Application Note

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EDACS repeater testing using the IFR 2945B Communications Service Monitor

Testing live EDACS repeater stations is made quick and easy using the IFR 2945B Communications Service Monitor. A step by step guide to a typical measurement application

Introduction

The IFR 2945B Communications Service Monitor is ideally suited to the testing of trunking repeaters. It provides an extensive array of tests, allowing verification of performance, and rapid diagnosis of faults.

This application note will assist the first time users by leading them through the initial stages in setting up the 2945B and testing an EDACS repeater.

The majority of this document is concerned with using the 2945B test set off-air, that is with no physical connection to the repeater. The limitations of this method will be explained, but the method does allow rapid set up and quick verification.

Trunked radio concepts

The idea behind trunking comes from the telephone system - the 'Trunk' line connecting telephone exchanges. This line is shared by the telephone users, without them being aware that it is happening. The process of "Trunking" is transparent to the telephone user.

The operation of a trunked radio system is very similar, as the use of the available radio channels is shared amongst the system users by a site controller, without them being aware of the process. As far as the radio system users are concerned, they each have a channel all to themselves.

What is EDACS?

EDACS is a computer controlled trunked radio system, that is geared towards one person calling a group of others. Additional services provide individual to individual calls, telephone interconnects, data transmission and secure speech calls.

The IFR 2945B Communications Service Monitor, when set up in EDACS repeater test mode, behaves as an EDACS radio on the system, but allows complete control over the identities it uses on the system.

The 2945B Communication Service Monitor can function in two major modes: either as a trouble shooting tool, in manual mode; or to run automatic tests, either for verification or remotely to ensure optimum performance of the installed systems.

What do you need to know?

In order for the 2945B test set to work on your system, it needs to be told some details about the system - EDACS is a custom made trunked radio system and each installation is different from all other EDACS systems in some details.

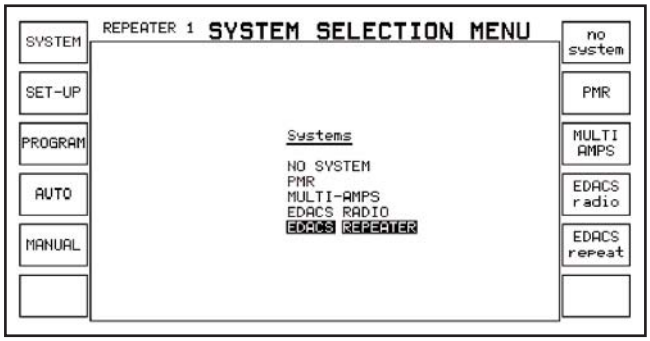
The first thing that you need to know is the frequency plan of the system you are going to test. One way to find this information is to get a radio that works on the system and use the manufacturer programming tools to read the 'personality' from the radio. The frequency plan can be examined and then entered into the test set.

Next, you need to know the data rate. EDACS can operate at two different data rates - 9600 baud (or bits per second), with a channel spacing of 25 kHz per channel, or 4800 baud with channel spacing of 12.5 kHz.

As a general rule, if the frequencies in the frequency plan are in the 900 MHz band, then the data rate will be 4800 baud. If they lie in the 400 MHz or 800 MHz bands, they are usually 9600 baud.

Finally, you need to know the control channel for the system you are testing. This isn't a problem for the radios on the system - they will scan all the channels until they find a control channel. The 2945B does not scan, allowing you to test a particular channel, so you have to find the control channel yourself. This can be done using the instrument's spectrum analyzer.

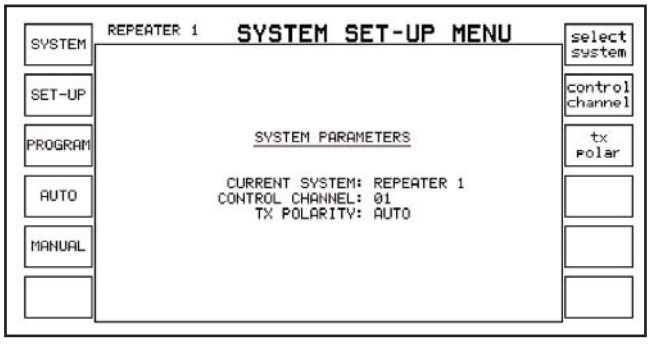
How to set up the 2945B



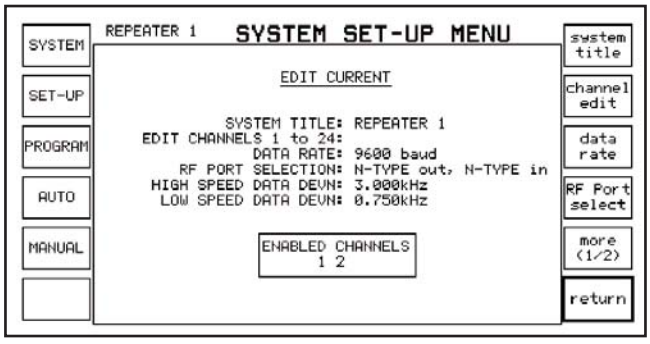
Selecting the EDACS repeater test system.

First of all, you need to tell the test set that you want to test EDACS repeaters - so press the blue [SYSTEM] key, the left [SYSTEM] softkey, and then select [EDACS repeat] from the list of available systems.

Now select [SET-UP], and the system parameters set-up screen shown below should appear. If it doesn't, keep pressing the [SET-UP] key as there are four set-up screens, selected in turn.



The system parameters set-up screen.



The screen for entering system details.

In order to enter details of the system you are going to test, you then need to select [select system] and [edit current].

Press [system title] to enter the text title that identifies the system you are setting up - the title is used at the top left of the display and the first 7 letters are used on the soft key label for the stored system.

[channel edit] allows you to set up the frequency plan of your system. It requires you to know the TX frequency of the repeater, and the duplex offset. If you know the TX and RX frequencies, the duplex offset is the RX frequency minus the TX frequency. You will

also need to enable each channel.

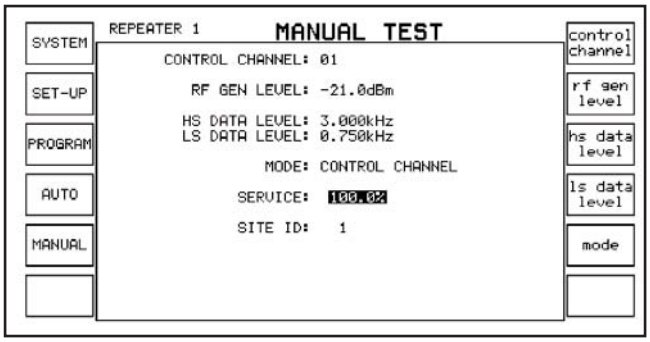
When you press the [return] key, the display will show you which channels are enabled. Check this is correct before you continue.

Pressing the [data rate] key toggles between 9600 and 4800 baud data. If you aren't sure what speed data is used on your system, try 9600, and if this doesn't work, try 4800.

The [RF port select] key allows you to change which of the ports on the front panel of the test set will be used for RF input and output. For simplicity, we'll start with off-air tests, so this should be set to [BNC out ANT in]. If the RF signal is very strong, such as the area immediately around a repeater, then you should select [BNC out N in] which greatly reduces the test set sensitivity. You should also connect an antenna to both the input and output ports since using two antennas avoid problems where the test set signal generator swamps reception of channels that have small duplex offsets.

Finally, you can set what data deviations are to be used by the test set. Altering these values is not really necessary at this stage - the values of 3 kHz for high speed deviation and 750 Hz for low speed deviation will work for all EDACS systems.

When you press the [return] key the system is set up, and your frequency plan is loaded into the instrument.

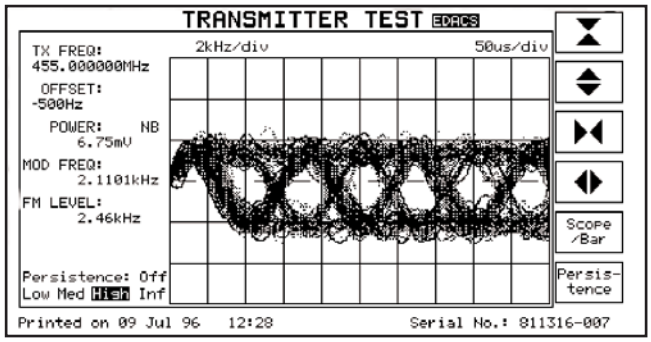


The manual test screen with a valid control channel.

Press [MANUAL] to access the manual testing screen. Now you have to establish which channel is the control channel. The easiest way is to step through the enabled channels in the frequency plan using the [control channel] key. When the correct control channel is found, the SERVICE indicator will change from NO SERVICE to a percentage figure, in inverse text.

If this doesn't work, first check that the system is available, using a radio programmed for that system. If it indicates service, and will make a call, then either the data rate is incorrect, the signal is too weak to be picked up by the test set, or the frequency plan is incorrect.

To check the data rate, you should turn the sound volume up on the front panel, and then step through the channels using the [control channel] key. When you hear a continuous drone, select [Tx TEST], and press [Scope /Bar] until the large 'scope display appears. Press the [Persistence] key until High is highlighted when you should see an 'eye' diagram of the modulation from the repeater. This then allows you to calculate the system data rate.

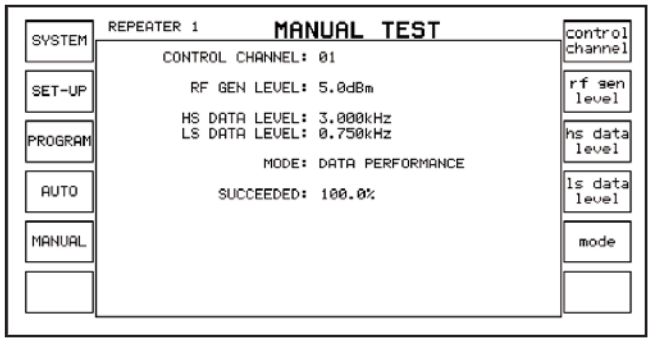


An 'eye' diagram produced off-air from an EDACS control channel.

Press [SYSTEM], and noting the channel, change the data rate using the [SET-UP], [edit current] and [data rate] keys. Then press [return] and [MANUAL], and select the channel again (altering the current system will force the test set to re-initialise the system).

If the test set still doesn't indicate service, or no channel gives a droning noise, then you should check the entered frequency plan again and ensure that there is reasonable signal strength present - the 2945B service monitor will detect a signal reliably at levels of around -40 dBm to -50 dBm using the ANT port. EDACS radios are far more sensitive, however, and if you are working without a direct connection you should get closer to the repeater and try again.

Once the service indicator shows that the control channel is 'visible' to the test set, the next step is to get the test set to communicate with the repeater. To do this, you need to use the data performance test, in the manual test screen, by pressing [model], [data perform].



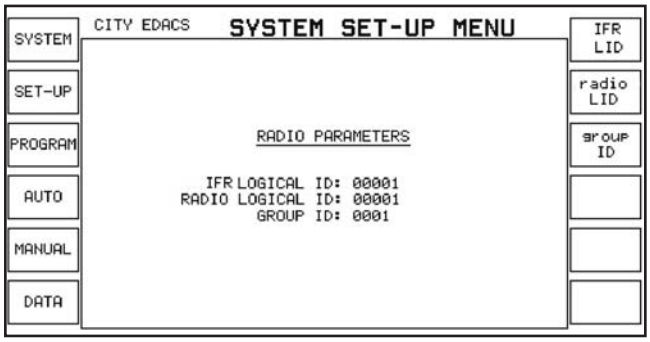
The MANUAL TEST screen showing a data performance test in progress.

In data performance mode the test set sends messages to the repeater on the control channel, and gets acknowledgement responses back. This allows you to check that you have set the duplex offset correctly for the channel that is currently the control channel.

Set the RF generator level to maximum (+5 dBm using the BNC output port), and when the SUCCEEDED count reads above 0%, contact is established.

Finally, you should check that the other channels are correct. This involves making a call on the system, which will then assign the test set to a working channel

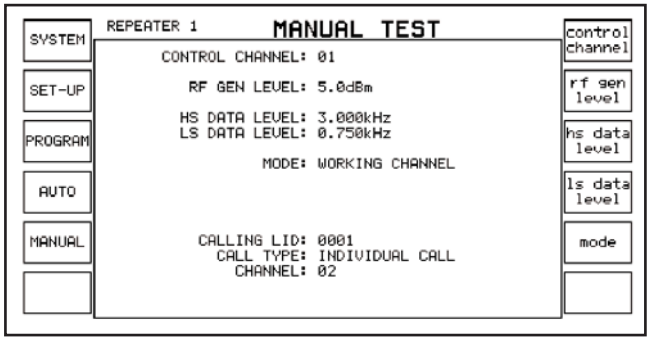
Before you make a call, you should set up the identity of the test set and of the radio you want to call, to avoid calling anyone else on the system. The test set has default values for group and logical identities of 1.



The radio parameters set-up screen.

Press the [SET-UP] soft key until the screen above appears. The radio logical ID is the identity of the radio the test set will call. The IFR ID is the identity that the test set will use when it makes or responds to calls. The group identity is both the group that the test set will call, and the group identity that it will respond to.

If you now go back to the Manual test screen, and select [mode], [individ call] the test set will attempt to make a call to the radio whose identity is in the RADIO LOGICAL ID field. The mode should change to WC CONFIRMATION, and then to WORKING CHANNEL.



The MANUAL TEST screen after a successful individual call.

Selecting [mode], [clear down] will return the test set to the control channel.

You should now have a working EDACS repeater test system, ready to go! The system parameters are stored internally in non-volatile memory, but you may also like to take this opportunity to save the settings on to a PCMCIA memory card.

Measuring off-air

The IFR 2945B test set has several tests built in to allow monitoring and diagnosis of EDACS repeaters. These are designed to be used off-air, and on a live system, so that the condition of the repeater can be continuously monitored, without disrupting the system traffic, as well as being connected physically to the repeater RF and audio connections.

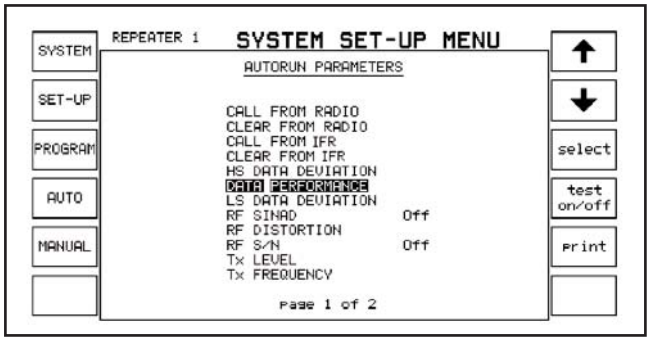
Distortion measurements can be performed on a channel without requiring audio access to that channel. Three different distortion measurements are available - SINAD, signal to noise and distortion, which should not be used in isolation. The values returned by these tests should be used to detect degradation in performance, with relative results being important, and not the absolute values.

Data deviation tests are provided for both low and high speed data, with the tests using advanced DSP (Digital Signal Processor) filtering.

A data performance test is also provided, to allow the receiver on the control channel to be tested.

All of these tests have test limits and parameters stored in memory so that you can tailor the test and the limits to your particular system. The parameters are set up using the AUTORUN PARAMETERS screen.

Additionally, one of the built in test programs, the QUICK TEST, is designed specifically for use off-air.



The AUTORUN PARAMETERS set-up screen.

As an example, in order to set up the Quick test, we need to alter the RF generator levels for all the signalling tests, and set the data deviations to those in use on the system.

1) Set the RF GEN LEVEL to be +5 dBm for the:
   CALL FROM IFR,

   CLEAR FROM IFR and

   DATA PERFORMANCE tests.

2) To do this, use either the up and down arrow keys, or the rotary control.

3) Highlight the test required (the DATA PERFORMANCE test in this example).

4) Now press [select] and a list of the test's parameters is given.

5) Select the RF GEN LEVEL entry, and press 5.

6) Then press either the [dBm] softkey, or the orange [dBm/ENTER].

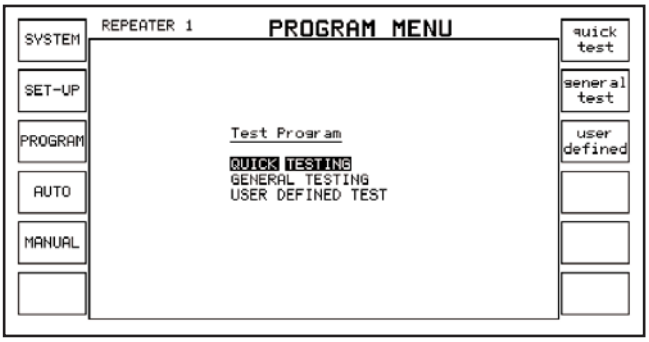
7) Pressing [return] returns you to the list of tests.

You should also set up the data deviations initially with either a generous error tolerance (say 30%) or the known correct values for your system.

Finally, the Tx LEVEL test is of little use in off-air measurement, and should be turned off. The problem is caused mainly by the variability of the environment around the antenna (people, vehicles, and buildings appearing between the antenna and the repeater),

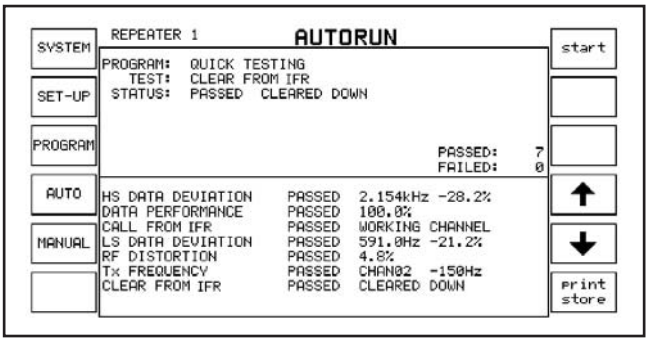
as well as multiple paths to the receiver

Having set all this up, press [PROGRAM] and select [quick test].



The autorun Test Program selection screen.

Then press [AUTO] and [start] to start the automatic test, which should run without any intervention, and give a result at the end.



The AUTORUN screen after the quick test has been run.

Now it is up to you to adjust the limits of the tests for your system, to detect problems before they become noticeable (for example, the RF distortion measurement will pick up problems on a particular channel's audio circuits before the system users notice anything wrong).

Remote control

The 2945B has remote control facilities available both from the built-in RS-232 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 briefly, if you wished to run a test remotely, you would first put the instrument into remote mode, then put it into systems mode and finally run the test you are interested in.

As an example, to check the high speed data deviation using the RS-232 serial interface, the following commands are sent to the test set (explanations in brackets):

<ctrl A> (Put the test set into remote mode)

:TESTMODE SYSTEMS

:STEST:HSDEVN? (The test returns 1 for pass, 0 for fail)

<ctrl D> (Put the test set back to local mode)

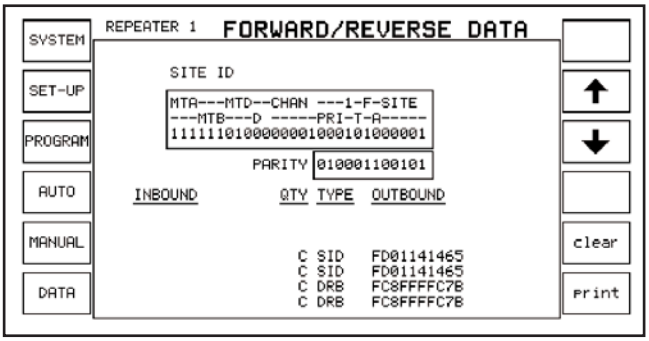
Data Displays and Decode Only

Since the data displays and decode only facilities may not be available for all systems the IFR 2945B product is normally supplied with this functionality disabled. For further information please contact the Aeroflex help desk +1-800-835-2350.

Data Display

The purpose of this screen is to show the data frames that make up the EDACS signalling - this allows you to check that the data that was set in the repeater is actually being transmitted, as well as letting you see exactly how EDACS works.

As an example, with the service indicator showing 100%, the data display would look something like this:



The DATA display screen showing a control channel.

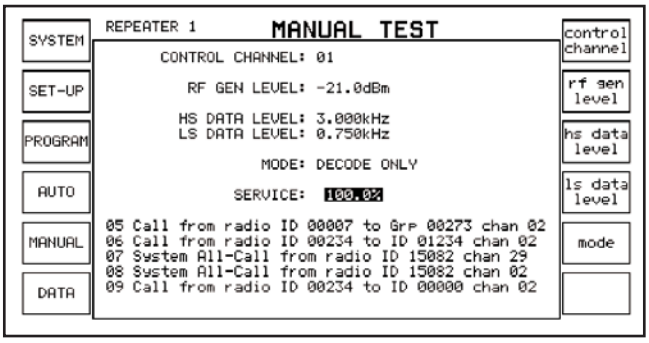
With this you can see that the channel is made up of SID (site ID) and DRB (dynamic regroup) frames. Each frame shows a quantity of C for continuous. The test set regards any frame that occurs more than 99 times as being effectively continuous.

You can use this screen to see that in this case, the repeater is operating in 'failsoft' mode (the 'F' bit in the frame is set to 1), the current channel is channel 1, it is the main control channel (the 'A' or auxiliary bit is 0), the site ID is 1, and so on.

For more information about how the frames are made up, refer to the "Enhanced Digital Access Communications System (EDACS) Digital Air Interface Specification".

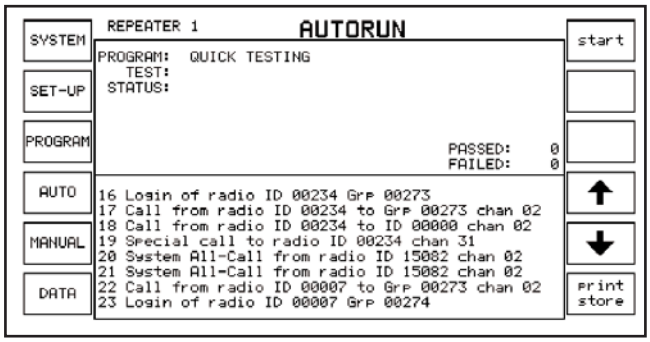
Decode only mode

Decode only mode allows you to monitor what is actually happening on the control channel. To use it, select [MANUAL], [mode], [more], [decode only]. The mode changes to DECODE ONLY, with a service indicator and events that happen are displayed on the screen in real time.



The MANUAL TEST screen in decode only mode.

This isn't very useful if there is a large amount of traffic on a heavily loaded system, so there are two other options that can be used. You can log the text that appears to either the internal results store (visible under the autorun screen) or you can log the results out to a printer. If you log the results to the results store (press [mode], [log to store]) then the test set will store about 200 events. Subsequent events will be discarded when the store is full.



The AUTORUN screen in decode only mode with logging to store enabled

For a complete record, you should connect a printer or a computer to the test set's serial port. To do this, first set the printer type to RS-232 (press [HELP/ SETUP], [Setup], [Setup Page 2], [Printer Setup] and ensure that the printer port is set to RS-232)

To log the results to a computer you need to connect the test set serial port to the computer, using a Null modem cable. You will also need a terminal program, such as the terminal program that comes with Microsoft Windows.

You need to set up the serial transfer parameters, both in the terminal program, and also on the test set. On the test set, the serial configuration is changed using the serial setup screen (press [HELP/SETUP], [Setup], [Setup Page 2], [Serial Setup]).

Finally, log the transfer on the computer to a file - if you are using the Windows terminal program, select 'Transfer', 'Receive Text File' and enter the filename.

Summary

The 2945B test set is an ideal tool for both monitoring and fault finding on EDACS repeater systems, allowing rapid diagnosis of both programming problems and hardware failure.

The remote control operation, together with the built in MI-BASIC programming language allows long term, remote monitoring of distant repeater sites, which can be tested and monitored off-air, removing the need to close a repeater down for maintenance.

The data display and logging features also allow long term monitoring for badly set up radios, as well as greatly easing the initial commissioning of a new EDACS installation.

References

2945B Operating Manual Supplement for Communications Service Monitors for EDACS Repeaters

[Aeroflex Part No. IFR46882-300]

Enhanced Digital Access Communications System (EDACS) Digital Air Interface Specification" [Telecommunications Industry Association December 28 1995, Doc #TSB69.3]

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