frequencies of each channel in the system. If you don't already know this information, it can be found out from a radio using the programming tools provided by Ericsson. If the personality used to program the radio is directly available, the frequency set can be obtained from this. Otherwise, the programming tools can be used to interrogate the radio to obtain its personality.

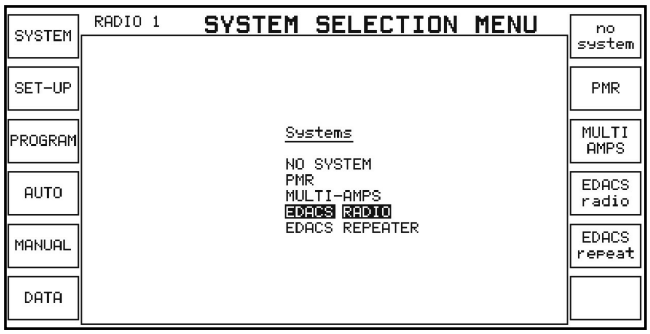
You will also need to know the data rate of the system. This is the speed at which the signalling information is transmitted. EDACS systems have one of two data rates, 9600 baud and 4800 baud. A 9600 baud system has a wide channel spacing of 25 kHz whereas a 4800 baud system has a narrow channel spacing of 12.5 kHz.

Typically, EDACS systems with a frequency set in the region of 900 MHz operate at 4800 baud and other systems operate at 9600 baud, so if the data rate is unknown, you can use this as a guide.

Finally, you will need to know the site ID of the system. This is a number transmitted by the site to identify itself and the radio must be able to recognise the number used during testing.

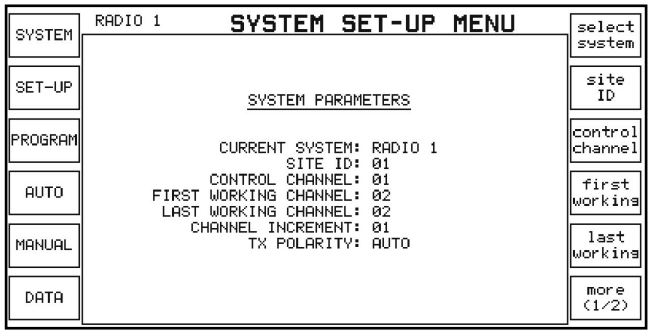
How to set up the 2945A

Firstly, you need to enter the EDACS radio testing mode. You can do this by pressing the blue **[SYSTEM]** key on the left side of the instrument, followed by the *[SYSTEM]* softkey at the top left of the screen. This will put you into the system selection menu which shows a list of available systems. Press the *[EDACS radio]* softkey to be able to test EDACS radios.



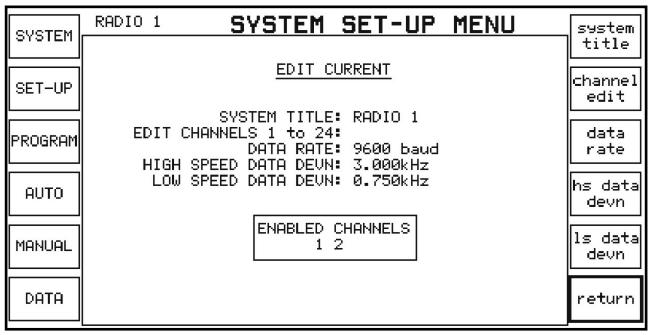
Selecting the EDACS radio test system

Once EDACS radio has been selected, press the *[SET-UP]* softkey. This will take you to one of the four system set-up menus. These are SYSTEM PARAMETERS, RADIO PARAMETERS, AUTORUN CONTROL and AUTORUN PARAMETERS menus. Pressing the *[SET-UP]* key repeatedly cycles through these menus in turn. If the SYSTEM PARAMETERS menu isn't already displayed, press the *[SET-UP]* softkey until it is displayed.



The default SYSTEM PARAMETERS menu screen

Press *[select system]*, *[edit current]* to enter the menu screen to edit the current system.



The EDIT CURRENT menu screen

Press *[system title]* if you want to refer to the system by a name other than the one shown (i.e. "RADIO 1"). You can enter this title by using the rotary control to select a letter at a time, pressing *[enter char]* to enter each character into the string and pressing *[title complet]* when finished. The *[return]* softkey will abort title entry. The title can be up to ten characters long and will appear in the top left hand corner of the screen. Up to the first seven characters of the title will also appear subsequently on the softkey used to select the system.

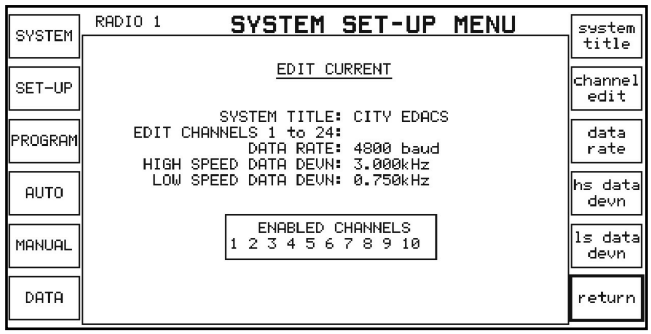
The *[channel edit]* softkey gives a list of channels to edit, from 1 to 24. Press *[channel edit]*, *[channel 1]* to edit the frequencies for channel number 1. Press *[tx freq]* followed by the frequency that the radio transmits on for channel 1, terminated with one of the orange units keys, e.g. **[MHz]**. Next, enter the duplex offset of the channel, by pressing the *[duplex offset]* softkey. If not known directly, the duplex offset can be determined as receive frequency minus the transmit frequency. For example, if the radio transmits on channel 1 at a frequency of 810 MHz and receives at a frequency of 855 MHz, then the duplex offset will be 45 MHz.

Pressing the *[next]* softkey gets you straight to the next channel to enter frequencies and in this manner, you can enter the frequency set one channel at a time. Make sure that each channel you want is actually included. Pressing the *[include exclude]* softkey toggles between included and excluded.

When you've finished entering the frequency set, press *[return]* to return to the EDIT CURRENT screen. At the bottom of the screen there is a box which shows a list of all the channels currently selected as included in the frequency set. Check that this is correct before proceeding.

Next you can change the data rate if necessary. Pressing the *[data rate]* softkey toggles between 9600 baud and 4800 baud data rates.

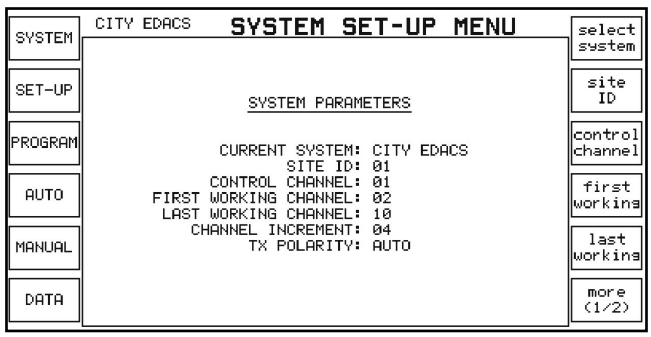
Finally, you can alter the high and low speed data deviations if you know what they should be on your system. However, the default values of 3 kHz for high speed and 750 Hz for low speed should work on all EDACS systems.



Example system

When you've finished entering these parameters, press the *[return]* key to get back to the SYSTEM PARAMETERS screen. If you changed the system title, your new title should now be visible in the top left hand corner of the screen.

When you changed the included channels, the 2945A Communications Service Monitor automatically reflects the new channels in the fields of the SYSTEM PARAMETERS screen. These channels define the channels used to test the radios, particularly in auto test mode. By default, the control channel is the first included channel, the first working channel is the next included channel, the last working channel is the last included channel and the channel increment is half the difference between the first and last working channels. These values can be changed if, for example, you want to test on a different range of channels but radios will usually work on the default values.

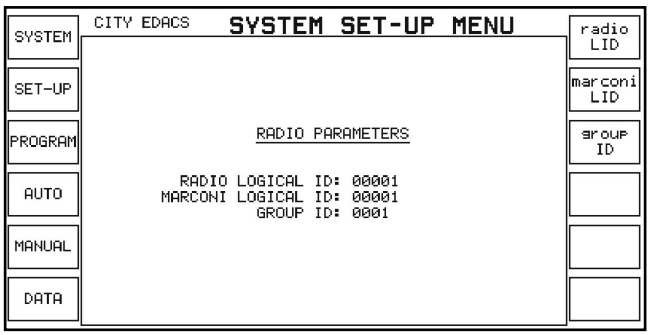


SYSTEM PARAMETERS screen after edit current changes

The other parameter on the SYSTEM PARAMETERS screen is Tx polarity. The default value is AUTO, which means that

the polarity is selected automatically depending on the system's data rate. The value can be AUTO, NORMAL or INVERTED and refers to the polarity of the signalling sent by the 2945A Communications Service Monitor. You should only change this if you know that your system's polarity is different from the usual value.

The 2945A Communications Service Monitor has capability to hold four different EDACS radio systems internally. These can be selected from the SYSTEM PARAMETERS menu by pressing *[select system]* then one of the systems: *[radio 1]*, *[radio 2]*, *[radio 3]* or *[radio 4]*. Once selected, each system can be changed as described above.



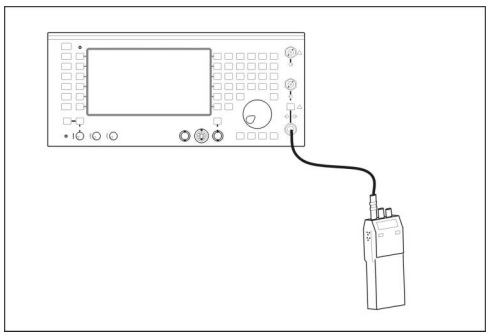
RADIO PARAMETERS screen

From the SYSTEM PARAMETERS menu, pressing the *[SET-UP]* softkey will show the RADIO PARAMETERS menu. This shows the radio logical identity, the IFR logical identity and the group identity. A logical identity is the individual number used to identify a particular radio, while the group identity specifies the group a radio belongs to. The radio logical ID is the logical identity of the radio under test and the IFR logical ID is the logical identity assumed by the 2945A Communications Service Monitor for the purposes of testing radios. The group identity is the number of the group that both the radio and the service monitor belong to, since they both need to be in the same group in order to perform some of the tests.

Although these identities are used by the 2945A Communications Service Monitor to communicate with EDACS radios, both the radio logical ID and the group ID are changed when a radio initiates a transaction - in effect the service monitor assumes that the last radio that "talked" to it is the one under test. Hence, you won't need to change these values explicitly since they will be updated when a radio places a call or logs in.

Checking the set-up is right

The simplest way of checking that the parameters you've entered are correct is to use a radio with the same set-up. This is most easily accomplished using the MANUAL TEST mode. Press the *[manual test]* softkey on the left hand side of the screen. Connect an appropriate radio with an RF cable to the N-type connector on the front of the 2945A Communications Service Monitor. The first check is to turn on the radio and ensure it sees service. Many radios show "NC" for "No Control" Most radios will automatically login to the system when switched on and this will be acknowledged by the Service Monitor, which will display "LOGIN ACKNOWLEDGED" at the bottom of the screen.



Basic radio connection

If this login occurs, then the set-up information for the control channel is correct. If it doesn't, then there are several things that might be wrong. First, ensure that the frequency information for the system in the EDIT CURRENT menu screen is correct. Other things to check are the data rate and the Tx polarity. If any of these are wrong, the radio will not detect the control channel.

If the control channel information is correct, try placing a call by pressing the PTT (push to talk) button on the radio. The Service Monitor should respond and go into working channel mode. Releasing the PTT on the radio should cause the Service Monitor to return to control channel mode. Press *[mode]*, *[call group]* softkeys to make a call to the radio. The radio should respond by indicating that it is on a working channel.

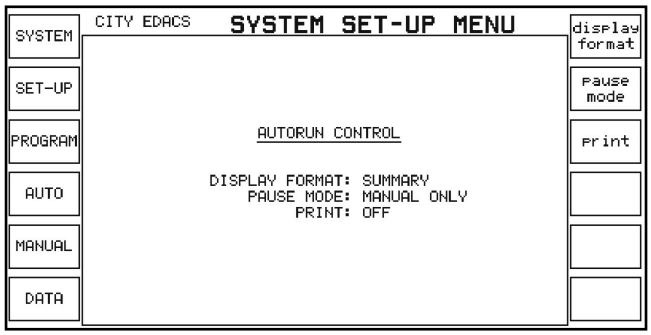
If either of these tests fail, check that the frequency information for the working channel in use is correct.

TESTING RADIOS USING AUTOMATIC TESTING

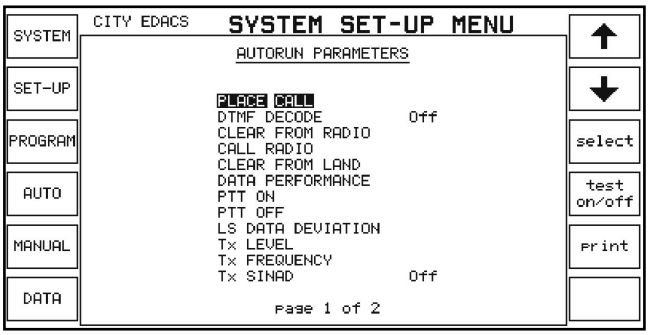
The primary method of testing radios is the automatic testing mode. This uses a test program which runs a sequence of tests according to parameters set using the various set-up menus and allows you to print test results for your records.

Changing program flow control

The third set-up menu, AUTORUN CONTROL, determines the flow of automatic testing. Each field can be changed by selecting the softkey associated with it and selecting one of the softkeys that subsequently appears.



Autorun control set-up menu



Autorun parameters set-up menu

The display format determines the information shown in the results window. The default value is summary, which shows one line results. Full display format displays, in addition, the parameters relating to the test.

Pause mode can be manual only, on failure or always. Selecting *[pause mode]*, *[manual only]* means that the automatic test program will pause on completion of a test only when the *[pause]* softkey on the AUTO screen has been pressed. When the pause mode is set to *[on failure]*, the automatic test program will pause if a test has failed, or if the *[pause]* softkey has been pressed. Selecting *[pause mode]*, *[always]* means that the automatic test program will pause after each test has finished.

When *[print]*, *[on]* is selected, the results are sent to the printer at the same time as being displayed on the screen.

Changing Autorun parameters

The parameters for automatic tests are found in the AUTORUN PARAMETERS set-up menu. To get to this menu, simply press the *[SET-UP]* softkey repeatedly until the menu appears.

This menu shows a list of available tests for testing EDACS radios. Each test has associated parameters and most of the tests can be turned on or off. The parameters are initialised to values that would be suitable for most radios, so you should only change the values if you know that the current ones are wrong for the radio you are testing. The [print] softkey will print out all the tests and their associated parameters to a connected printer.

The autorun parameters associated with a test can be either settings which are selected for the duration of the test, such as the RF generator level and filter types, or values which the result of the test is compared against, for example, upper limits and error tolerances.

To change values for a particular test, move the highlight bar onto that test with the arrow softkeys or the rotary control, then press the *[select]* softkey. The screen will then show a list of values for that test which can then be selected in a similar way by using the arrow softkeys or rotary control and then the *[edit]* softkey. The new value can be changed by entering a number or in some cases by pressing a softkey out of a selection.

Selecting channels to test

Each test program performs tests on a number of channels which are chosen by the first and last working channel and channel increment fields of the SYSTEM PARAMETER set-up menu. Tests are performed on the first working channel, then, by adding the channel increment, on each channel until the last working channel is reached. So by setting the channel increment to 1, each channel in the block from first working channel to last working channel will be tested.

Selecting the program

Automatic testing allows you to test radios with a minimum of user effort. There are four in-built test programs and one user defined test program. Press the *[PROGRAM]* softkey to get you to the program selection screen where the list of programs is displayed.

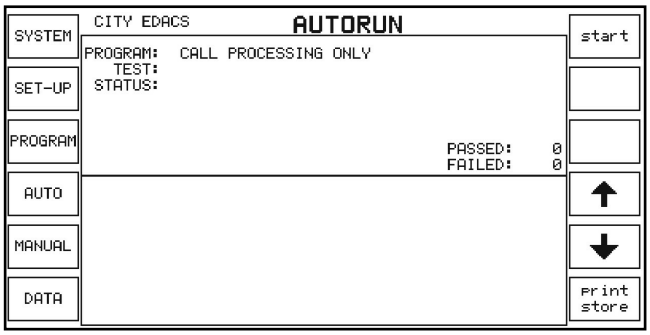
CALL PROCESSING ONLY just tests the signalling aspects of a radio, including call set-up and clear down. CALL AND RF TESTING tests, in addition to the signalling, properties of the RF part of the radio, such as power, frequency and low speed data deviation. BRIEF TESTING and COMPREHENSIVE TESTING both test the audio properties of the radio and require audio break-out access to the radio in addition to the RF connection.

The other program in the selection is USER DEFINED TEST which can only be selected when a program has been downloaded to the 2945A Communications Service Monitor by a user. It is beyond the scope of this application note to explain how to write your own program, but more information can be obtained from the Programming Manual.

The currently selected program is shown highlighted. To select a program, press the corresponding softkey.

To run the selected program, press the *[AUTO]* softkey to get to the automatic test screen.

Running the automatic test program

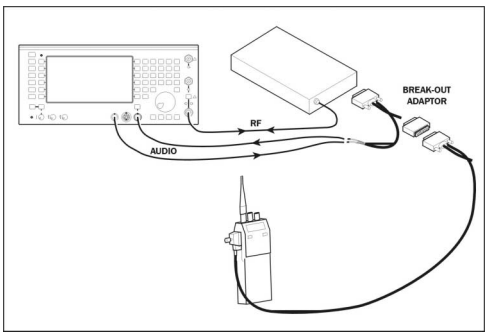


The Autorun screen

The autorun screen has two main parts to it - the status window at the top of the screen and the results window at the bottom. The results window shows a part of the results store and the rest of this store can be viewed using the up and down softkeys, [M], [N]. Pressing the [print store] softkey prints the current results store.

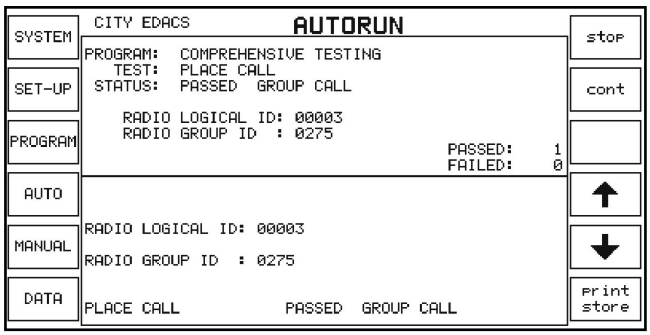
The [start] softkey starts the autorun program running. While the program is running, the status window displays the current autorun program, the current test being run and that test's status which can be active, passed, or failed. When running, the [stop] softkey will abort the current test and the [pause] softkey will pause the program after the current test has been completed. When paused, the [stop] softkey will abort the whole program and the [cont] softkey will continue the program.

With the desired program selected and the parameters adapted for your radio, the next step is to connect the radio and press [start]. The RF connection is necessary for all tests, and some tests in both BRIEF TESTING and COMPREHENSIVE testing programs also require audio connections. You will need an audio breakout adapter for the phone. Connect the audio input to the phone to the "AF GEN OUTPUT" socket on the 2945A Communications Service Monitor and the audio output from the phone to the "AF INPUT" on the Instrument.



Automatic test connections

When the test is under way, any further actions required will be prompted on the screen. For example, the PLACE CALL test will display flashing text in the STATUS: line on the screen telling you to "PRESS PTT". It is important that when you press the PTT for any test, you don't release it until the 2945A Communications Service Monitor prompts you to, since some of the tests rely on this.

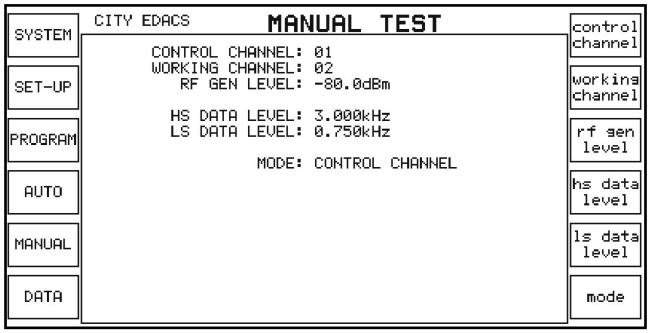


Autorun screen during a program

When an autorun program has completed, a test summary will be shown in the results window, indicating how many tests have passed and failed.

TESTING RADIOS USING MANUAL TESTING

The manual testing mode is useful for trouble shooting purposes, or for when a particular area of a radio's performance is to be tested. Whereas automatic testing requires call placement operations to occur at particular times, with prompts, in order to perform measurements. manual testing allows call operations at any time but has few measurements directly available.



Manual test screen in control channel mode

In the manual test screen, you can change the current control channel and the working channel assigned when a call is placed. This could be used, for example, to examine the mobile's use of a particular channel, both as a control channel and as a working channel, in turn. Note that call placement does not work if these two are the same.

You can also change the RF generator level and the high and low speed data levels. All these values can be changed by pressing the relevant softkey and using the number key pad, with the orange unit entry keys.

Handling calls in manual test

The *[mode]* softkey lists a number of modes accessible from the current mode. From the control channel mode, you can select *[control channel]* which restarts the control

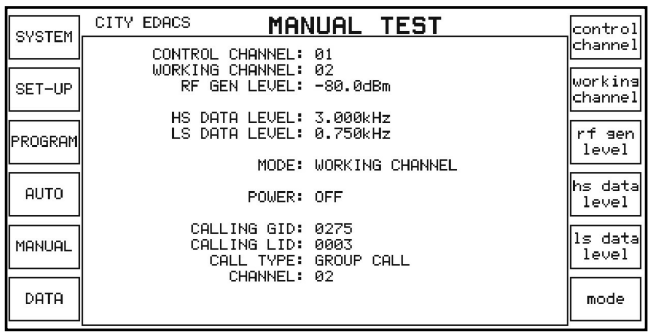
channel, *[individ call]*, *[group call]* and *[emerg call]* which call the radio with an individual call, group call and emergency call respectively. If you have a microphone with PTT switch (IFR part number 44991/145) plugged into the accessory socket on the front panel of the 2945A Communications Service Monitor, this can also be used to make a group call to the radio and will also allow talk through.

[data perform] starts the data performance test which sends continuous unit enable/disable messages to the radio, which it must acknowledge and displays the percentage of correct replies received. *[late entry]* sends update messages to the radio, so that it "thinks" there is a group call already in progress and joins it.

In addition, actions initiated by the radio, such as placing a call or logging in are also supported. When a call is made either to or from the radio, information about the call is displayed and the mode changes to working channel.

In working channel mode, an indicator shows whether power is being detected from the radio. If the service monitor initiated the call, the radio can still be keyed up and unkeyed by pressing and releasing the PTT and the power indicator should switch from OFF to ON as appropriate.

If the radio initiated the call, the modes available by pressing the *[mode]* softkey are *[convers]* which returns you to the previous softkey selections, *[control channel]* which forces a control channel and *[measure LS devn]* which measures the low speed deviation of the radio.



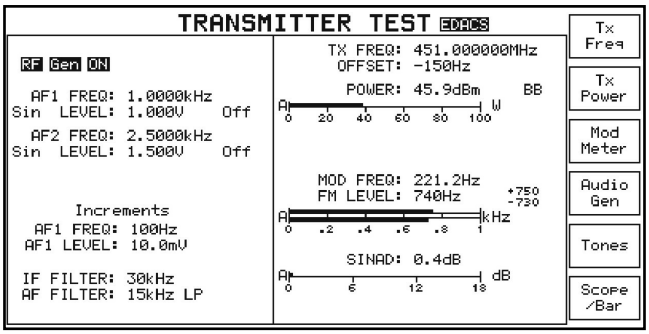
Manual test screen in working channel mode

If you initiated the call from the service monitor, the *[measure LS devn]* mode is no longer available, but *[clear down]* allows you to clear the call down.

Making manual measurements

If, for example, a radio has failed a particular automatic test, the radio can be observed more closely, over a longer period of time, using a combination of manual test and either the transmitter or receiver test modes of the main instrument. While the EDACS signalling can only be performed from within the SYSTEMS mode, access is available via manual test. Press either of the blue **[Rx TEST]** or **[Tx TEST]** keys as appropriate, returning to the manual test screen by pressing the blue **[SYSTEM]** key.

For example, if the radio failed on the Tx sinad automatic test, from manual test, press the radio's PTT to place a call, then **[Tx TEST]** to get to receiver test (holding the PTT down the whole time), then *[Mod Meter]*, *[Dist/S-N]*, then *[Sinad]*. If the display previously showed the scope, it will now show a figure for sinad. If a modulation bar chart was previously displayed, a sinad bar chart is added. These two displays can be reached by pressing the *[Scope/Bar]* softkey which allows you to select between bar charts and large or small scope.



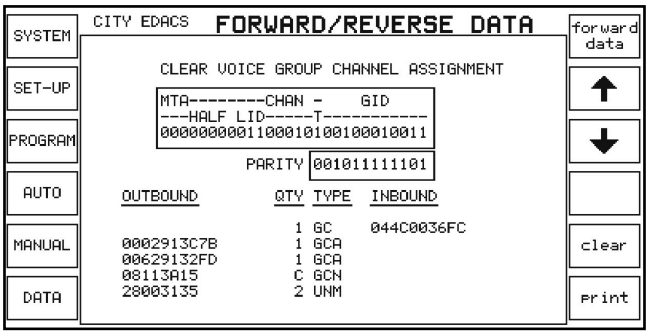
Transmitter test screen from working channel mode

The transmitter test screen can also be used to measure power, frequency, modulation level, S/N and distortion.

Similarly, the Rx tests can be examined by using **[Rx TEST]**, *[Dist/S-N]* and the appropriate test.

DATA DISPLAYS

Pressing the *[DATA]* softkey on the left hand side of the screen gets you to data displays mode. This shows a display of the signalling traffic that is sent between the radio under test and the service monitor.



Data display of a group call

In the forward/reverse data screen, the bottom part of the display shows the frames interleaved in the order the service monitor sends and receives them. Inbound messages are sent from the radio to the service monitor and outbound messages are sent to the radio. The data is shown under OUTBOUND or INBOUND in hex format, together with the quantity sent or received and the type. The message highlighted in the bottom part of the display is expanded in the top box, which shows the full message title and the breakdown of the message contents.

The [⇑] and [⇓].softkeys scroll up and down the data list. The *[clear]* softkey clears the display and the *[print]* softkey

prints the data to the printer.

Pressing *[forward data]* selects the forward overhead data screen. This shows the data that the 2945A Communications Service Monitor continuously sends out as part of the control channel.

The data displays mode can be used to see if a radio has sent the correct messages in response to ones sent by the service monitor. For example, while performing a data performance test, you can select *[DATA]* to see the messages sent to and from the radio. However, no signalling is performed by the service monitor while in data displays, it is solely an examination tool.

The data displays mode is particularly useful if you are conversant with EDACS terminology and signalling. It is possible, for example, to look at a particular message and see if the radio is sending the correct information.

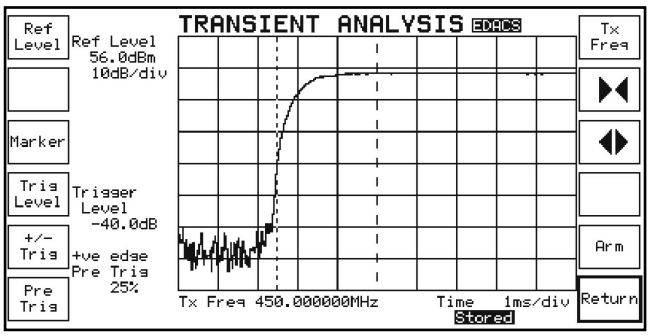
FREQUENCY KICK MEASUREMENT

Frequency kick is the term given to the transient frequency characteristics of a radio when transmitting a burst of information. The 2945A Communications Service Monitor's transient analysis screen can be used to gain a qualitative picture of the radio's frequency kick which is sufficient to identify poor radios.

To perform this test, start with a radio in service and press **[Tx TEST]** to get to the transmitter test screen. The IF filter should be set to 30 kHz, since this is the EDACS default. Press *[Tx Power]*, *[Trans Analys]* to get to the transient power analysis screen. Set the parameters on the left hand side of the screen as follows: Reference level 56 dBm, trigger level -40 dB, +ve edge trigger, pre trigger 25%. Press the PTT on the radio to capture a power burst.

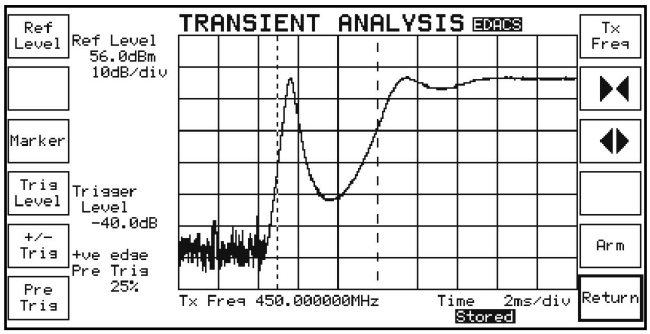
With a good radio, the trace should show a smooth rising curve settling to a straight line near the top of the screen. This is the power output of the radio when transmitting a signalling burst.

If the flat top of the trace is too low on the screen, you can make the reference level lower. It is worth experimenting with the reference level and the time/div. (using the **[<=]**, **[=<]** softkeys) until you get a trace that best utilises the screen. When you change any of these values, or press the *[Arm]* softkey, the screen is armed for the next power burst.

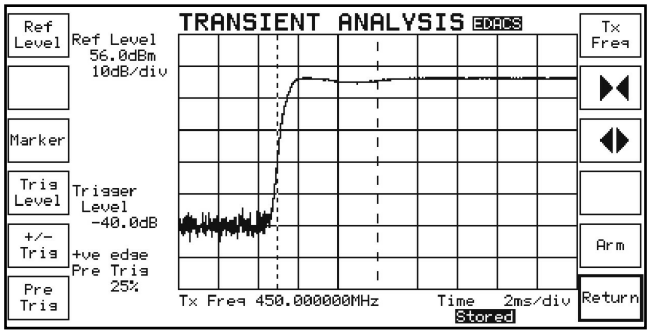


Transient power analysis showing a good radio

A radio with a bad frequency kick will show an erratic trace, rising in a jagged line. To ensure that this is caused by poor frequency response rather than by a poor power profile, press *[Return]* to get to the Transmitter test screen, followed by *[Mod Meter]*, *[IF Filter]*, *[300 kHz]*, *[Return]*, *[Return]* to select the 300 kHz IF filter. Then press *[Tx Power]*, *[Trans Analys]* and repeat the test. If the trace is significantly improved, this indicates that the frequency kick of the radio is poor.



Transient power analysis showing a bad radio with the 30 kHz IF filter



Transient power analysis showing a the same bad radio with the 300 kHz IF filter

The explanation of this is that the 30 kHz IF filter filters out all of the signal that is transmitted out of band by the radio, whereas the 300 kHz IF filter passes more of the signal. Hence, if the radio is not transmitting the whole signal in the required band, then the part of the signal which is out of band will not be displayed on the trace when the filter selected is 30 kHz, but will show with the 300 kHz filter, unless the radio is exceptionally poor. The above example shows a poor radio with a frequency that starts in band, moves out of band, then back in again. The slight dip in the trace with the 300 kHz filter shows that the radio is even at the limits of the 300 kHz filter bandwidth.

REMOTE CONTROL

The 2945A has remote control facilities available both from the built - in RS232 serial interface, as well as the optional GPIB (IEE488.2) interface. It also features a built in MI-BASIC interpreter, for user defined programs which can be downloaded from a PC.

Detailed explanation of the remote operation of the test

set is beyond the scope of this document, but all the tests that form automatic testing and all the parameters that have been described in this application note are available to be run remotely.

SUMMARY

The 2945A Communications Service Monitor is a versatile tool for both routine testing and fault finding of EDACS radios.

The automatic tests, whether run directly or remotely can be used to thoroughly test a radio and the manual testing mode is ideal for detailed examination of particular areas of a radio's operation.

ACKNOWLEDGEMENTS

EDACS is a trade mark of Ericsson Inc.
(Tel +1 804 528 7000)

REFERENCES

Operating Manual Supplement for Communications Service Monitors 2945A and 2946A for EDACS Radios. [Part Number 46882-301L]

Programming Manual for Communications Service Monitor 2945A and Avionics Communication Service Monitor 2946A [Part Number 46882-318B]

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