CODAN
RADIO COMMUNICATIONS

MT-4E Analog and P25 Digital Radio Systems

MAINTENANCE GUIDE

www.codanradio.com

Codan MT-4E Analog and P25 Digital Radio Systems

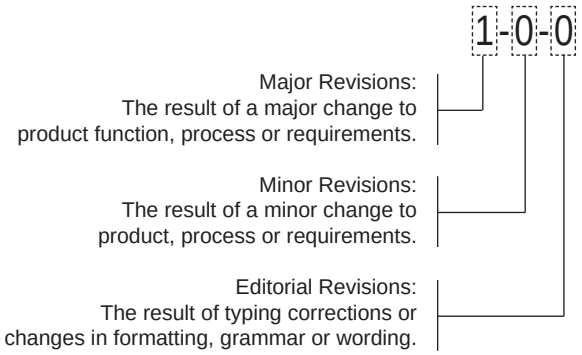
Maintenance Guide

NOTE

The English version takes precedence over any translated versions.

DOCUMENT REVISION DEFINITION

Documentation uses a three-level revision system. Each element of the revision number signifies the scope of change as described in the diagram below.



Three-level revision numbers start at 1-0-0 for the first release. The appropriate element of the revision number is incremented by 1 for each subsequent revision, causing any digits to the right to be reset to 0.

For example:
If the current revision = 2-1-1 Then the next major revision = 3-0-0
If the current revision = 4-3-1 Then the next minor revision = 4-4-0
If the current revision = 3-2-2 Then the next editorial revision = 3-2-3

Document revision history is provided at the back of the document.

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DANIELS ELECTRONICS IS NOW CODAN RADIO COMMUNICATIONS

On August 7th, 2012 - Codan Limited (ASX: “CDA”) announced the acquisition of Daniels Electronics Limited, a leading designer, manufacturer and supplier of land mobile radio communications (LMR) solutions in North America. The acquisition of Daniels delivers on Codan’s stated strategy of growing market share and diversifying its radio communications product offering. Codan Limited designs, manufactures and markets a diversified range of high value added electronic products, with three key business divisions; radio communications, metal detection and mining technology.

ABOUT CODAN RADIO COMMUNICATIONS

Codan Radio Communications is a leading international designer and manufacturer of premium communications equipment for High Frequency (HF) and Land Mobile Radio (LMR) applications. We’ve built our reputation for reliability and customer satisfaction over 50 years in radio communications, in some of the toughest conditions on the planet.

For over 50 years Codan has provided customers in North America and internationally with highly reliable Base Stations and Repeaters that are environmentally robust to operate in rugged and extreme temperature conditions where low current consumption (solar powered) is a key requirement.

Codan is a pioneering member of the P25 Digital standard, for radio system interoperability between emergency response governmental organizations, providing enhanced functionality and encryption. Our products operate between 29 - 960 MHz and are available in a variety of Base Station and Repeater configurations for two way voice and mobile data applications.

Our self-servicing customers range from Forestry and National Park services through Police and Fire departments and on to Utility and Transportation groups. Our products have been deployed in every imaginable situation from the Antarctic to Hawaiian mountaintops to Alaska, enabling respondents to Forest Fires, Ground Zero rescue and routine patrols.

Codan is an industry leader in Analog and P25 radio systems design. We offer modular rack-mounted Base Stations and Repeaters capable of operating in Low Band VHF,VHF AM , VHF FM, UHF FM, 700 MHz, 800 MHz, 900 MHz

RESOURCES

Codan Radio Communications provides many resources for the testing, tuning, maintenance and design of your Codan MT-4E Analog and P25 Digital Radio System.

Instruction Manuals

Codan instruction manuals are very comprehensive and include information on:

Theory of operation
Detailed Specifications
Testing and tuning instructions
Component layout illustrations

Instruction manuals can be obtained from the factory.

Technical Notes

Technical notes outline key aspects of tuning, installing, maintaining and servicing Codan Radio Systems.

Technical Notes can be found online at www.codanradio.com.

Codan MT-4R/D and IFR 2975 Test Procedures (TN950)

Technical Note TN950 is an aid to configuring and testing Codan MT-4R/D radios using an IFR 2975 Service Monitor by Aeroflex. TN950 is intended to be used with IFR 2975 Setup files that can be loaded into the Service Monitor.

TN950 and Setup Files can be found online at www.codanradio.com and can also be found on the Aeroflex web page at www.p25.com.

Application Notes

Application Notes provide an overview of the range of applications in which Codan Radio systems can be used.

Application Notes can be found online at www.codanradio.com.

P25 Training Guide

The P25 Training Guide provides the reader with a simple, concise and informative description of Project 25.

The P25 Training Guide can be found online at www.codanradio.com.

MT-4E Analog and P25 Digital Radio Systems User Guide

The MT-4E User Guide provides an overview of the configuration, operation and programming of Codan MT-4E radios.

The MT-4E User Guide can be found online at www.codanradio.com.

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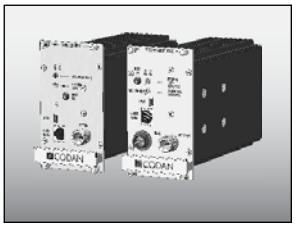

CHAPTER 1: CODAN RADIO MAINTENANCE

This document is written as a maintenance guide to Codan MT-4E Analog and P25 Digital Radio Systems. The document assumes the reader is familiar with conventional Two-Way Radio Communications systems and general electronics maintenance practices. This document is a companion document to the Codan Radio Communications MT-4E Analog and P25 Digital Radio Systems User Guide.

INTRODUCTION TO CODAN MT-4E

Codan MT-4E radio systems are designed for operation in highly varied conditions. Your application may require high performance radio systems (intermodulation and selectivity) for operation in congested radio sites, operation over wide temperatures using battery solar powered systems (low current drain), or a configurable system for emergency deployment in a transportable case. Codan manufactures a diverse range of radio products tailored to the type of operation you need.

The MT-4E radio system is characterized by high performance and reliability, whether it is a remote, low current repeater or a high performance base station. The total system is designed to provide dependable, low maintenance performance and great flexibility for expansion and servicing.

The MT-4E series of radio and control modules are packaged in the compact Eurostandard housing with anodized aluminum front panels, and are ruggedly designed for remote or transportable applications. All of the modules use high reliability components and corrosion resistant fasteners.

The MT-4E radio system is specifically designed to deliver high performance under adverse conditions. Voltage stress testing and a 24 hour burn-in is performed on the radio system and performance of the system at room temperature (25°C) is documented and measured. As an option, extensive environmental testing can be conducted over the temperature range - 30°C to + 60°C and the performance measured to ensure compliance with the design specifications.

A Codan MT-4E radio system consists of separate RF receiver and transmitter modules plugged into a standard 19” subrack. Each subrack also requires a control card and system regulator. External connections to the system (COR, PTT, audio, channel select, etc.) are made through an auxiliary connector on the rear of the subrack. An optional cable or terminal strip connector is available to connect externally through the auxiliary connector to the radio system.

RECOMMENDED MAINTENANCE SCHEDULE

Codan Radio Communications does not recommend any specific maintenance schedule for our MT-4E radio systems. Many organizations have annual preventative maintenance scheduled as part of their standard maintenance procedures; other organizations will only maintain the radio system when a system failure occurs; and other organizations will use a combination of preventative maintenance and maintenance for failures.

REPAIR NOTE

The MT-4E Radio System employs a high percentage of surface mount components which should not be removed or replaced using an ordinary soldering iron. Removal and replacement of surface mount components should be performed only with specifically designed surface mount rework and repair stations complete with Electrostatic Discharge (ESD) protection. When removing Surface Mount Solder Jumpers, it is recommended to use solder wick braid in place of vacuum type de-soldering tools. This will help prevent damage to the circuit boards.

ESD - ELECTROSTATIC DISCHARGE

Static Electricity can damage electronic equipment, causing it to stop functioning immediately, or degrading it, leading to breakdown later. Static sensitive parts should be handled by technicians grounded with wrist and/or two heel straps. Transferring of ESD sensitive components to or from different areas should be conducted in ESD safe bags, tote boxes or carts.

AUDIO AND CARRIER LEVELS REFERENCE

The following are conversions for both audio levels and RF carrier levels.

Audio Levels

2.500 Vrms	6.928 Vpp	+10 dBm (@ 600 ohms)
0.975 Vrms	2.758 Vpp	+2 dBm
0.775 Vrms	2.191 Vpp	0 dBm
0.388 Vrms	1.098 Vpp	-6 dBm
0.308 Vrms	0.872 Vpp	-8 dBm
0.245 Vrms	0.692 Vpp	-10 dBm
0.098 Vrms	0.276 Vpp	-18 dBm
0.077 Vrms	0.219 Vpp	-20 dBm

Carrier Levels

70.71 uV	-70 dBm (@ 50 ohms)
0.707 uV	-110 dBm
0.398 uV	-115 dBm
0.354 uV	-116 dBm
0.316 uV	-117 dBm
0.282 uV	-118 dBm
0.251 uV	-119 dBm
0.224 uV	-120 dBm
0.199 uV	-121 dBm
0.178 uV	-122 dBm
0.158 uV	-123 dBm

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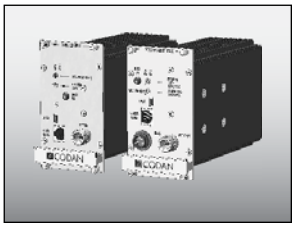

CHAPTER 2: INSTALLATION

INSTALLATION OF CODAN SUBRACKS

1. Ensure the 19” rack has enough room for the Codan subrack to be installed. Each Codan subrack requires 5 1/4” height (3 RU) and 13.5” (maximum) depth clearances.

2. Install the subrack unit(s) in the 19” rack using four #10 x 3/4” screws as shown in Figure 2-1. Eight screw holes are available, only four screws are required to mount the subrack properly. Use stainless steel screws if the equipment is to be placed in a corrosive environment.

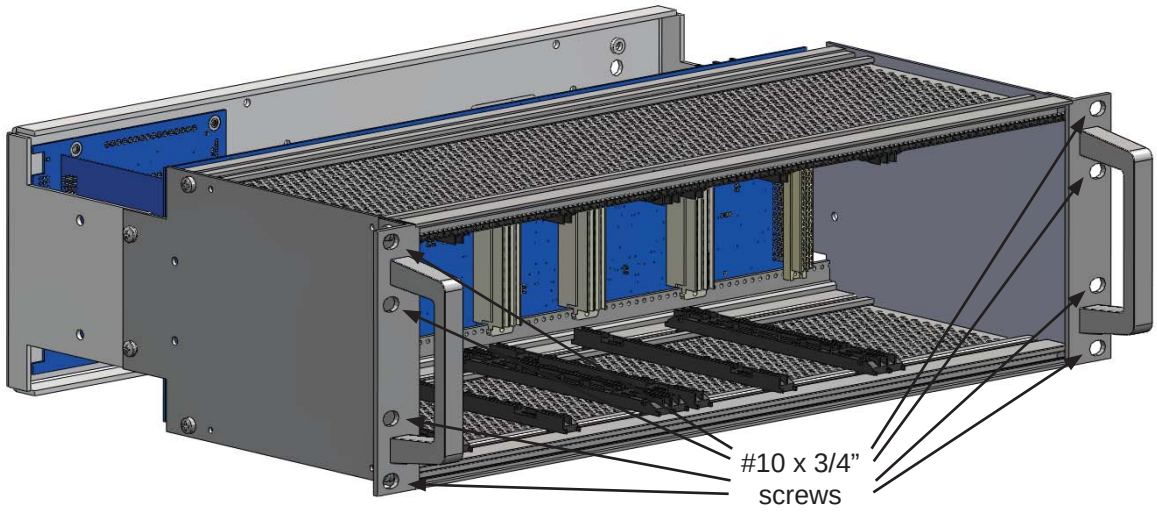

Figure 2-1: Subrack Installation

3. Connect the primary power (+10 Vdc to +17 Vdc, +13.8 Vdc nominal) to the Barrier Strip power input on the rear of the subrack as shown in Figure 2-2. Ensure that the power source does not exceed +18 Vdc. Use a wire gauge suitable for delivering the power required by the subrack(s). If the subrack is using a DC-DC or AC-DC Power Supply, refer to the specific manual supplied with the equipment for installation instructions.

Reverse voltage protection and over voltage protection (transient suppressor) is provided at the main power (+13.8 Vdc) input as well as the +9.5 Vdc line. The main power input is protected with a standard fast-blow 15 amp fuse. These components may require replacing if the power supply is not connected properly, or even after a power surge or a lightning strike. The two transient suppressors have different voltage ratings for the main power input and +9.5 Vdc lines.

4. Install the System Regulator, Receiver, Transmitter, Power Amplifier and Control Card modules in to the subrack using the proper guide rail slots if not already done. When installing modules, ensure the quick release fasteners on the top and the bottom of the modules are in the unlocked (slot should be horizontal) position before insertion to the guide rails. To lock the quick release fasteners, push and turn the fastener 90 degrees clockwise with a flat screwdriver.

Note: MT-4E modules may be removed or inserted from the subrack while power is supplied without damaging the equipment.

5. Interconnect +9.5 Vdc and +13.8 Vdc power between subrack units if one of the subracks does not include a system regulator (no system regulator is required for a second subrack with only power amplifiers mounted in it). If a CI-RC-4M Multiple Link Controller is part of the system, connect the +9.5 Vdc from the subrack to the controller. Connect the audio, channel select and control signal lines from a CI-RC-4M Multile Link Controller to the optional screw-type A-PNL-AUX96-3 auxiliary terminal connector or use the DB25 connector to connect the to a CI-RC-4M-G2 Multiple Link Controller.

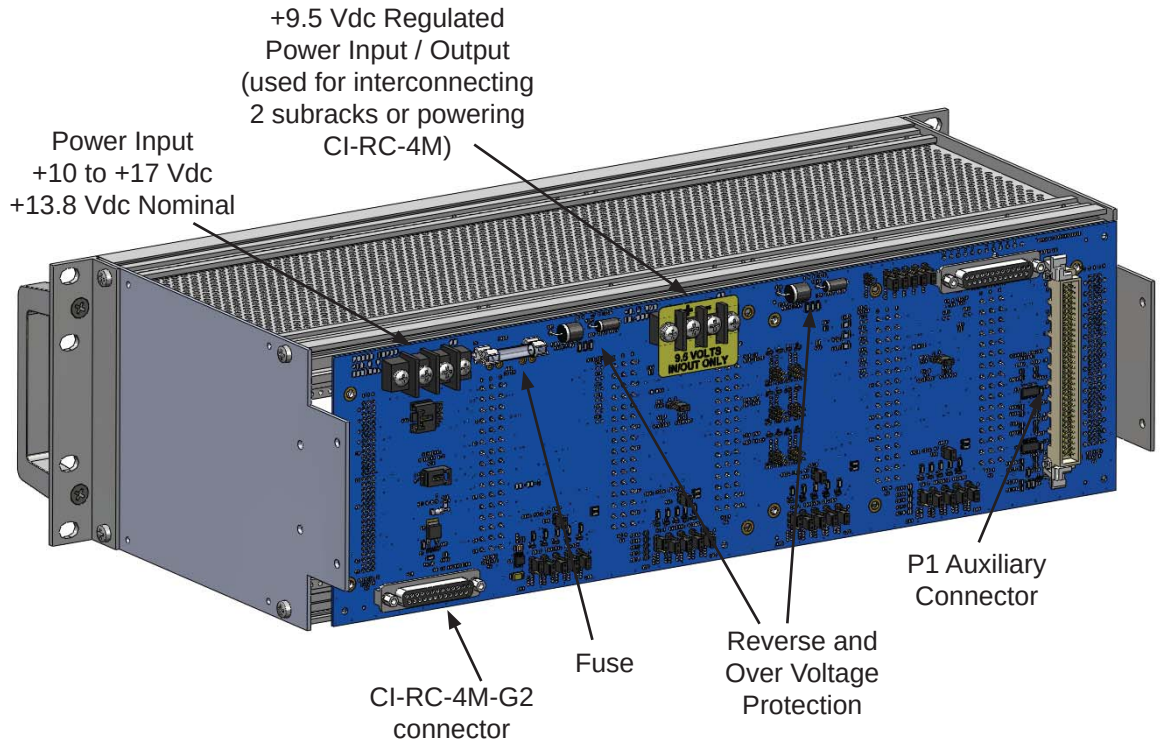

Figure 2-2: Subrack Power Connections

6. If an external controller (eg. Telex tone-remote adapter) is to be connected to the system, all wiring should be made to the DB25 connector or to the optional screw-type A-PNL-AUX96-3 auxiliary terminal connector shown in Figure 2-3.

The female DB25 connector can be used for basic base connections to a Telex DSP-223 or IP-223, using a standard straight-through male-to-male DB25 cable. The IP-223 also requires that 2 pins on the DB25 (PTT COM - pin2 and MON COM - pin 16) are wired to ground for proper operation.

WARNING: JU108 must be configured correctly for DSP-223 or IP-223 or damage can occur. JU108 A for +13.8 Vdc / DSP-223 or JU108 B for Rx A COR / IP-223

The plug in screw connectors on the A-PNL-AUX96-3 can be removed to allow for easy connection of the wires.

For some applications, a cable, not a terminal strip connector, is used to connect to the auxiliary connector. The cable must be plugged into the P1 auxiliary connector shown in Figure 2-2 on the rear of the subrack. Ensure locking tabs on the connector are completely engaged.

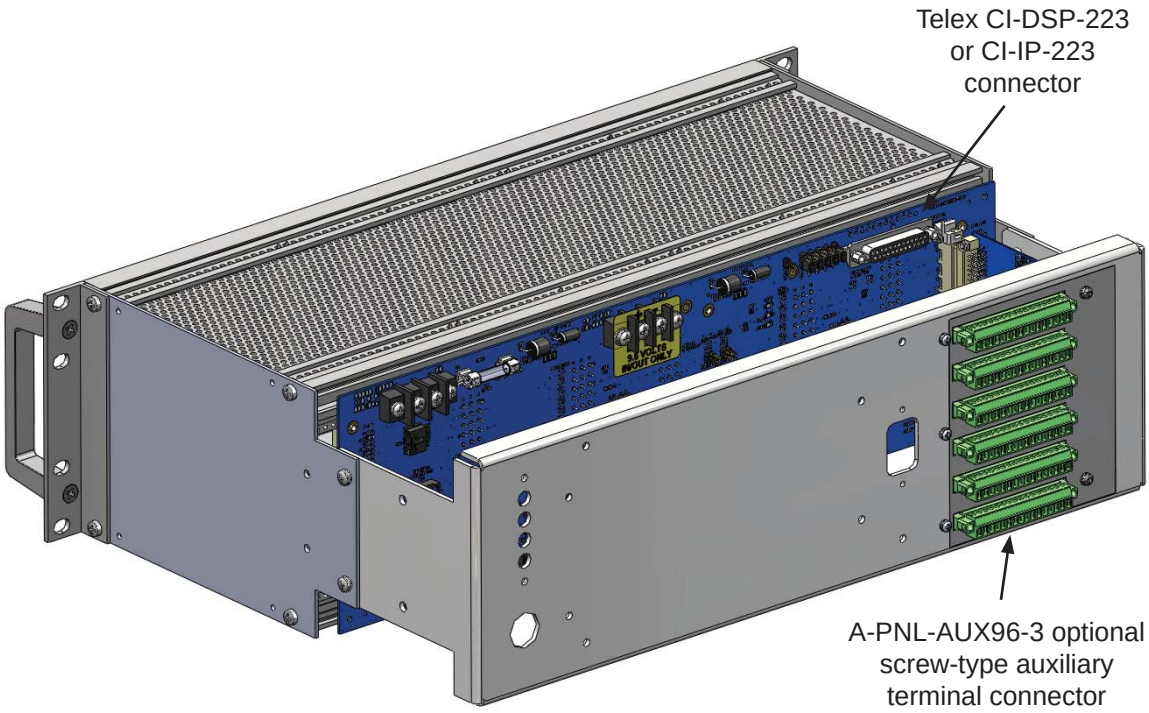

Figure 2-3: Auxiliary Terminal Connector

7. Connect the RJ45 cables between the Receiver, Transmitter and Control Card for repeater operation.

8. Connect the RF cables to the Receiver and Transmitter and ensure they are firmly screwed on. Ensure the RF cables are properly connected to the Duplexer / Antenna Relay / Multicoupler / Combiner and Antenna.

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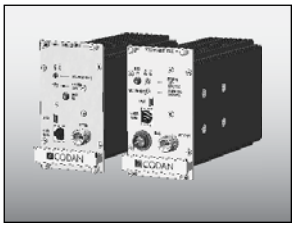

CHAPTER 3: TEST EQUIPMENT AND SPARES

RECOMMENDED TEST EQUIPMENT

Codan Radio Communications recommends the following test equipment for maintenance of an MT-4E radio system:

+13.8 Vdc Power Supply (rated for current draw of equipment)	Codan PSA-12-40-RB-00 (40 Amp rack-mounted power supply) ICT ICT24012 (60 Amp desktop power supply) ICT ICT12012 (10 Amp desktop power supply)
Current Meter / Multimeter	Fluke 75 Multimeter
Communications Service Monitor (Analog)	Marconi Instruments 2965A Aeroflex IFR 1200 (Super S) Aeroflex IFR COM-120
Communications Service Monitor (P25 Digital and Analog)	Aeroflex IFR 2975 Aeroflex IFR 3920 Aeroflex IFR 3500 Aeroflex IFR 3550 General Dynamics R2670 General Dynamics R8000
Alignment Tools	Codan A-TK-04
RF Signal Sampler	Bird Model 4275 Variable RF Signal Sampler
Wattmeter	Bird Model 43 Wattmeter

It is recommended that when in the shop / service area, the Communications Service Monitor be frequency locked to an external reference (WWVH, GPS, Loran C) so that the high stability local oscillator may be accurately set to within its ±1 ppm frequency tolerance.

The test equipment should be calibrated on an annual basis to ensure accurate measurements.

RECOMMENDED SPARES

Codan Radio Communications recommends one complete radio system spare for every ten radio systems (or less) in operation to account for lightning damage or other maintenance issues. The amount of spares could be dependant on the critical nature of the radio system and the availability of service for the system. Codan recommends a complete radio system spare for every critical / essential site in the system. The design of Codan MT-4E radio systems makes it easy to swap components of a radio system and can save valuable time and effort during maintenance. The exact spares would depend on the types of systems in operation, but would typically include:

Subrack / Motherboard	SR-39-1
System Regulator	SM-3-H0-014-00 (Standard) SM-3-H0-014-01 (with main power switch) SM-3-H0-R1N-00 (with single antenna relay) SM-3-H0-R2N-00 (with dual antenna relays)
Control Card	CI-RC-4L (Repeater Control Card) CI-BC-4E (Base Control Card) CI-RC-4M (Multiple Link Controller)
Receiver	VR-4E150-A0-000 (136 - 174 MHz Class A) UR-4E420-A0-000 (406 - 430 MHz Class A) UR-4E460-A0-000 (450 - 470 MHz Class A) VR-4E150-00-000 (136 - 174 MHz Class B) UR-4E380-00-000 (380 - 406 MHz Class B) UR-4E420-00-000 (406 - 430 MHz Class B) UR-4E440-00-000 (430 - 450 MHz Class B) UR-4E460-00-000 (450 - 470 MHz Class B) UR-4E500-00-000 (470 - 520 MHz Class B) UR-4E768-00-000 (768 - 776 MHz Class B) UR-4E800-00-000 (798 - 824 MHz Class B) UR-4E850-00-000 (851 - 869 MHz Class B) UR-4E900-00-000 (896 - 902 MHz Class B) UR-4E950-00-000 (930 - 960 MHz Class B)
Transmitter	VT-4E150-00-800 (136 - 174 MHz) UT-4E380-00-800 (380 - 406 MHz) UT-4E450-00-800 (406 - 470 MHz) UT-4E500-00-800 (470 - 520 MHz) UT-4E850-00-300 (768 - 869 MHz) UT-4E900-00-300 (896 - 960 MHz)
Amplifier	AMP-4-150-30-00 (136 - 174 MHz) AMP-4-410-30-00 (380 - 430 MHz) AMP-4-470-30-00 (450 - 470 MHz
Auxiliary Connector	A-PNL-AUX96-3

RECOMMENDED MAINTENANCE ITEMS

Codan Radio Communications recommends the following maintenance items at each radio site:

A-TK-04	MT-4 Tool Kit
EC-48RD	48 pin Direct Connect Extender
EC-96D1	96 pin Direct Connect Extender
5059-TP110300	Test Points (included with all extender cards)

Additional extender kits can also be located at the radio shop:

EC-48RK-1.22	48 pin Extender Kit with cable
EC-96K-1.22	96 pin Extender Kit with cable

Items included in the MT-4 Tool Kit include:

5192-WJ01BJ01	SMB to BNC Jack Adapter
7910-WP0WP012	SMB to SMB Cable
2007-1N637500	10V Transient Suppressor
2007-1N637800	18V Transient Suppressor
2001-MR751000	Reverse Voltage Diode (Qty=2)
5604-5GAGC150	15 Amp Fast-Blow Fuse
CBLC46-12506050	50 cm RJ45 Cable

Radio Service Software (RSS)

APP-RSS03-WC-XX	Radio Service Software for programming and service of the Receiver and Transmitter modules.
CBLC44-20704305	type A to 5 pin mini-type B USB cable to connect from computer to Receiver or Transmitter.

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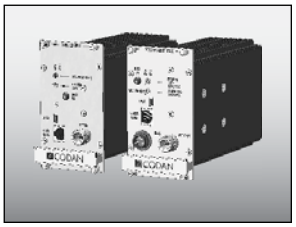


CHAPTER 4: RADIO SITE SURVEY

INTRODUCTION TO A RADIO SITE SURVEY

Radio sites (repeaters, base stations, etc.) can be located in remote locations and require extensive travel to visit. Remote radio sites could require helicopter transportation, be motor vehicle accessible, or even require travel by horseback in order to reach them. Typically when visiting these sites it is a good idea to perform a site survey to document and inspect the site for possible damage (weather related, vandalism, wildlife), and general maintenance of the site. Radio sites that are not remote can also benefit greatly from a site survey.

A site survey is a valuable tool in the preventative maintenance of the radio site. Documenting site condition, inventory and radio system operation on each visit can highlight action that is needed and allows the technician to prepare for subsequent visits.

While every site is different and many organizations may have their own procedures for site surveys, this chapter can be used as a general outline for a radio site survey.

Codan Radio Site Checklist and Inventory

A Codan Radio Site Checklist and a Codan Radio Site Inventory is included in Chapter 7 of this Maintenance Guide. It is recommended that the checklist and inventory be filled out each time the radio site is visited.

PREPARATION FOR A SITE SURVEY

When preparing for a site survey, remember to bring the following items:

- Communications Service Monitor
- Multimeter
- Spare radio equipment
- Standard tool box with wire strippers, screwdrivers, crimper, etc.
- Extra RF cabling to replace any damaged cables
- Adapters (N Type to BNC, etc.)
- Extender cards for radio maintenance
- Codan A-TK-04 Tool Kit

Optional Items:

- Paper, pens and pencils for documenting
- Soldering Iron, solder and de-soldering tool
- Portable radio
- Survival gear, food and drink
- Camera for photographing site condition
- Keys for the buildings / gates
- Documentation for the radio system (manuals, diagrams, previous site survey / inventory)
- Wildlife deterrent (pepper spray)

Check that all test equipment and spare radio equipment is operational and tuned to the correct frequency for that site.

Be aware of all applicable safety measures and regulations for working at, and travelling to and from a radio site (eg. does anyone know where you are going and when you are expected back?).

EXTERIOR SITE SURVEY

When first arriving at the radio site, an external survey of the site and surrounding area should be conducted to identify any hazards. Actions or repairs that may be required for this or the next site survey can also be identified.

- Check that the building is in good condition (no cracks, leaks, vandalism or other damage)
- Check the antennas, and antenna structure (tower) for visible damage
- Check the external RF cables and connectors for visible damage or corrosion
- Check the external leased lines and / or power cables for damage
- Check the lightning protection for damage
- Check that there are no obstructions in the area (branches, overgrown brush, etc.)
- Exterior site photographs can be taken

INTERIOR SITE SURVEY

Once the radio site is entered an interior survey of the site should be conducted.

- Check the interior of the building, including the floor, for water leaks, animal entry or other damage
- Check the condition of the cabinet / equipment rack
- Check the internal RF cables and connectors for visible damage or corrosion
- Check the duplexers / combiners / multicouplers for damage, loose parts or corrosion
- Check the internal leased lines and / or power cables for damage
- Check the power supply / batteries / solar panels and ensure they are operating correctly
- Interior site photographs can be taken

RADIO SITE INVENTORY

It is a good idea to fill out a complete inventory of all model numbers and serial numbers of the radio equipment, duplexers, antennas, power supplies and all other equipment at the site when performing a site survey. Use the Codan Radio Site Inventory to record this information. Codan Radio Communications suggests that customers maintain a site inventory, as serial and model numbers can help the factory with any customer support issues.

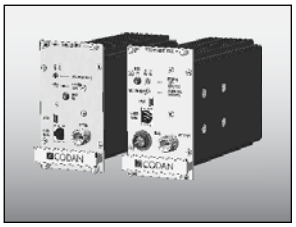
RADIO SYSTEM TESTING

Test the radio system as detailed in Chapter 5 and 6 of this Maintenance Guide. Chapter 5 includes detailed testing information on the Codan radio system using an IFR 2975 test set, and Chapter 6 includes information on additional tests that can be performed on a complete radio system at the radio site.

DEPARTURE CHECKLIST

It is extremely important to perform a final departure check before leaving the radio site.

- Check the RF cables, filtering system and antenna system to ensure it is all connected properly, and that the RF connectors are all firmly in place on all equipment
- Check that the power supply is turned on, connected, and operational
- Check that the switches on the Receiver and Transmitter are in the NORM position and the System Regulator speaker switch is OFF (turning the LED on the System Regulator OFF), and any other additional switches are in the correct position
- Ensure that the RJ45 interconnection cables are plugged in (if used)
- Check that the building lights are turned off, tower lights are turned on and any other lights are set correctly
- Perform a radio check on air with a portable radio and have another user verify the radio operation (dispatcher / operator)
- Check that the door is closed and locked



CHAPTER 5: CODAN RADIO SYSTEM TESTING

MT-4E TESTING WITH THE IFR 2975 BY AEROFLEX

This Chapter contains instructions for Tuning, Testing, Maintaining and Servicing MT-4E Analog and P25 Digital Radio Systems with the IFR 2975 Service Monitor by Aeroflex.

This Chapter is intended as an aid to configuring and testing Codan MT-4E radios using the IFR 2975. Neither Codan Limited or Aeroflex Inc. assume responsibility for damage caused to either unit as a result of misinterpretation or misuse of this procedure. Codan manufactured products are warranted against defective materials and workmanship. This warranty does not extend to damage due to misuse, neglect, accident, improper configuration or installation. Codan and Aeroflex shall be released from all obligations under its respective warranty in the event the Products are subject to misuse, neglect, alteration, accident, improper installation or testing, or if unauthorized repairs are performed by the customer or others.

These procedures can be modified, changed and altered at any time to better suit your specific needs and requirements. The alarm points set in the IFR 2975 test set do not necessarily reflect a radio system that is not operating to specification. Refer to Codan Radio Communications Instruction Manuals for complete radio system specifications.

GENERAL SET-UP AND CONNECTIONS

Uploading Codan Configurations to the IFR 2975

The IFR 2975 allows for configuration files to be saved and recalled on the test set. These configuration files are uploaded to the test set from a floppy disk and can also be uploaded from your computer if the test set is connected to your network.

Firmware version 1.8.1 or higher is required on your IFR 2975 to use these configuration files. To check the firmware version of the IFR 2975, go to System (7) then Version (3). If Version 1.8.1 or higher is not installed in the IFR 2975, go to www.P25.com for the latest update. On some firmware versions, the files would be recalled with the MOD TYPE off. Update the firmware version or remember to turn the MOD TYPE to FM or P25 after recalling a setup.

The IFR 2975 configuration files are available from the Codan website at www.codanradio.com. The file can be downloaded, then unzipped and copied onto a floppy disk or transferred onto the network. If a Codan directory already exists on your IFR 2975 (for MT-4R/D testing), rename that directory or it will be overwrittwen by the MT-4E Codan directory.

To upload a file from a floppy disk, insert the floppy disk into the drive and go to System (7) then Save / Recall Setups (6). Click on the BACKUP SETUPS button on the right hand side of the screen. In the window that opens, click on the BACKUP TO button and select RESTORE FROM floppy. This will download the Codan directory to the internal drive of your IFR 2975.

The recalled setups could affect some of the System Configuration settings on the IFR 2975 (such as the 10 MHz reference selection). You may need to change and re-save these saved files depending on your system configuration (eg. if you are using an EXTERNAL 10 MHz reference).

Please note that some of the setups that are recalled are generic and may need to be changed for your specific receiver and transmitter settings.

The generic saved setups are as follows:
Audio = 1000 Hz @ 1.5 KHz deviation (for wideband set this to 3.0 KHz deviation)
CTCSS = 100.0 Hz @ 0.35 KHz deviation (for wideband set this to 0.5 KHz deviation)
NAC = 293
TGID = 1

Radio Service Software (RSS)

Start the RSS program on the computer and ensure you are connected to the receiver or transmitter via the type A to 5 pin mini-type B USB cable. Read the transmitter or receiver programming and familiarize yourself with the settings (RF frequency, wide / narrowband, digital / analog, CTCSS / NAC, etc.).

Control Cards

Some Codan MT-4E radio systems may have an AC-3E Audio Control Card or CI-BC-4E Base Control Card for use in the radio system. The Control Cards connect to the receiver and transmitter balanced audio lines with an unbalanced load, which could cause some measurements to be in error. If the radio system includes an AC-3E Audio Control Card or CI-BC-4E Base Control Card, remove the control card from the rack for the individual receiver and transmitter tests unless otherwise noted.

Adapters, Cables and Extender Cards

Various adapters, cables and extender cards are required for the different radio tests. Extender cards and adapters are available from Codan Radio Communications. The receiver reference oscillator and RF preselector filter tests require an SMB - BNC adapter and a small SMB - SMB cable is required for the reference oscillator test as well. The SMB adapters and cables are included in the A-TK-04 Tool Kit.

Codan MT-4E Radio System Test Sheet

A Codan MT-4E Radio System Test Sheet is included in Chapter 7 of this Maintenance Guide. It is recommended that this test sheet be filled out each time the radio system is tested. If two or more pairs of transceivers are tested, use a second test sheet to record the results. The test sheet will record settings for a single Tx and Rx frequency, however other frequencies can be tested and recorded if desired.

Turning OFF the MT-4E Receiver and Transmitter Modules

Turning the switch on the front panel of the MT-4E receiver or transmitter modules to the OFF position can cause unwanted effects on other MT-4E receiver and transmitter modules.

When the MT-4E receiver and transmitter are connected directly together with the LVDS serial data RJ45 cable, turning the MT-4E transmitter front panel switch to the OFF position will cause the MT-4E receiver module to turn off. The MT-4E receiver modules A and D LEDs on the front panel will blink on and off when this occurs. Turning the MT-4E receiver modules front panel switch to the OFF position will not cause any adverse effects on the MT-4E transmitter. When turning the MT-4E receiver modules front panel switch from the OFF to NORM position (or vice versa), it will cause the MT-4E transmitter to reboot. Remove the RJ45 cable to stop this interaction from occurring. When connecting the LVDS serial data RJ45 cables to the CI-RC-4L repeater control card or CI-RC-4M-G2 multiple link controller, the MT-4E receiver and transmitter modules are isolated from each other and the modules can be turned on or off independently of each other.

When the MT-4E receiver and transmitter channel and bank select lines are connected together in parallel, turning the MT-4E receiver or transmitter front panel switch to the OFF position will cause the channel and bank select lines to be grounded. This will cause the other MT-4E module to operate on Bank B, Channel 1 regardless of how the channel and bank select lines are set. If the bank select lines are not connected in parallel, only the channel will be affected. The channel select lines are independent of the LVDS serial data RJ45 cables (the cables will have no impact on the channel select).

When the MT-4E receiver and transmitter are connected to the antenna relay in the System Regulator module, turning the MT-4E transmitter front panel switch to the OFF position will cause the MT-4E transmitter PTT OUT line to be grounded, activating the antenna relay and causing it to be switched so that the transmitter is connected to the antenna. This makes it impossible to test the MT-4E receiver through the antenna relay when the MT-4E transmitter is turned off.

When performing maintenance on the Codan MT-4E radio system it is best to simply remove the MT-4E receiver or transmitter, that is not being tested, from the subrack and disconnect all RJ45 cables, rather than turning the front panel switch to the OFF position. All Codan modules are hot swappable. There is no need to disconnect the power supply when inserting or removing the modules from the subrack.

Audio Connections

The Receiver, Transmitter and Auxiliary Balanced audio lines are available for connection on Codan extender cards or by connecting to the optional back panel A-PNL-AUX96-3 screw-type terminal connector. The extender cards have solder points available on each signal line that can have a small test point (5059-TP110300) that is supplied with the extender card, soldered to them for easy connection with clip-on type clips. Recommended Test Points are:

Audio Control Card and Base Control Card Extender Card pins (EC-96D1 and EC-96K-1.22):
Auxiliary 1 Audio Output = B11 and A11
Auxiliary 2 Audio Output = C1 and C3 (Audio Control Card); C2 and C4 (Base Control Card)
Auxiliary 1 Audio Input = C19 and C20
Auxiliary 2 Audio Input = B14 and A14

Receiver and Transmitter Extender Card pins (EC-48RD and EC-48RK-1.22):
Rx Balanced Audio Output = B26 and Z26
Tx Balanced Audio Input = B18 and Z18
Tx Subtone Input = B22 and Ground (B32)

The test points can be soldered into the extender cards as shown in Figure 5-1.

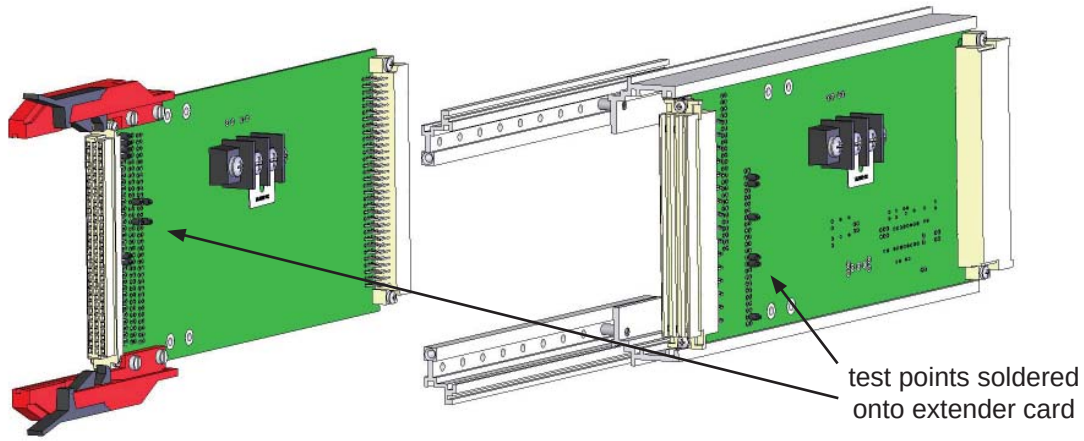


Figure 5-1: EC-96D1 and EC-48RD Direct Connect Extender Cards with Test Points Added

SYSTEM REGULATOR TESTING

System Voltage Testing

The first stage of testing a Codan MT-4E radio system is to perform a basic system check on the supply and regulated voltages. The System Regulator module is designed with a convenient and easy test point built into the front panel. This test point allows a technician access to the DC supply and regulated voltages. Simply connect a standard Digital Volt Meter (DVM) to the METER jacks on the front panel of the System Regulator as shown in Figure 5-2.

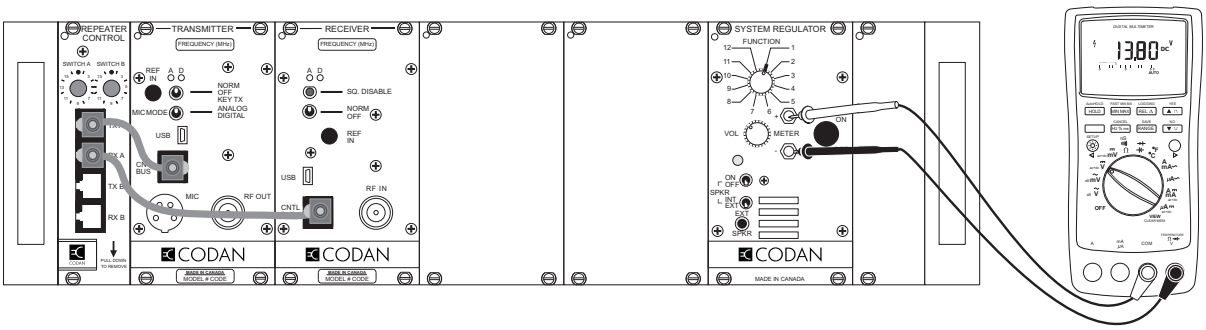


Figure 5-2: System Regulator Voltage Testing

The FUNCTION rotary switch on the front panel of the System Regulator will allow you to test various points in the radio system. Following is a list of System Regulator rotary switch positions, the functions they measure and the parameters measured:

1	Supply Voltage	+10 Vdc to +17 Vdc (+13.8 Vdc nominal)
2	+9.5 Volts Regulated	+9.5 Vdc (± 0.1 Vdc)
3	Rx A Audio	Receiver A Audio (NOT Rx Balanced Output)
4	Rx A Carrier Strength	0 Vdc to +5.0 Vdc based on received signal strength (0 Vdc is a low RF signal level, +5.0 Vdc is high)
5	Rx B Audio	Receiver B Audio (NOT Rx Balanced Output)
6	Rx B Carrier Strength	0 Vdc to +5.0 Vdc based on received signal strength (0 Vdc is a low RF signal level, +5.0 Vdc is high)

Enter the Supply Voltage and +9.5 Volts Regulated values on the MT-4E Test Sheet. Inject a -100 dBm carrier signal into the Receiver and record the RSSI Voltage on the MT-4E Test Sheet. Enter the Date, Firmware Versions and Serial numbers of the Receivers and Transmitters on the MT-4E Test Sheet. The Firmware Version and Serial Number can be found by connecting the RSS and clicking on Rx ID or Tx ID. The Serial Numbers can also be found on the side of the modules.

The standby current draw of the radio system should be measured for battery / solar powered systems. Connect an ammeter to the power input line and measure the standby current draw and transmit current draw of the system. Enter the Standby Current Draw and Transmit Current Draw readings on the MT-4E Test Sheet. The maximum standby and transmit current draw is dependent on the radio system (number and class of receivers, transmitter output power, amplifiers, auxiliary equipment, etc.).

RECEIVER TESTING

Receiver Analog Testing

Connect the IFR 2975 and Codan Radio as shown in Figure 5-3:

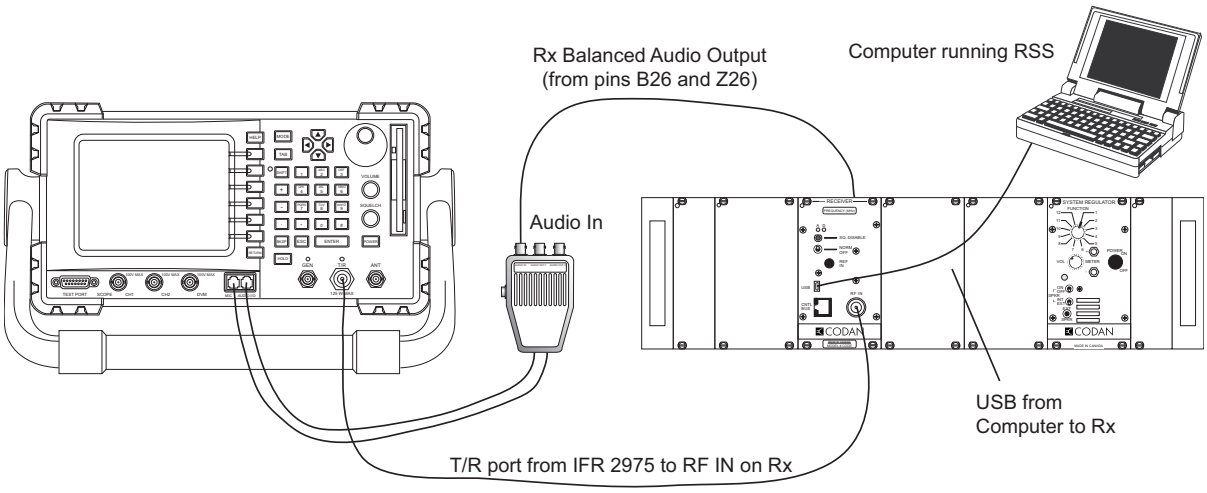


Figure 5-3: Receiver Analog Testing

On the IFR 2975, recall Codan setup 1 (Rx_Ana) from your internal drive. Enter the correct RF frequency and ensure that the deviation level of the 1.0 KHz tone is set correctly for your receiver (wide / narrow). Enter the correct CTCSS tone (if used) and deviation level for the tone. On the Codan Radio system, ensure the receiver is turned on and turn the System Regulator Speaker switch to ON and INT. Set the FUNCTION rotary switch to position 3 for Rx A or position 5 for Rx B (depending on the receiver being tested), then turn the volume up until the 1 KHz tone is audible.

In the Jumper Settings area of the Service section on the RSS, ensure that the “Subtones on audio path” selection is set to “Don’t pass” as shown in Figure 5-4. The IFR 2975 will conduct all tests with CTCSS tones on the audio, giving erroneous measurements, if the Subtones are set to “Pass”.

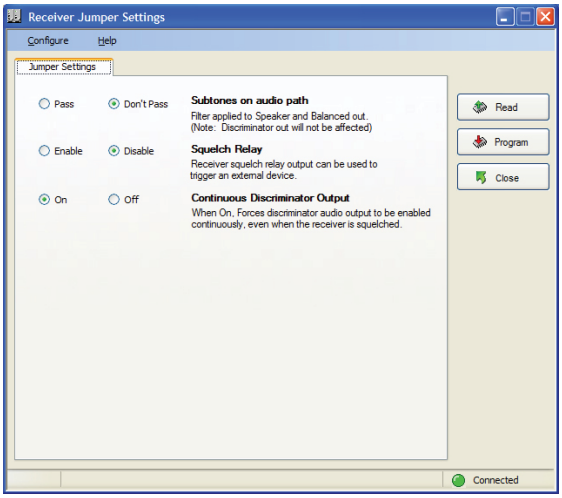


Figure 5-4: RSS Subtone Settings

Audio Distortion:

To check receiver distortion, inject -70 dBm RF carrier level into the receiver and measure the distortion on the meter as shown in Figure 5-5. The High Alarm is set to 2.0 %.

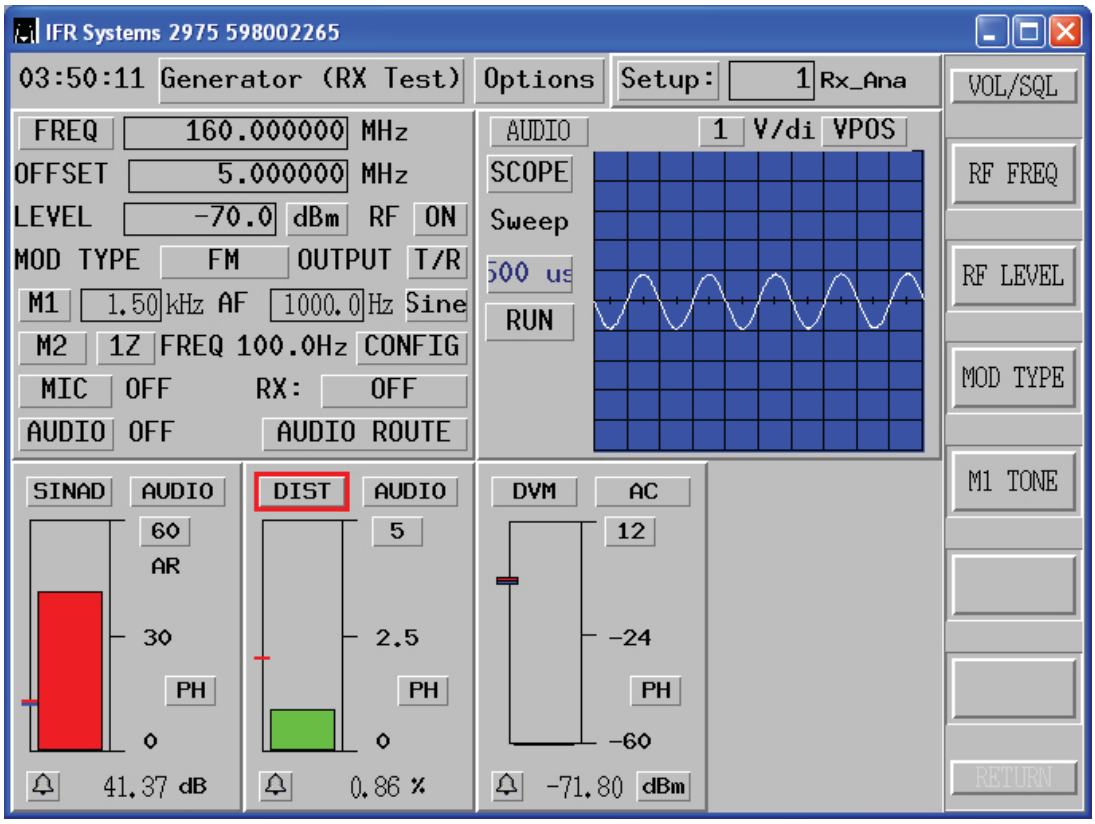


Figure 5-5: Receiver Distortion Measurement

Enter the Audio Distortion reading on the MT-4E Test Sheet.

Reference Sensitivity:

Monitor the SINAD meter while slowly reducing the RF carrier level as shown in Figure 5-6. The 12 dB SINAD point should be at an RF carrier level less than the specified Analog Sensitivity point of the receiver. The high and low alarms are set for 11.5 and 12.5 dB SINAD to help you locate the 12 dB SINAD point. When the indicator bar turns green, the signal is close to 12 dB SINAD.

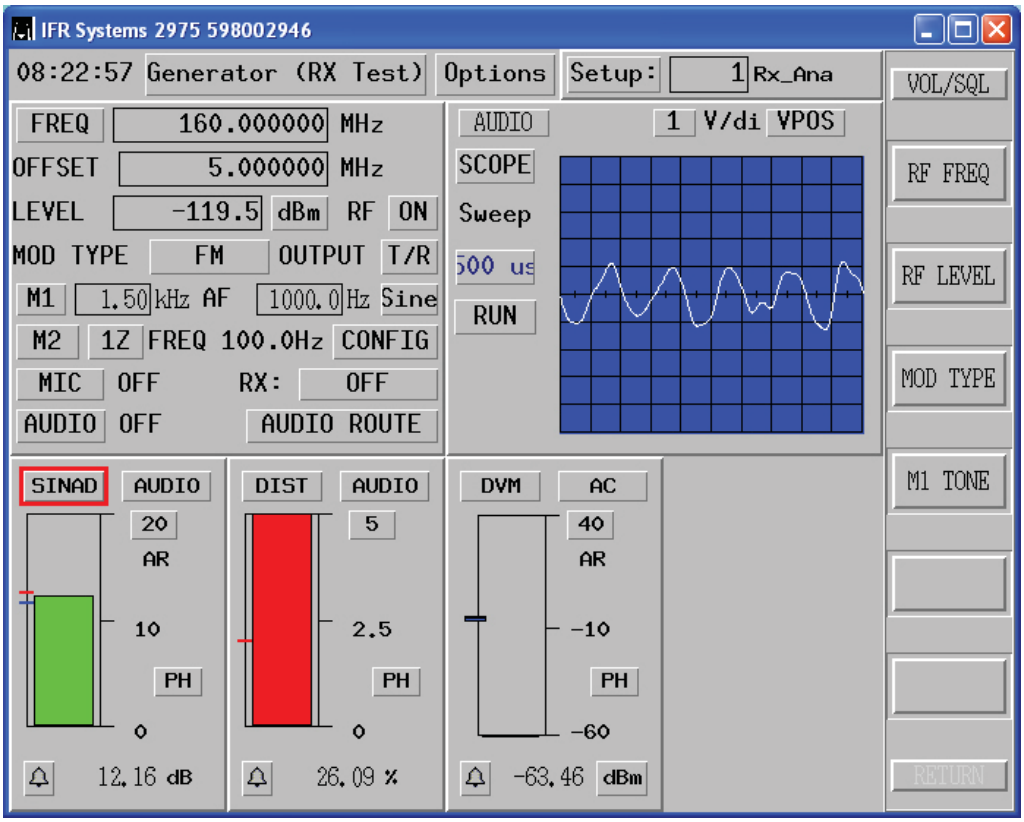


Figure 5-6: Receiver Reference Sensitivity Measurement

Enter the Reference Sensitivity (12 dB SINAD) reading on the MT-4E Test Sheet.

If the distortion or reference sensitivity measurements are not within Codan published specifications, the RF Preselector may need re-alignment. Refer to the Receiver RF Preselector Alignment and Tuning section.

Squelch:

Adjust the RF carrier level up and down until the receiver squelches and unsquelches. There should be approximately 6.0 dBm of hysteresis between the squelch and unsquelch points. The squelch point can be adjusted in the Squelch Levels area of the Service section on the RSS.

The Receiver operates on a Noise based squelch (default) or a Received Signal Strength based squelch (optional). The squelch can be set globally for all channels, or on a per channel basis. To set the squelch Open and Close points, inject an RF signal at the desired Open or Close level and click the Set button.

Enter the Squelch and Unsquelch readings on the MT-4E Test Sheet.

Audio Level:

The audio level adjustment is not required when connecting the receiver in a repeater configuration using LVDS Serial Data. The audio level adjustment can be done on both the Rx Balanced Audio Output and the Auxiliary Balanced Output (1 and 2). The Auxiliary Balanced Output is only available on the AC-3E Control Card or CI-BC-4E Base Control Card.

To adjust the receiver balanced audio output, ensure that the AC-3E Control Card or CI-BC-4E Base Control Card is NOT plugged into the subrack, disconnect the Rx Balanced audio output from the Audio Input of the IFR 2975 (audio box) and connect it to the DVM input directly on the IFR 2975 as shown in Figure 5-7 (no external load is required as the internal 600 ohm load of the IFR 2975 is used). Inject -70 dBm RF carrier level into the receiver.

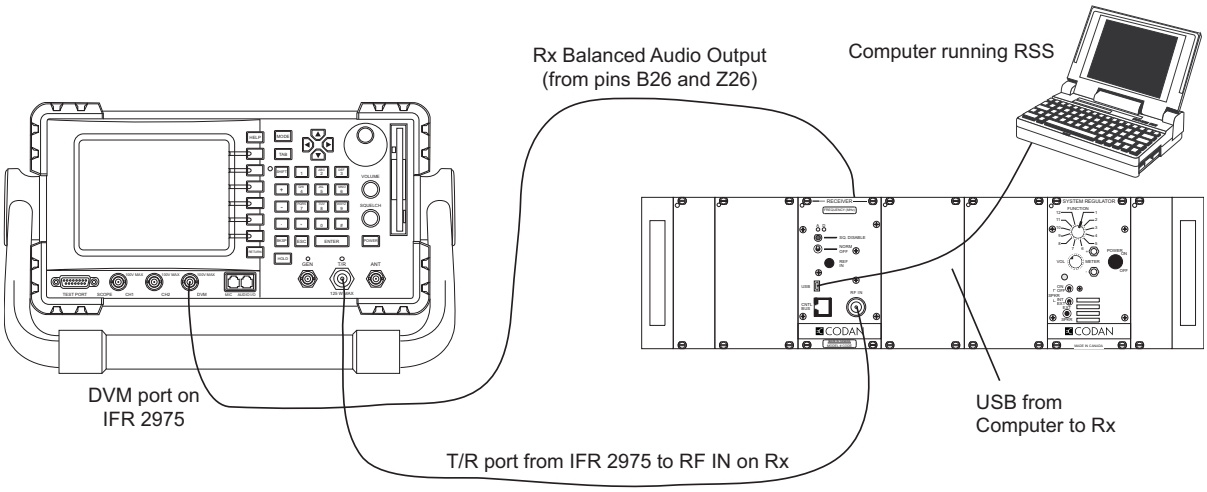


Figure 5-7: Receiver Analog Audio Testing

In the Audio Levels area of the Service section on the RSS, adjust the Rx Balanced Audio Output level adjustment as shown in Figure 5-8 until -8.0 dBm audio level (0.308 Vrms @ 600 ohms) is measured on the DVM meter of the IFR 2975 as shown in Figure 5-9. The high and low alarms are set at -7.5 dBm and -8.5 dBm audio levels.

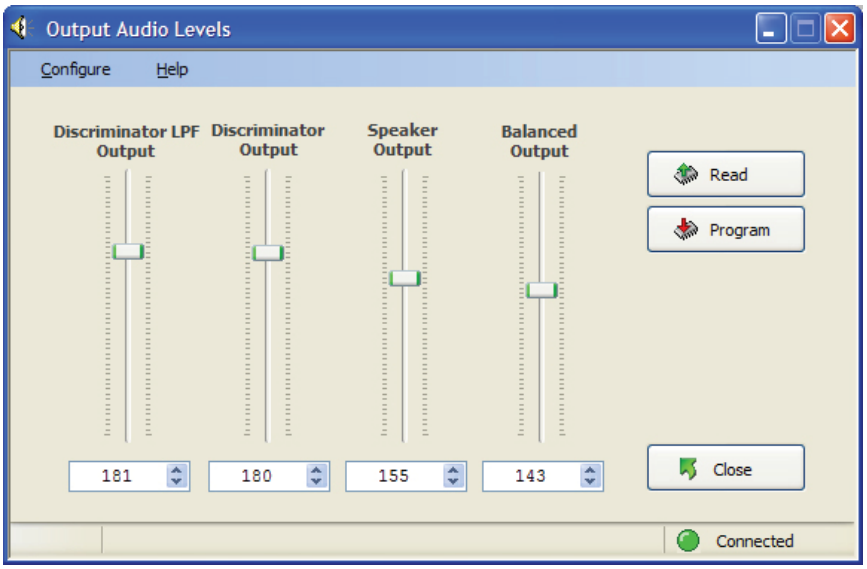


Figure 5-8: RSS Receiver Audio Level Adjustment

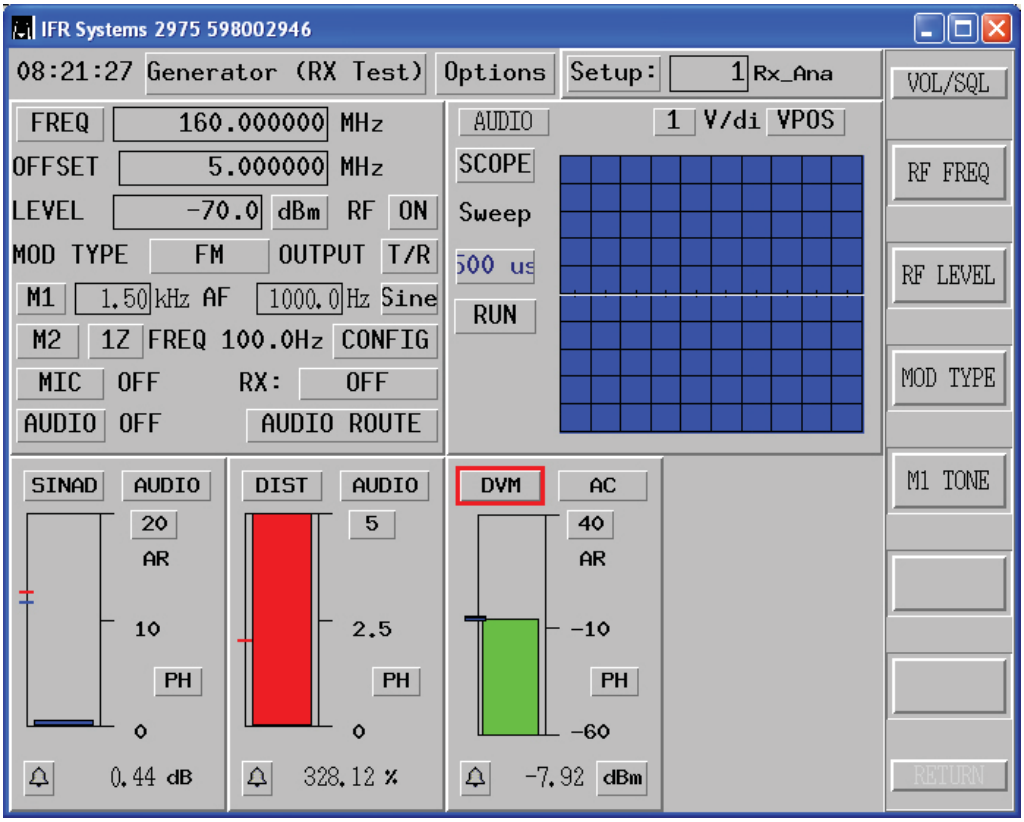


Figure 5-9: Receiver Balanced (and Auxiliary) Audio Output Measurement

To adjust the auxiliary balanced audio output, plug the AC-3E Control Card or CI-BC-4E Base Control Card into the subrack using an extender card and connect the Auxiliary Balanced audio output to the DVM input directly on the IFR 2975 (no external load is required as the internal 600 ohm load of the IFR 2975 is used). Auxiliary 1 audio output is available on pins B11 and A11, and Auxiliary 2 audio output is available on pins C1 and C3 for the AC-3E Control Card and pins C2 and C4 for the CI-BC-4E Base Control Card. Ensure that NO external devices (eg. tone remote adapter or IP router) are connected to the auxiliary audio output. Adjust the Auxiliary Balanced Audio Output level adjustment (R13 for Aux Out 1, R56 for Aux Out 2) for 0.0 dBm audio level (0.775 Vrms @ 600 ohms).

Enter the Balanced Audio Output Level and Auxiliary Audio Output Level (if used) readings on the MT-4E Test Sheet.

There are no specific measurements to check Receive CTCSS, just verify that the receiver CTCSS is operating.

Receiver Digital Testing

Connect the IFR 2975 and Codan Radio as shown in Figure 5-10.

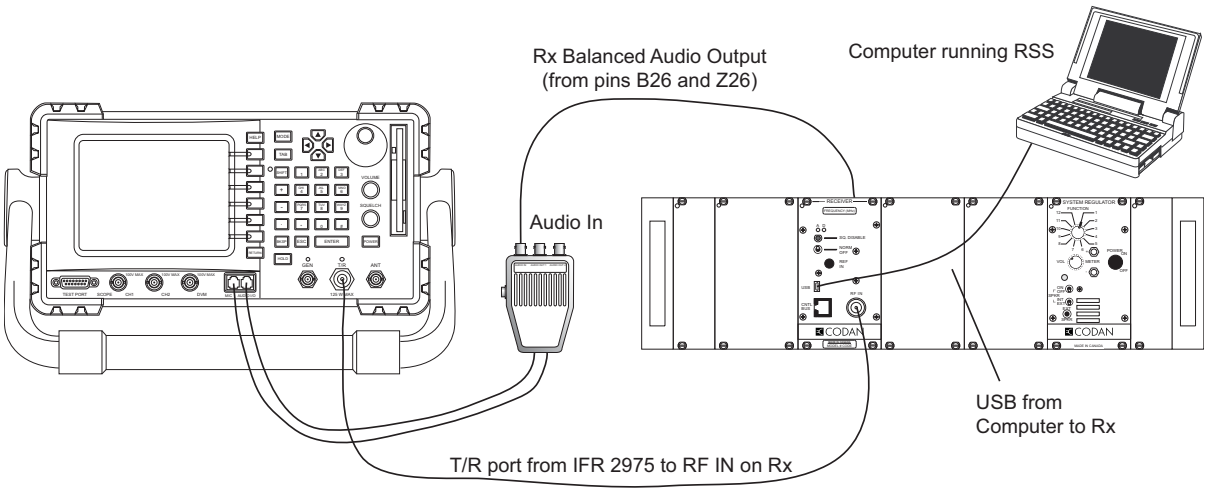


Figure 5-10: Receiver Digital Testing

On the IFR 2975, recall Codan setup 2 (Rx_Dig) from your internal drive. Enter the correct RF frequency, and ensure that the MOD TYPE is set to P25 and it is set for the SPEECH test pattern (or optionally the 1011 test pattern).

Inject the correct NAC (and TGID if programmed) and ensure that the receiver is operating as shown in Figure 5-11. There are no specific measurements to make on this test, just verify that the receiver is operating.

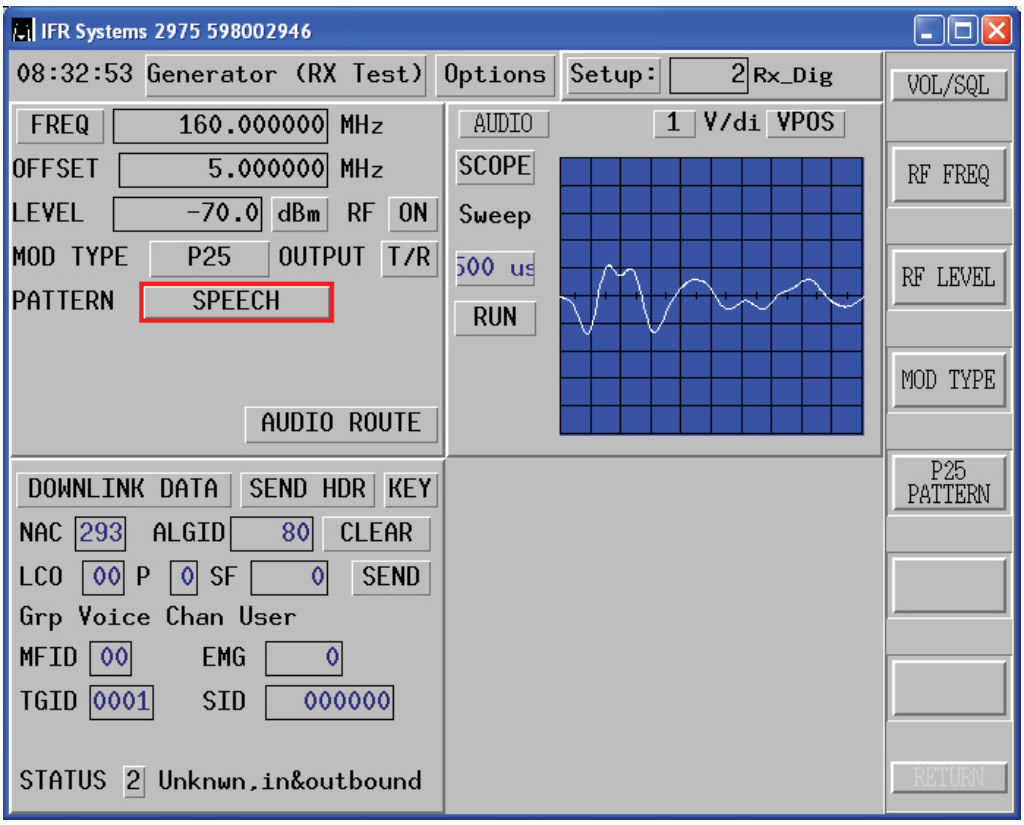


Figure 5-11: Receiver Digital Check

Receiver Bit Error Rate Testing

Connect the IFR 2975 and Codan Radio as shown in Figure 5-12.

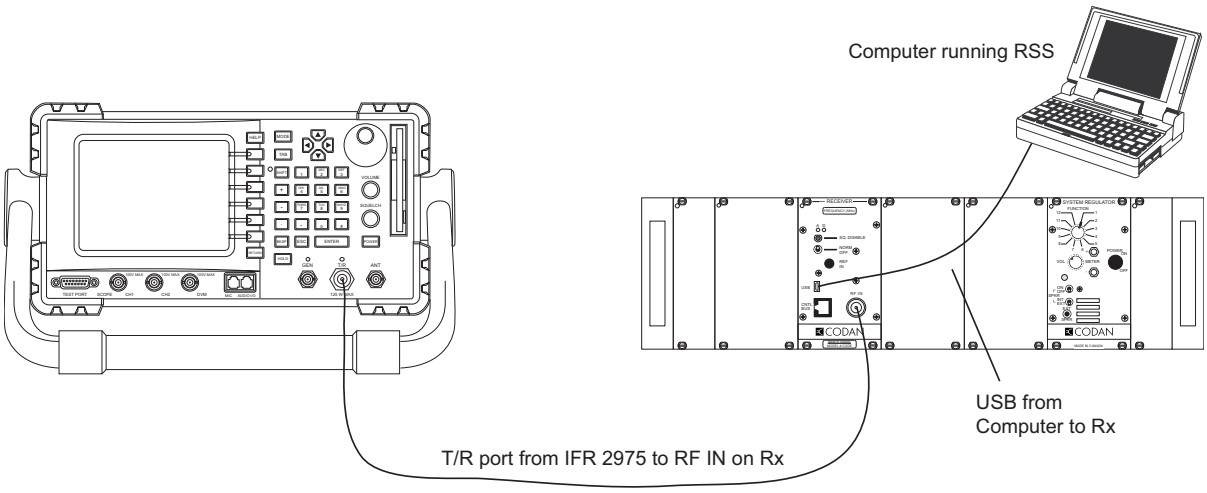


Figure 5-12: Receiver Bit Error Rate Testing

On the IFR 2975, recall Codan setup 3 (Rx_BER) from your internal drive. Enter the correct RF frequency, and ensure that the MOD TYPE is set to P25 and it is set for the STD 1011 test pattern (the 1011 test pattern will not operate correctly for this test) as shown in Figure 5-13.

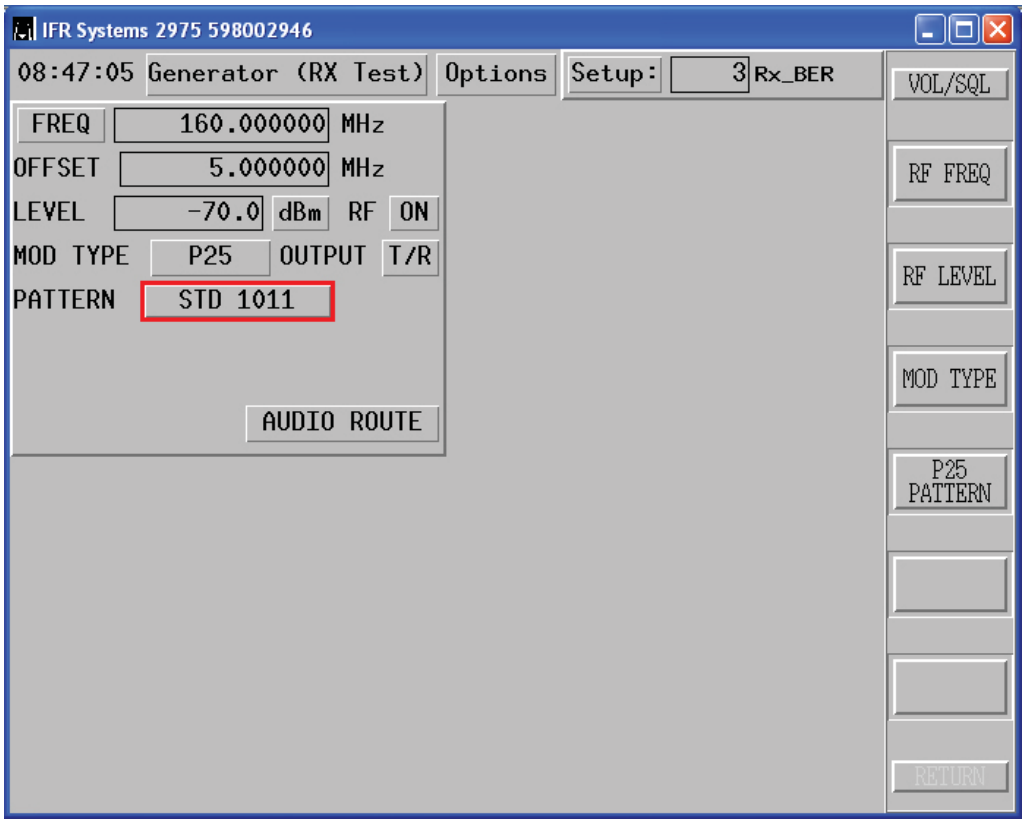


Figure 5-13: Receiver Bit Error Rate Test Injection

In the receiver RSS, enter the Service section and click on “Bit Error Rate”. The receiver frequency should automatically be shown in the frequency box. Select the Test Type to “Continuous” and Average Frames to “8”. Click on the “Start Test” button to start the BER test. You should get 0% BER at the -70 dBm default RF carrier level.

Monitor the BER reading while slowly reducing the RF carrier level as shown in Figure 5-14. The 5% BER point should be at an RF carrier level less than the specified Digital Sensitivity point of the receiver.

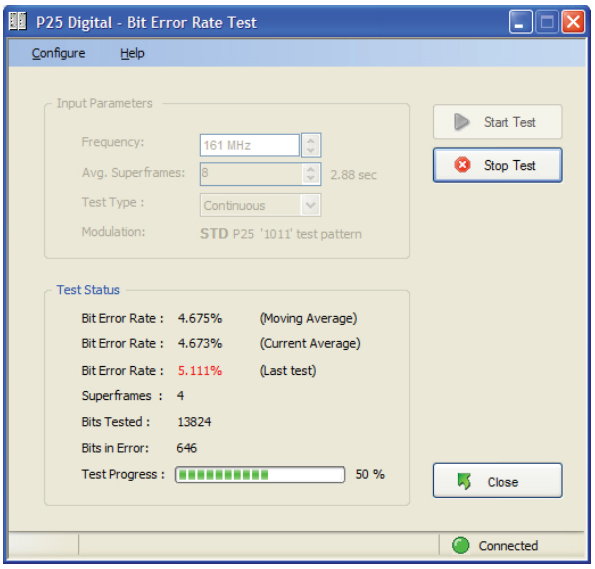


Figure 5-14: RSS Receiver Bit Error Rate Test

Enter the Reference Sensitivity (5% BER) reading on the MT-4E Test Sheet.

If the BER measurements are not within Codan published specifications, the RF Preselector may need re-alignment. Refer to the Receiver RF Preselector Alignment and Tuning section.

Receiver RF Preselector Alignment and Tuning

Tuning of the RF Preselector filter is typically only required when the Analog or Digital Sensitivity or Analog Distortion do not meet published specifications, or when the receiver RF frequency is changed beyond the band pass of the filter (typically 5 - 7 MHz in a VHF or UHF 400 MHz receiver). The UHF 700 / 800 / 900 MHz receiver RF Preselector is Full Band and does not require any tuning.

Connect the IFR 2975 and Codan Radio as shown in Figure 5-15.

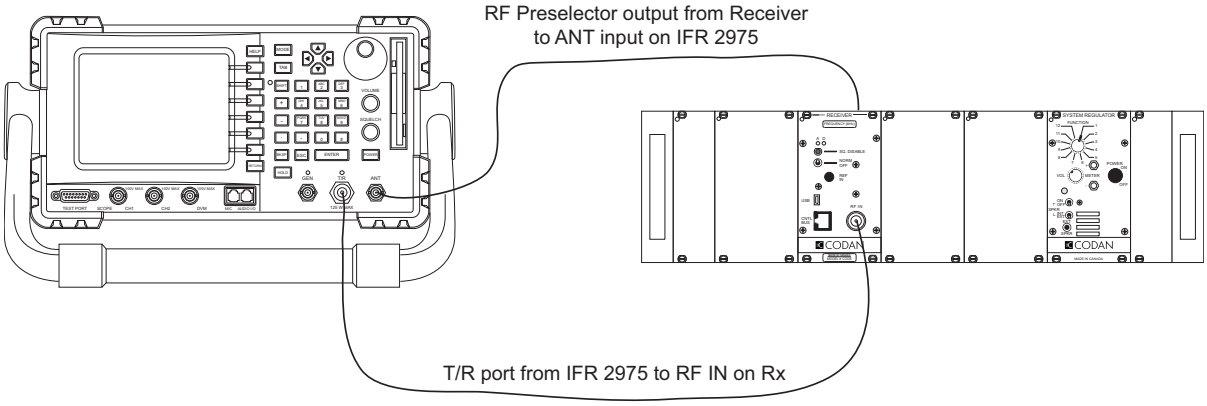


Figure 5-15: Receiver RF Preselector Tuning

The RF Preselector output is a small RF cable internal in the receiver that terminates in an SMB connector. The SMB plugs into J3 on the Receiver Mainboard. Disconnect the SMB cable from J3 and use the SMB-BNC adapter to connect this point to the ANT input on the IFR 2975 as shown in Figure 5-16.

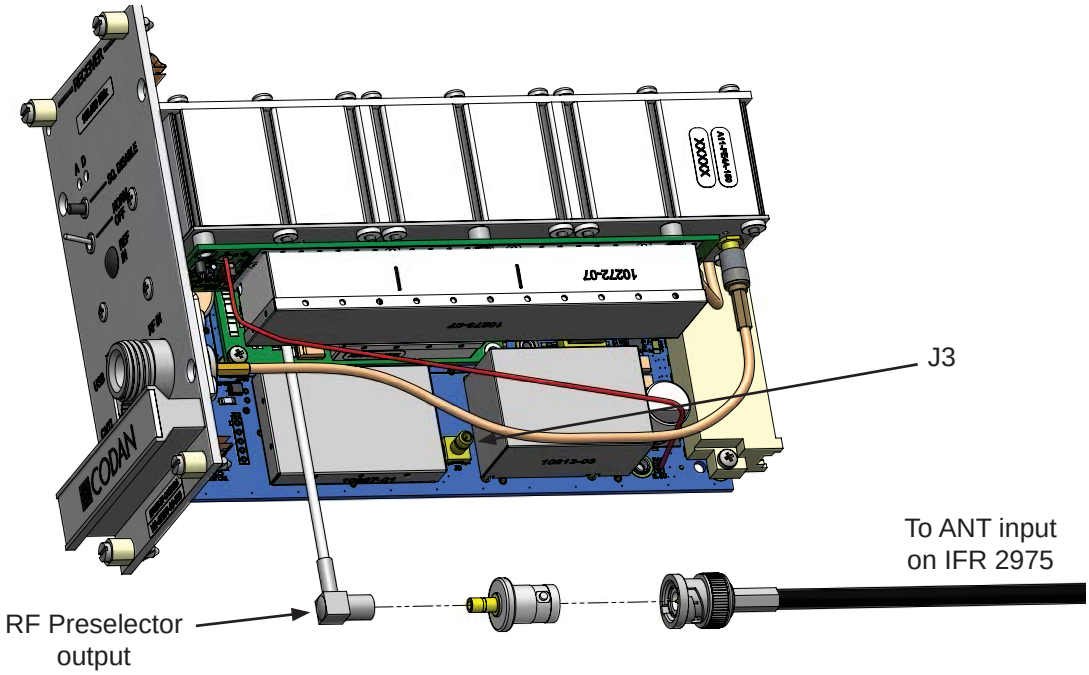


Figure 5-16: Receiver RF Preselector Connection

On the IFR 2975, recall Codan setup 4 (Rx_PreTune) from your internal drive. Enter the correct RF frequency and ensure the receiver is turned on. In the “Trace” box on the right hand side of the screen click on the “Run” button. The filter waveform should appear as shown in Figure 5-17. Click on Options then Configure Markers to add optional markers to the spectrum analyzer if desired.

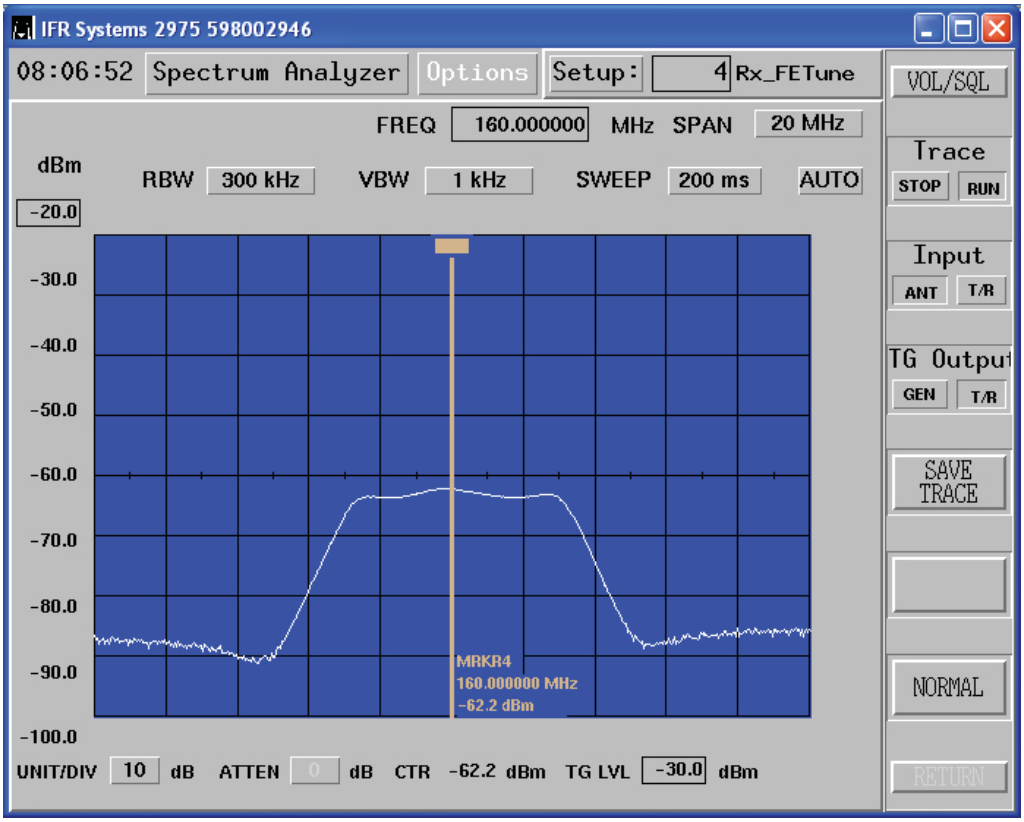


Figure 5-17: Receiver RF Preselector on the Spectrum Analyzer

To tune the RF Preselector filter, remove the dust caps on the variable capacitors and, starting from the capacitor closest to the front panel of the receiver and moving back, tune the filter to its new frequency.

Receiver Reference Oscillator Adjustment

Connect the IFR 2975 and Codan Radio as shown in Figure 5-18.

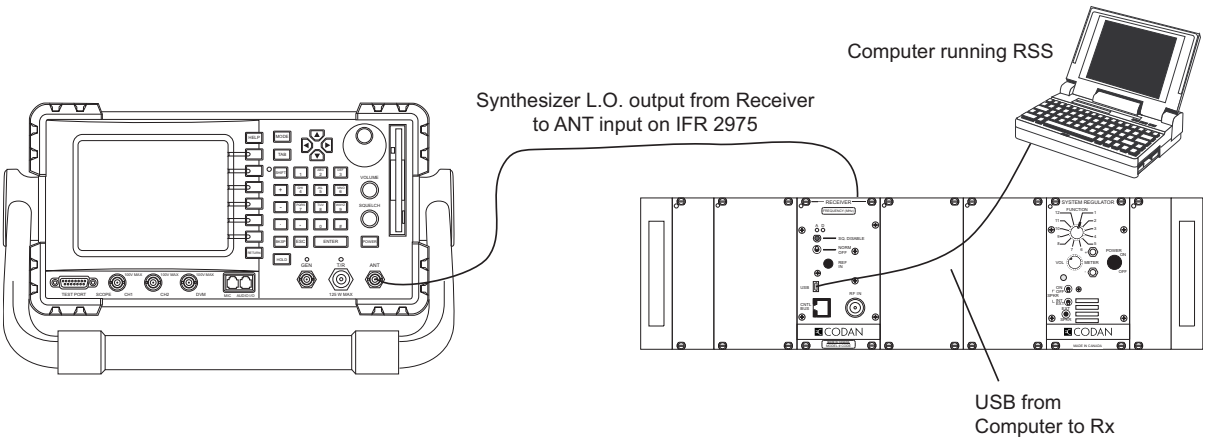


Figure 5-18: Receiver Reference Oscillator Testing

The reference oscillator test on the receiver requires a connection directly into the Synthesizer, which uses an SMB connector. Disconnect the SMB cable from the LO output of the synthesizer and connect the small SMB-SMB cable to the SMB jack that is mounted on the Synthesizer (beneath the RF Preselector). The SMB-BNC adapter is required to connect this point to the ANT input on the IFR 2975 as shown in Figures 5-19 (VHF and UHF 400 MHz Receiver) and 5-20 (UHF 700 / 800 / 900 MHz Receiver).

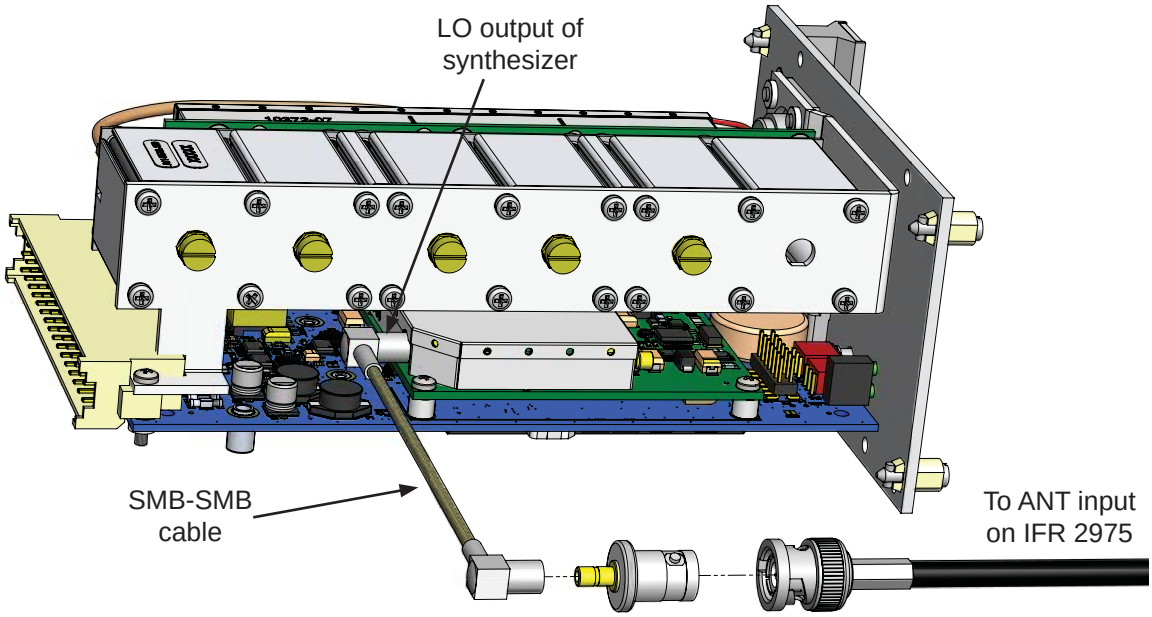


Figure 5-19: VHF and UHF 400 MHz Receiver Reference Oscillator Connection

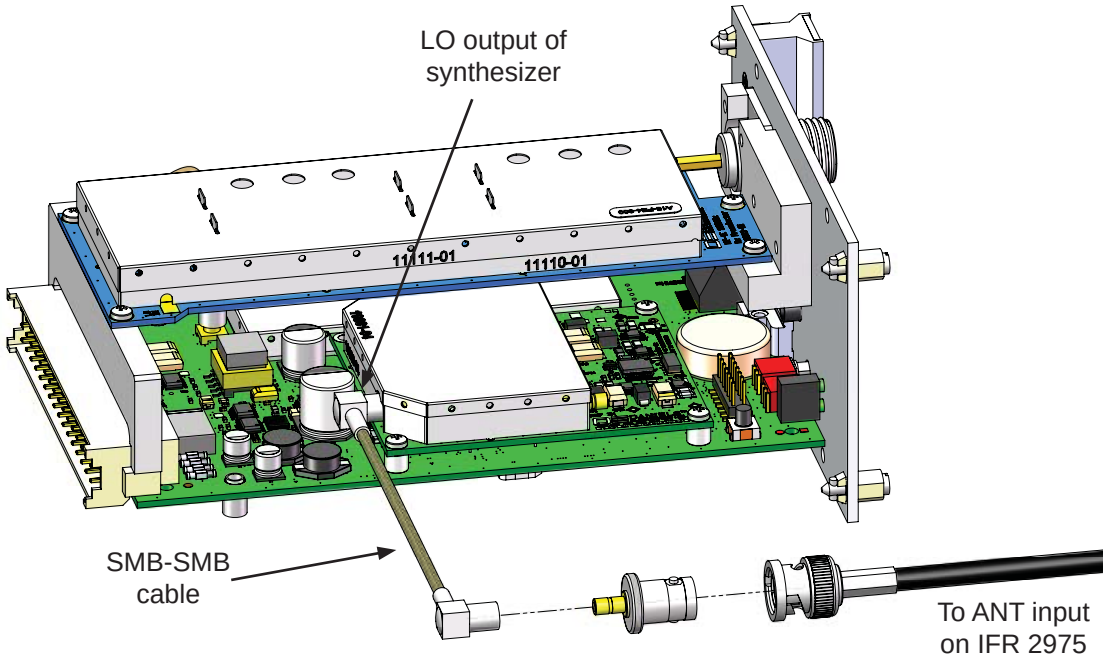


Figure 5-20: UHF 700 / 800 / 900 MHz Receiver Reference Oscillator Connection

On the IFR 2975, recall Codan setup 5 (Rx_Ref) from your internal drive as shown in Figure 5-21.

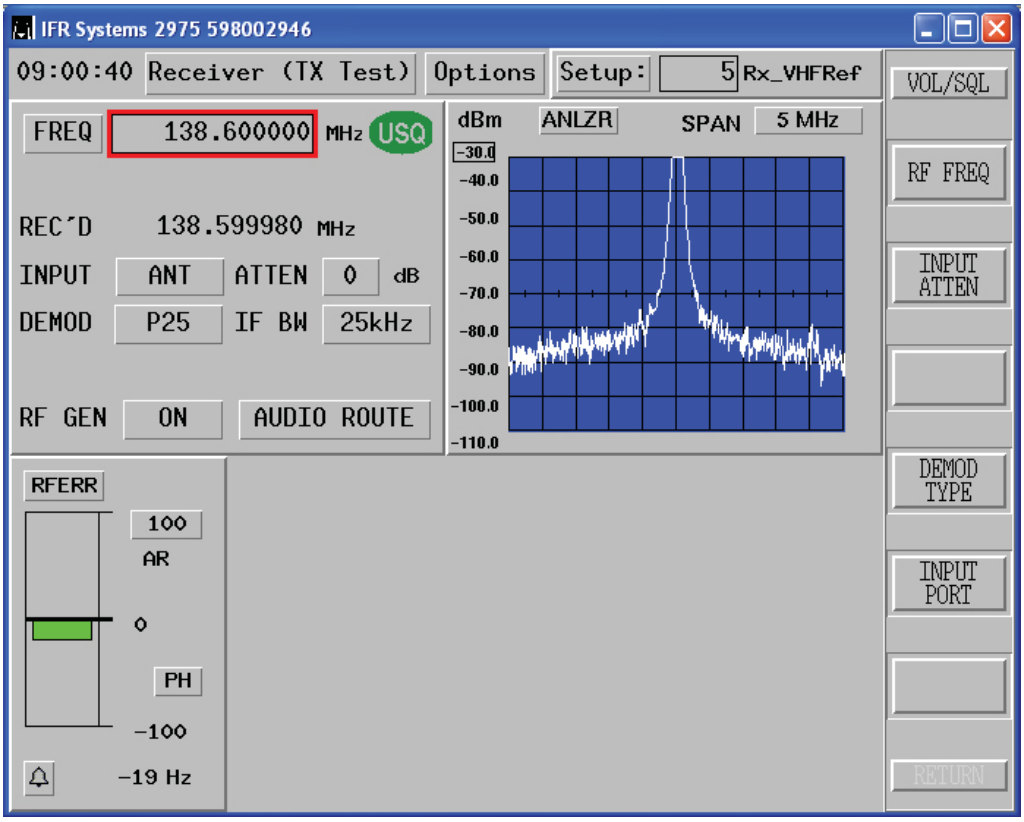


Figure 5-21: Receiver Reference Oscillator Measurement

In the receiver RSS, enter the Service section and click on “Ref Oscillator”. The reference oscillator frequency is shown as the “Target Synthesizer RF OUT”. Enter this RF frequency into the IFR 2975. The receiver generates this frequency out of the Synthesizer into the IFR 2975.

Monitor the RF Error window on the IFR 2975. To change the reference frequency, adjust the softpot slider in the RSS as shown in Figure 5-22. Adjust until the RF error is as close to 0 Hz as possible. Click on the “Program” button to program in the new Reference Oscillator softpot value. The high and low alarms are turned off.

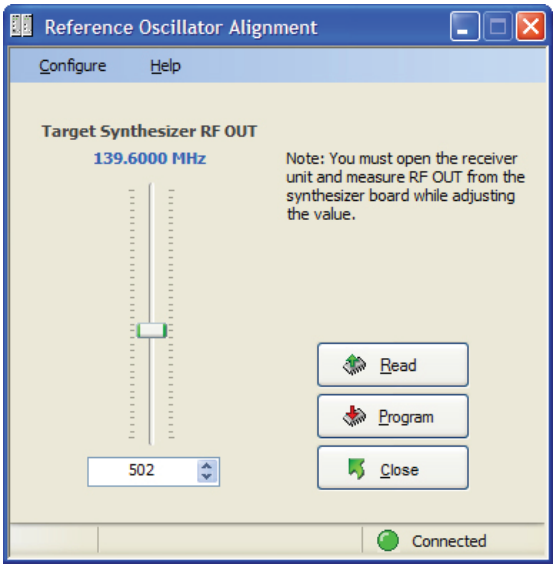


Figure 5-22: RSS Receiver Reference Oscillator Alignment

Enter the L.O. Reference Oscillator Offset reading on the MT-4E Test Sheet.

TRANSMITTER TESTING

Transmitter Analog Testing

Connect the IFR 2975 and Codan Radio as shown in Figure 5-23.

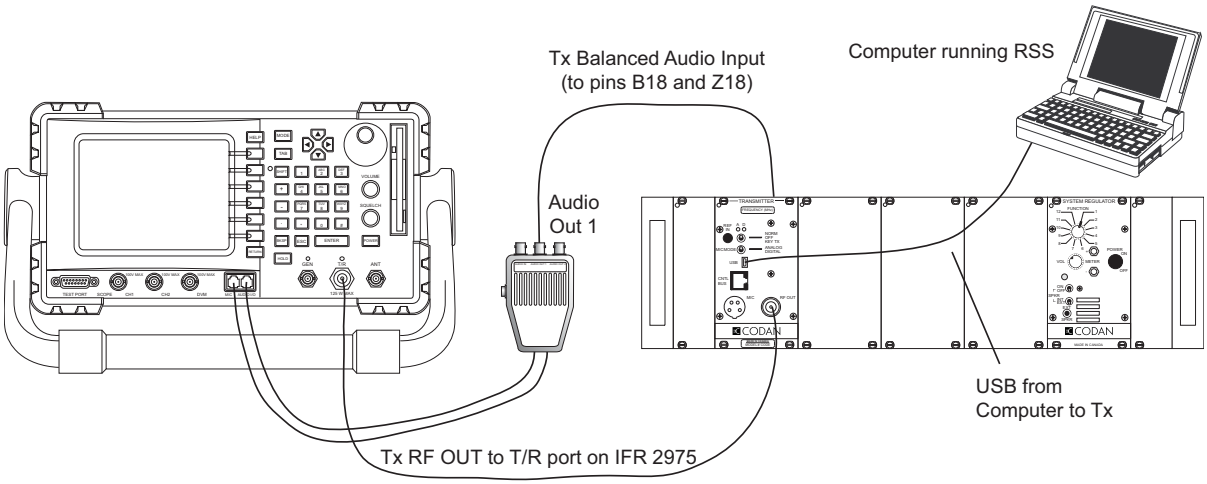


Figure 5-23: Transmitter Analog Testing

On the IFR 2975, recall Codan setup 6 (Tx_Ana) from your internal drive. Enter the correct RF frequency on the IFR 2975, set the MIC MODE switch on the front panel of the transmitter to Analog, and flip the other switch to KEY TX (or set the switch to NORM and key the transmitter through the RSS).

FGEN1 is configured to inject a 1.0 KHz tone at -8.0 dBm (0.308 Vrms) into the transmitter balanced input.

Audio Distortion:

The distortion meter will read demodulated audio and give you a transmitter distortion reading as shown in Figure 5-24. The High Alarm is set to 3.0 %.

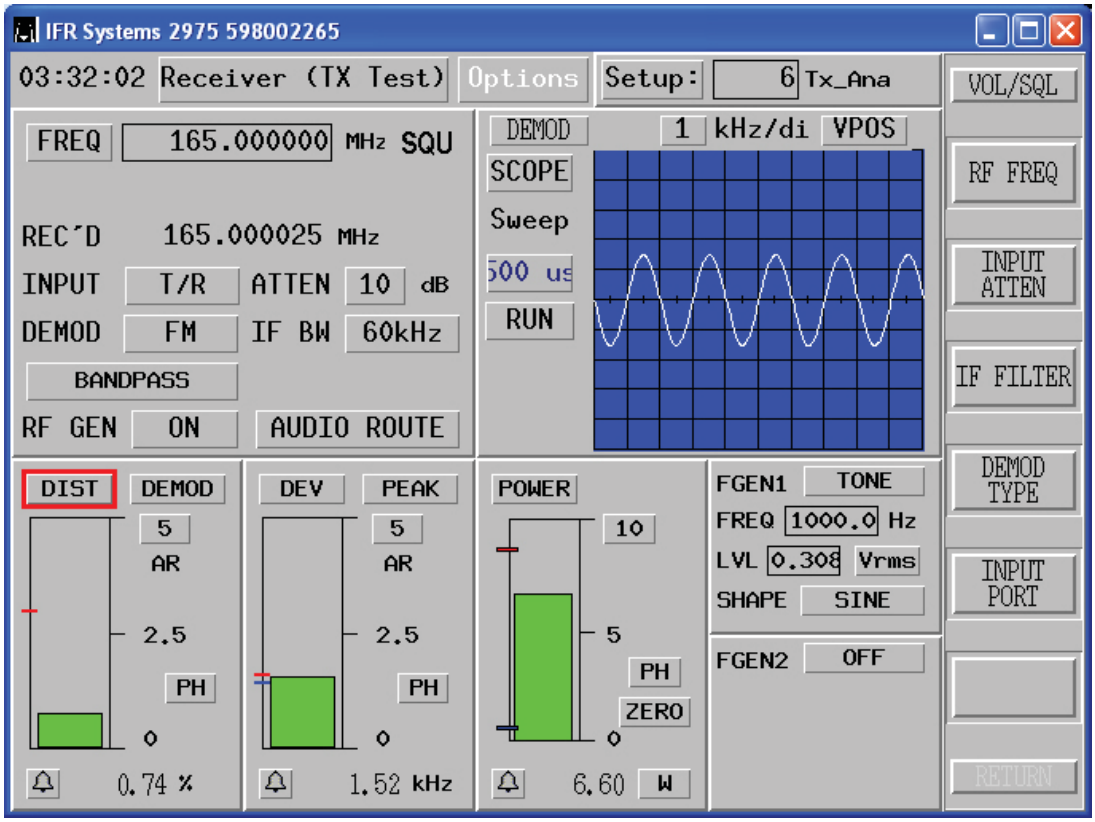


Figure 5-24: Transmitter Distortion and Power Measurements

Enter the Audio Distortion reading on the MT-4E Test Sheet.

RF Power:

Monitor the RF power output of the transmitter as shown in Figure 5-24. In the Power Level area of the Service section on the RSS, click on the “Key Tx” button and adjust the Transmitter Output Power adjustment as shown in Figure 5-25 to change the RF output power. The High Alarm is set at 8.5 Watts and the Low Alarm is set at 0.5 Watts. Transmitter RF power output will vary slightly with the +10 - +17 Vdc input.

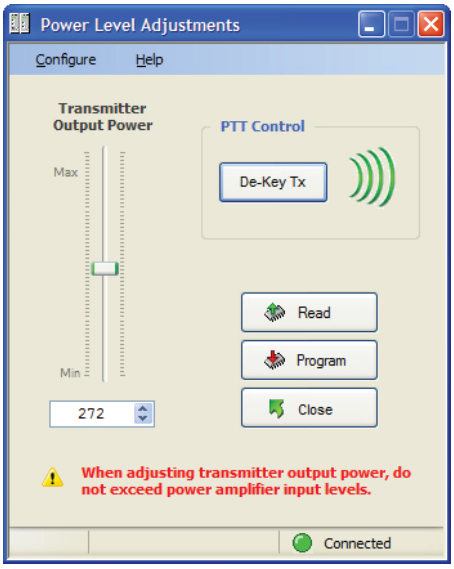


Figure 5-25: RSS Transmitter Power Level Adjustment

Enter the RF Power Output reading on the MT-4E Test Sheet.

Connect the transmitter to the power amplifier (if used) and measure the RF power output of the amplifier. Do not exceed power amplifier input levels.

Enter the Amplifier RF Power Output reading on the MT-4E Test Sheet.

Deviation Level:

The deviation level adjustment is not required when connecting the transmitter in a repeater configuration using LVDS Serial Data. The audio level / deviation level adjustment can be done on both the Tx Balanced Audio Input and the Auxiliary Balanced Input (1 and 2). The Auxiliary Balanced Input is only available on the AC-3E Control Card or CI-BC-4E Base Control Card.

Change the Audio Filter (below DEMOD) from BANDPASS to 15 KHz LP as shown in Figure 5-26 for a more accurate deviation reading without CTCSS encode. If the transmitter has CTCSS encode, leave the Audio Filter on BANDPASS.

To adjust the transmitter balanced input, ensure that the AC-3E or CI-BC-4E Control Card is NOT plugged into the subrack. FGEN1 is configured to inject a 1.0 KHz tone at -8.0 dBm (0.308 Vrms) into the Tx Balanced audio input.

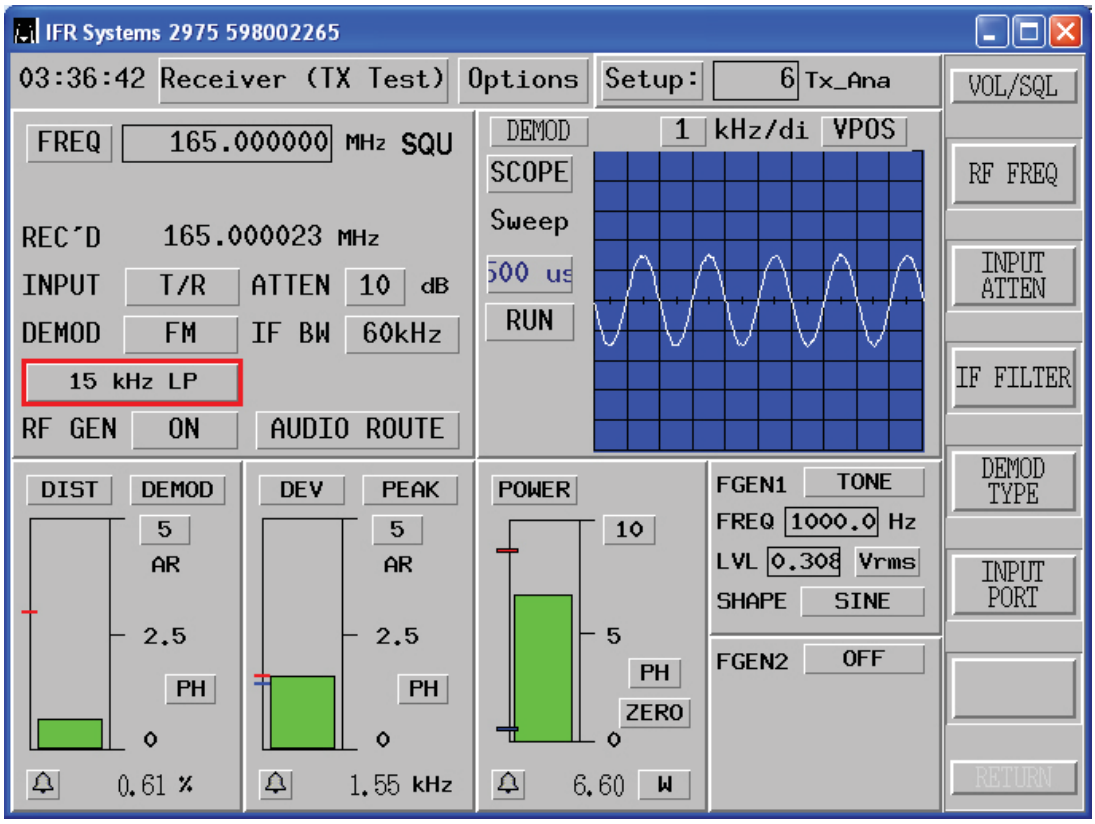


Figure 5-26: Transmitter Deviation Measurement

In the Deviation Levels area of the Service section on the RSS, click on the “Key Tx” button and adjust the Tx Balanced Audio Input level adjustment as shown in Figure 5-27 until a deviation of +/- 1.5 KHz (narrowband) or +/-3.0 KHz (wideband) is measured on the IFR 2975. The high and low alarms are set at +/-1.4 KHz to +/- 1.6 KHz deviation.

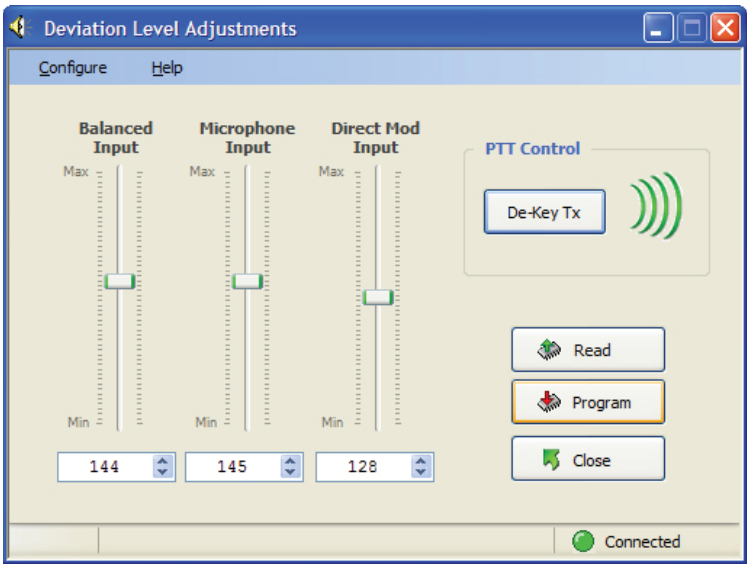


Figure 5-27: RSS Transmitter Audio Level Adjustment

Enter the Transmitter Deviation Level reading on the MT-4E Test Sheet.

Configure FGEN1 to inject a 300 Hz tone at +10.0 dBm (2.500 Vrms) into the Tx Balanced audio input and adjust the audio frequency from 300 Hz to 3400 Hz in increments of 100 Hz and check that the transmitter deviation does not rise above +/- 2.5 KHz (narrowband) or +/-5.0 KHz (wideband). The MT-4E Transmitter will transmit a maximum deviation at an audio frequency of approximately 1300 Hz.

Enter the Transmitter Maximum Deviation Level reading on the MT-4E Test Sheet.

To adjust the auxiliary balanced audio input, plug the AC-3E Control Card or CI-BC-4E Base Control Card into the subrack using an extender card, disconnect the Tx Balanced audio input and connect the Auxiliary Balanced audio input to the Audio Out 1 on the IFR 2975 (audio box). Auxiliary 1 audio input is available on pins C19 and C20, and Auxiliary 2 audio input is available on pins B14 and A14. Ensure that NO external devices (eg. tone remote adapter or IP router) are connected to the auxiliary audio input. Configure FGEN1 to inject a 1.0 KHz tone at 0.0 dBm (0.775 Vrms) into the Auxiliary Balanced audio input. Adjust the Auxiliary Balanced Audio Input level adjustment (R120 for Aux In 1, R123 for Aux In 2) for deviation of +/- 1.5 KHz (narrowband) or +/-3.0 KHz (wideband). The high and low alarms are set at +/-1.4 KHz to +/- 1.6 KHz deviation.

Enter the Auxiliary Deviation Level (if used) reading on the MT-4E Test Sheet.

Transmitter CTCSS Testing

MT-4E Transmitters can be programmed, per channel, to generate CTCSS tones internally, or to allow for External Input of the CTCSS tones from another device (such as a tone-remote adapter).

Connect the IFR 2975 and Codan Radio as shown in Figure 5-28. The Tx Subtone input connection is only required when testing the External Input. If the internal programming is used to generate the CTCSS tone, disconnect the Tx Subtone input from the IFR 2975.

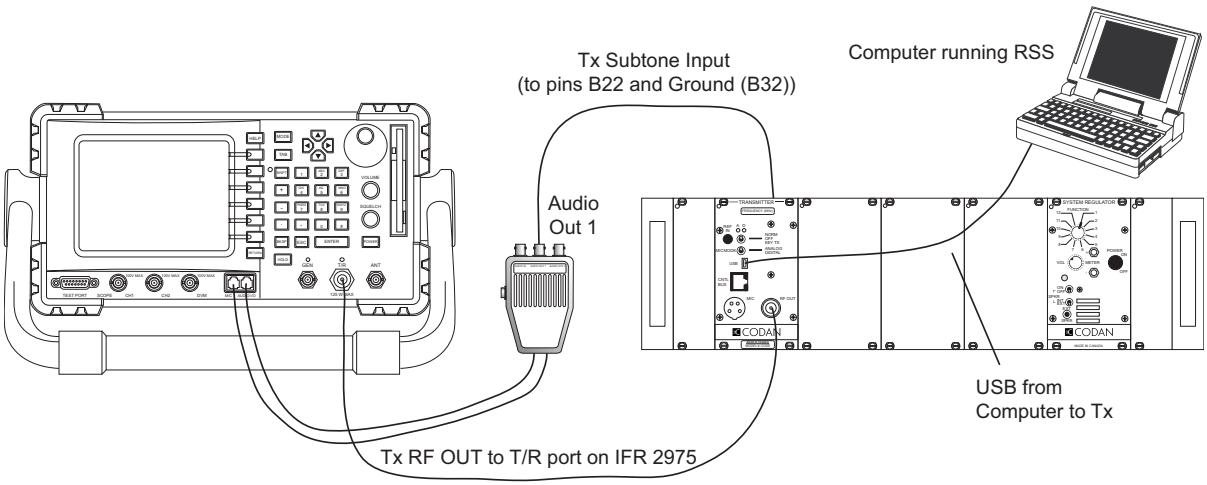


Figure 5-28: Transmitter CTCSS Testing

On the IFR 2975, recall Codan setup 7 (Tx_CTCSS) from your internal drive. Enter the correct RF frequency on the IFR 2975, set the MIC MODE switch on the front panel of the transmitter to Analog and flip the other switch to KEY TX (or set the switch to NORM and key the transmitter through the RSS).

FGEN1 (if used) is configured to inject a 100 Hz tone at -18.0 dBm (0.098 Vrms or 0.277 Vpp) into the Tx Subtone input as shown in Figure 5-29. If the internal programming is used to generate the CTCSS tone, FGEN1 is not used and the CTCSS tone is generated internally in the transmitter.

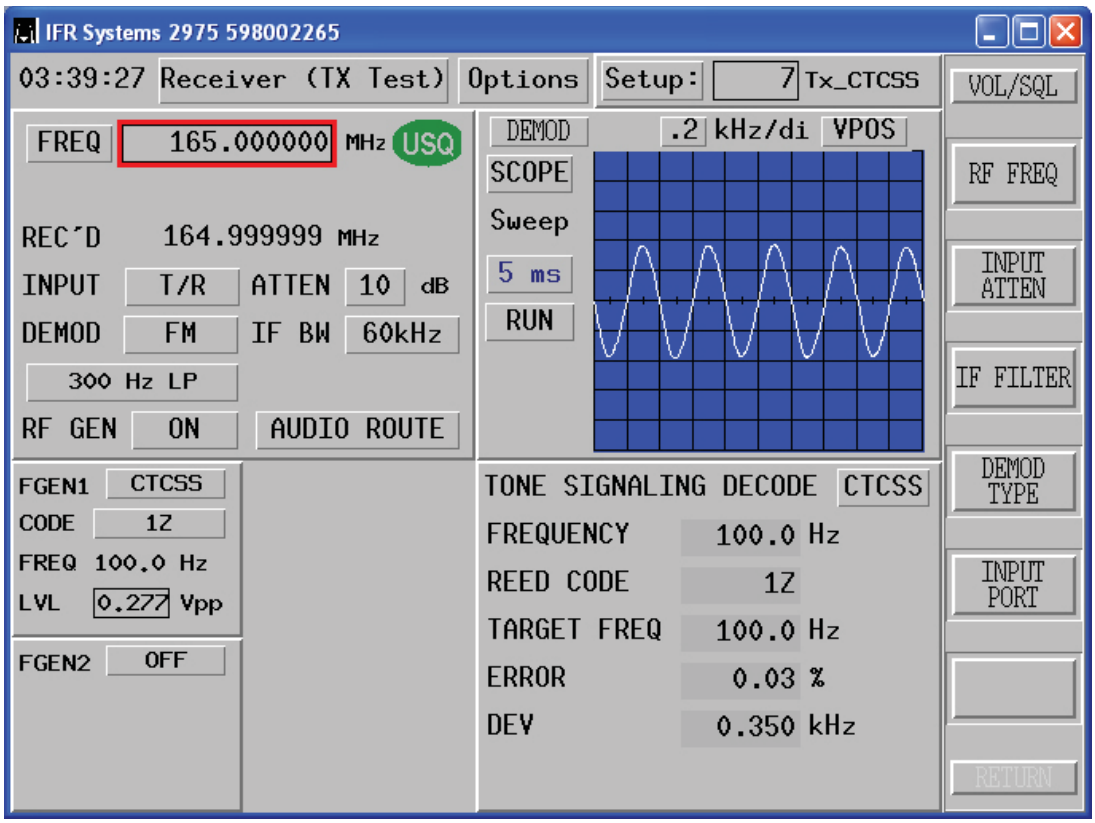


Figure 5-29: Transmitter CTCSS Tone and Deviation Measurement

In the Subtone Levels area of the Service section on the RSS, click on the “Key Tx” button and adjust the Narrow and/or Wide Internal and/or External Subtone Deviation level adjustment as shown in Figure 5-30 until a deviation of +/- 0.35 KHz (narrowband) or +/-0.5 KHz (wideband) is measured on the IFR 2975. There are no high and low alarms.

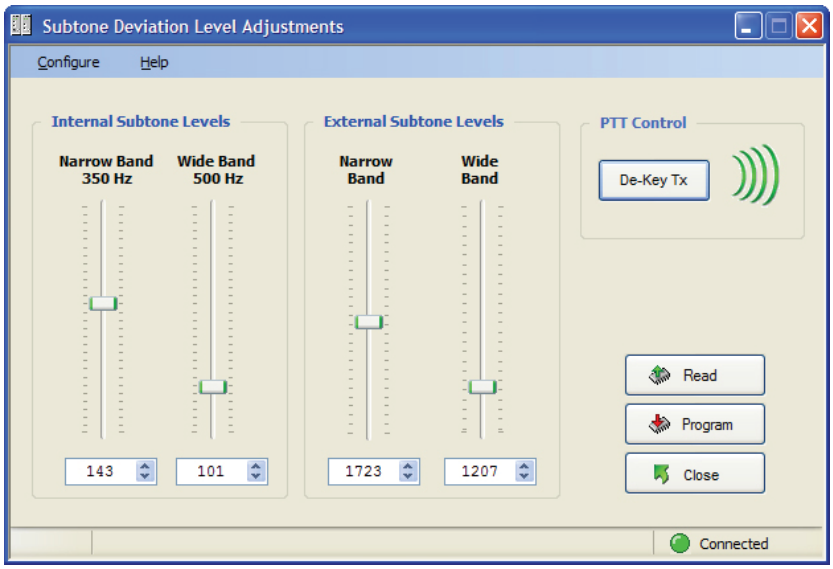


Figure 5-30: RSS Transmitter Subtone Deviation Level Adjustment

Enter the CTCSS Encode Deviation level reading on the MT-4E Test Sheet.

Transmitter Digital Testing

Connect the IFR 2975 and Codan Radio as shown in Figure 5-31.

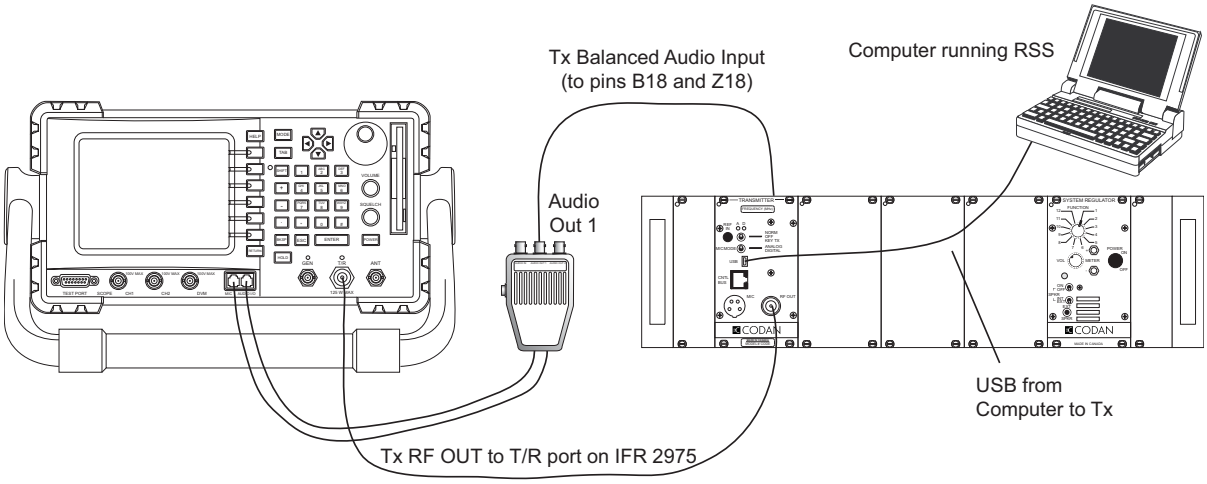


Figure 5-31: Transmitter Digital Testing

On the IFR 2975, recall Codan setup 8 (Tx_Dig) from your internal drive. Enter the correct RF frequency on the IFR 2975, set the MIC MODE switch on the front panel of the transmitter to Digital and flip the other switch to KEY TX (or set the switch to NORM and key the transmitter through the RSS).

FGEN1 is configured to inject a 1.0 KHz tone at -8.0 dBm (0.308 Vrms) into the transmitter balanced input. A continuous tone injected into the transmitter will be demodulated as a “fluctuating” audio level and tone. This is inherent in all P25 radio systems. Optionally, a microphone can be connected to the front panel of the transmitter and the tester can speak into the microphone and listen to the demodulated audio on the IFR 2975.

Ensure the correct NAC, TGID and Unit ID are being transmitted properly as shown in Figure 5-32. The NAC, TGID and Unit ID are all programmed into the transmitter via the RSS. There are no specific measurements to make on this test, just verify that the transmitter is operating.

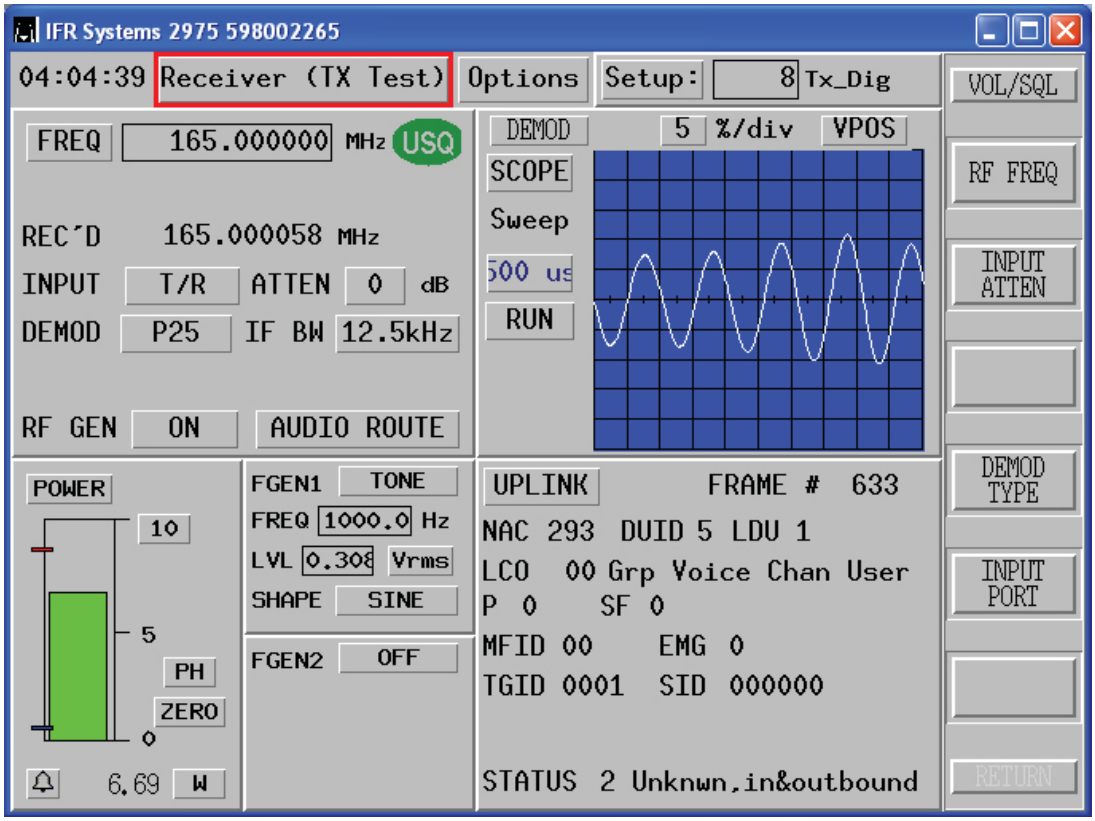


Figure 5-32: Transmitter Digital Check

Transmitter Modulation Fidelity Testing

Connect the IFR 2975 and Codan Radio as shown in Figure 5-33.

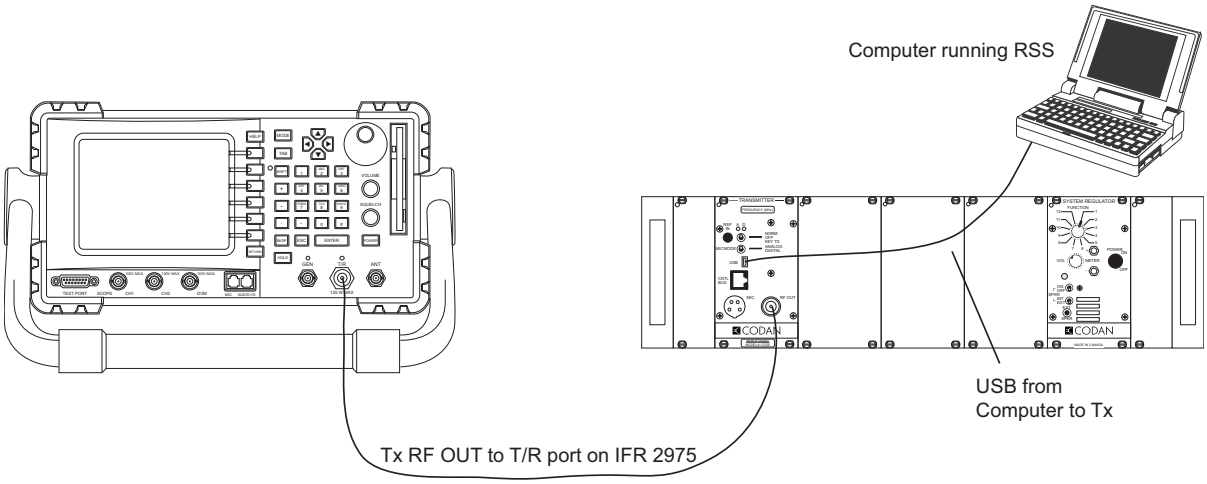


Figure 5-33: Transmitter Modulation Fidelity Testing

On the IFR 2975, recall Codan setup 9 (Tx_ModFid) from your internal drive. Enter the correct RF frequency on the IFR 2975 and set the transmitter front panel switch to NORM. The MIC MODE switch on the front panel can be set to either Digital or Analog (this test does not make use of the front panel switch).

In the transmitter RSS, enter the Service section and click on “Test Patterns”. Ensure the transmitter frequency is in the frequency box. In the Select Pattern window select “C4FM Modulation Fidelity”. Click on the “Key Tx” button as shown in Figure 5-34 and the transmitter will begin generating the test pattern out the RF output.

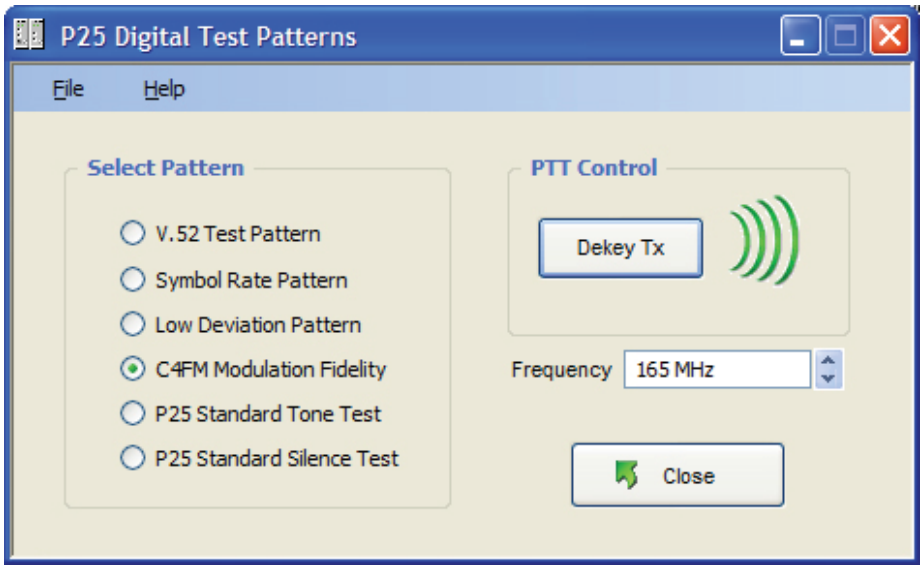


Figure 5-34: RSS Transmitter Modulation Fidelity Test Pattern

Measure the Modulation Fidelity of the transmitter as shown in Figure 5-35. The transmitter should not read more than 5% Modulation Fidelity. If the Modulation Fidelity is more than 5%, the transmitter will need to be returned to the factory for service. The high alarm point is set at 5%.

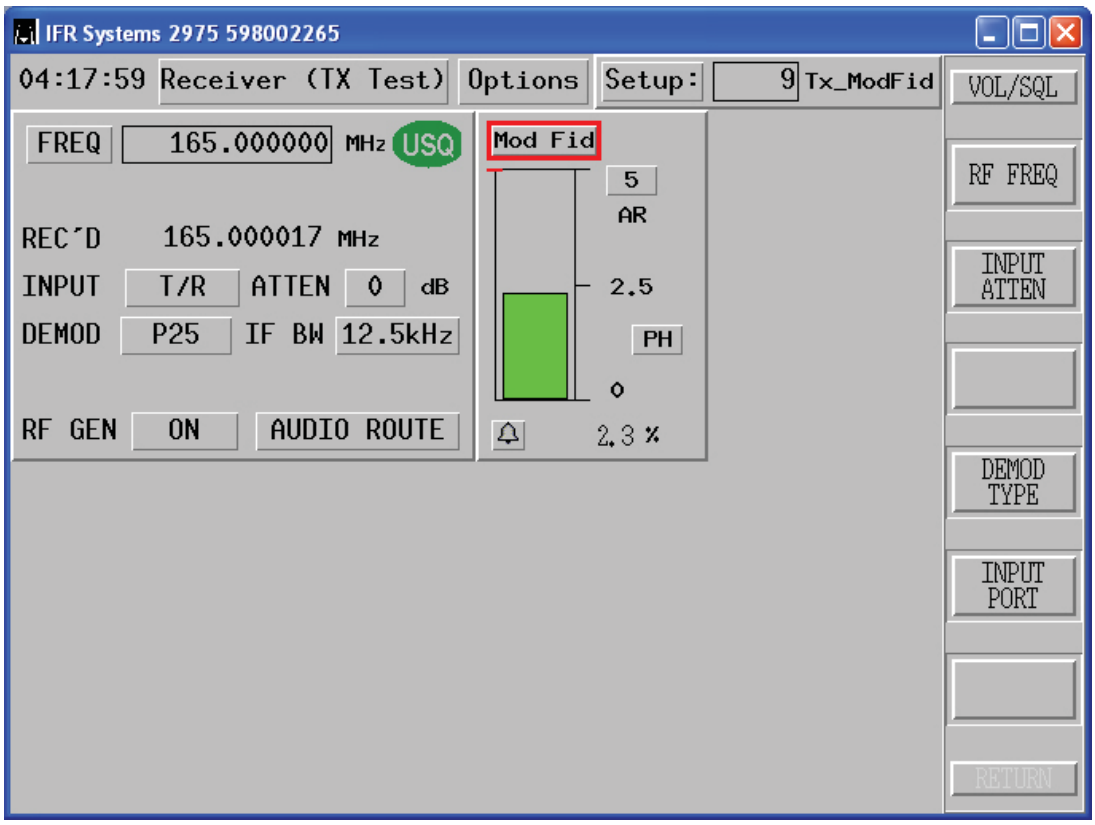


Figure 5-35: Transmitter Modulation Fidelity Measurement

Enter the C4FM Modulation Fidelity reading on the MT-4E Test Sheet.

Transmitter Reference Oscillator Adjustment

Connect the IFR 2975 and Codan Radio as shown in Figure 5-36.

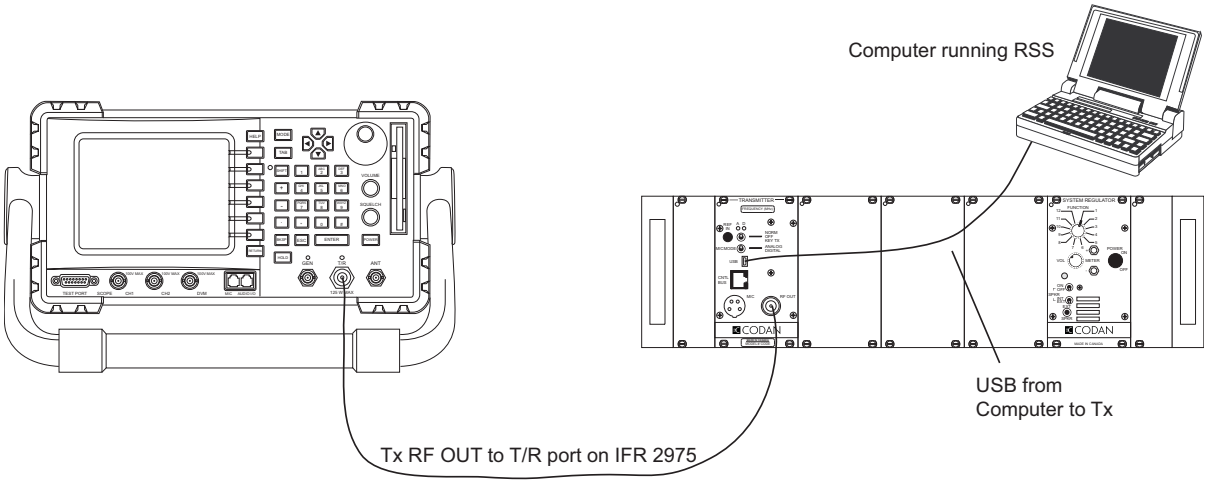


Figure 5-36: Transmitter Reference Oscillator Testing

On the IFR 2975, recall Codan setup 10 (Tx_Ref) from your internal drive. Set the transmitter front panel switch to KEY TX (or set the switch to NORM and key the transmitter through the RSS). The MIC MODE switch on the front panel can be set to either Digital or Analog (this test does not make use of the front panel switch).

In the transmitter RSS, enter the Service section and click on “Ref Oscillator”. The reference oscillator frequency is shown as the “Target Frequency”. Enter this RF frequency into the IFR 2975. Click on the “Key Tx” button and the transmitter will generate the reference frequency out of the RF output into the IFR 2975.

Monitor the RF Error window on the IFR 2975. To change the reference frequency, click on the “Key Tx” button and adjust the softpot slider in the RSS as shown in Figure 5-37.

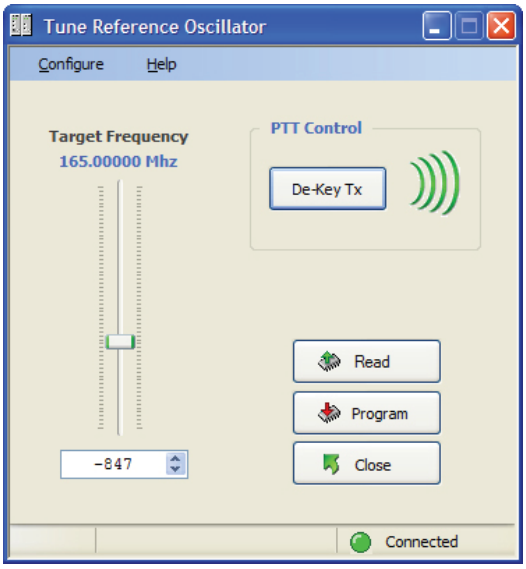


Figure 5-37: RSS Transmitter Reference Oscillator Alignment

Adjust until the RF error is as close to 0 Hz as possible as shown in Figure 5-38. Click on the “Program” button to program in the new Reference Oscillator softpot value. The high and low alarms are turned off.

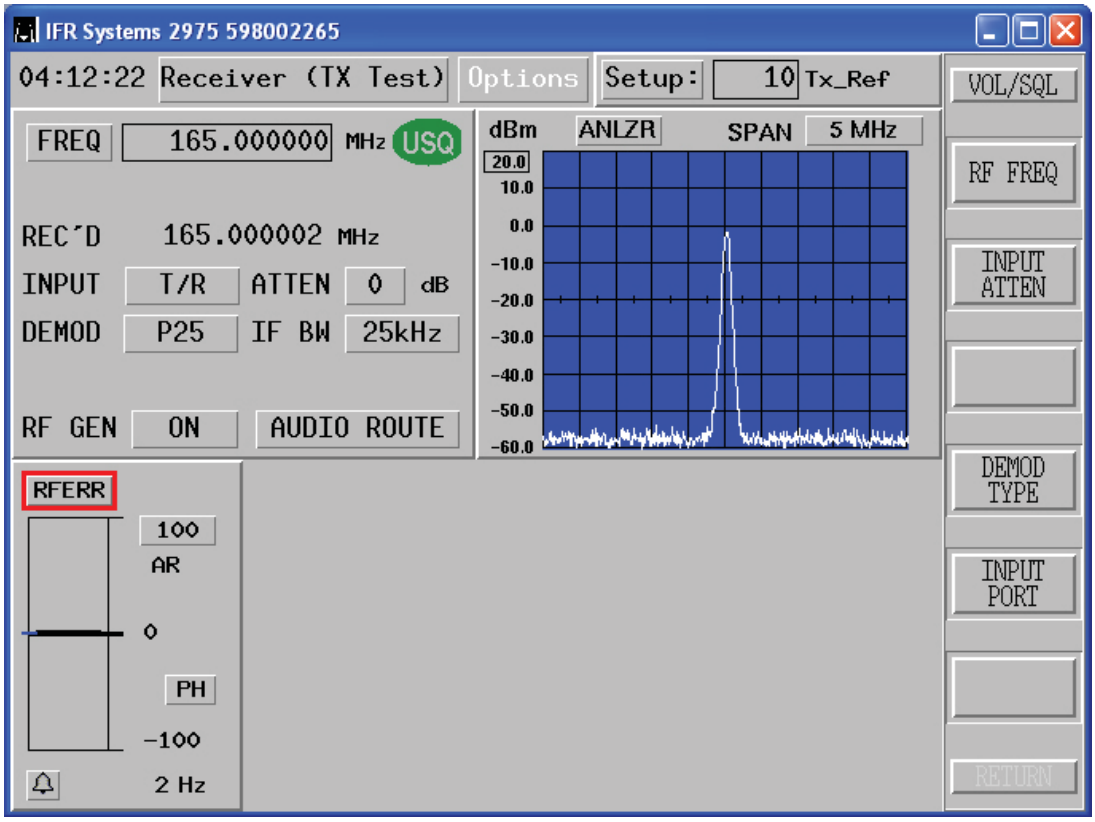


Figure 5-38: Transmitter Reference Oscillator Measurement

Enter the Carrier Reference Oscillator Offset reading on the MT-4E Test Sheet.

SYSTEM TESTING

Duplex Analog Testing

Connect the IFR 2975 and Codan Radio as shown in Figure 5-39:

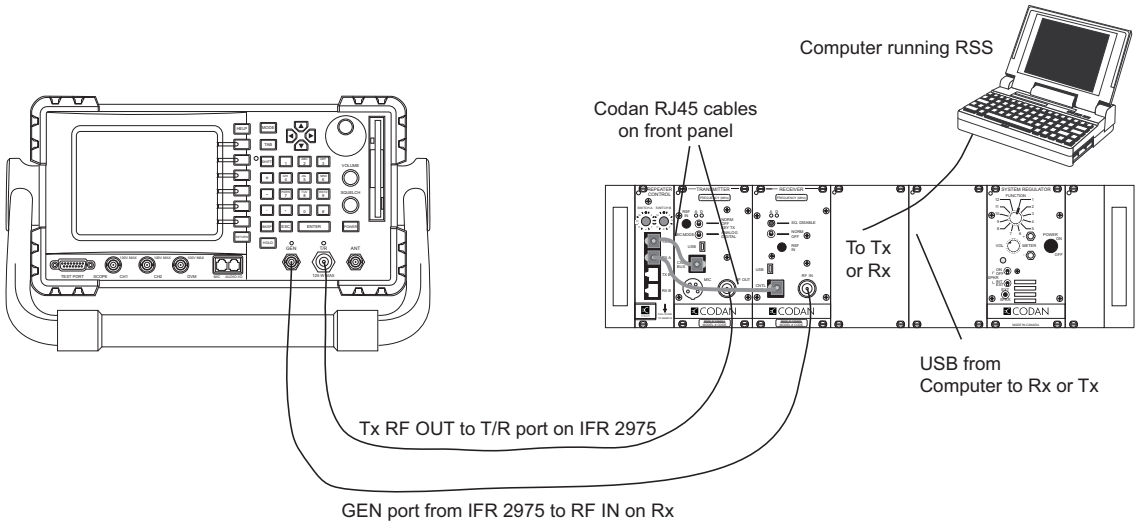


Figure 5-39: System Duplex Analog Testing

On the IFR 2975, recall Codan setup 11 (Dup_Ana) from your internal drive as shown in Figure 5-40. Enter the correct RF frequencies for the receiver and transmitter and ensure that the deviation level of the 1.0 KHz tone is set correctly for your receiver (wide / narrow). Enter the correct CTCSS tone (if used) and deviation level for the tone. Set the receiver and transmitter front panel switch to NORM. The MIC MODE switch on the transmitter front panel can be set to either Digital or Analog (this test does not make use of the front panel switch).

Ensure that the receiver and transmitter are connected to the repeater controller via the RJ45 cables on the front panel. In some systems, the receiver and transmitter may be connected directly together using the RJ45 cables.

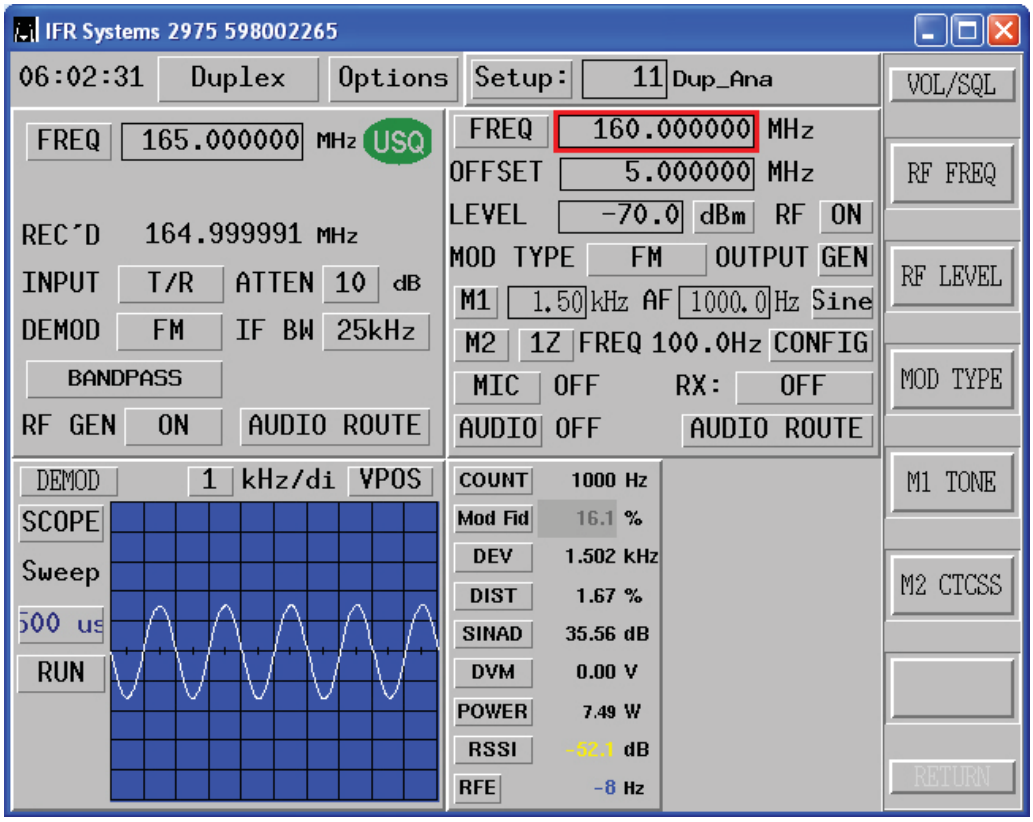


Figure 5-40: System Analog Duplex Measurement

Demodulated Audio Frequency:

Check the COUNT meter on the meter panel. The demodulated audio should read the same as the modulated input. The low and high alarms are set for 995 Hz and 1005 Hz.

Distortion:

The distortion meter will read demodulated audio and give you a complete repeater system distortion reading. The High Alarm is set to 4.0 %.

Enter the System Distortion reading on the MT-4E Test Sheet.

Deviation Level:

Check the deviation level. Ideally the deviation level out of the transmitter should match the input to the receiver. The repeater deviation level matching is adjusted by the analog LVDS level adjustment that is available in both the receiver and transmitter (only one needs to be adjusted).

In the receiver or transmitter RSS, enter the Service section and click on “LVDS Level”. A default value of 100 on the softpot slider should be close to matching receiver and transmitter deviation levels, however minor adjustments can be made. Adjust the softpot slider in the RSS as shown in Figure 5-41 until a deviation of +/- 1.5 KHz (narrowband) or +/- 3.0 KHz (wideband) is measured on the IFR 2975. The low and high alarms are set for 1.40 KHz and 1.60 KHz.

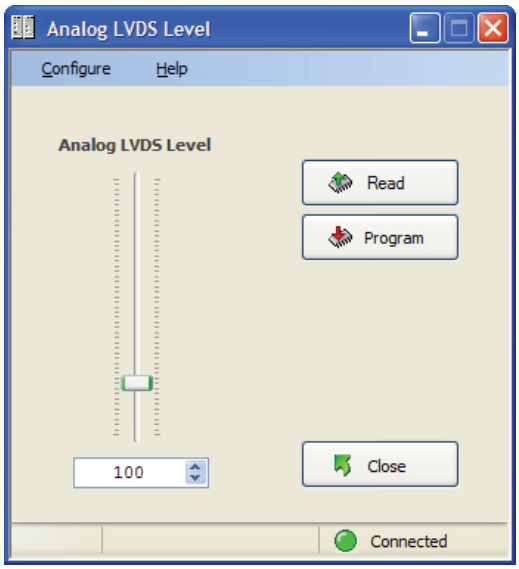


Figure 5-41: RSS Receiver or Transmitter Analog LVDS Level Adjustment

Enter the Repeat Deviation Level reading on the MT-4E Test Sheet.

Duplex Digital Testing

Connect the IFR 2975 and Codan Radio as shown in Figure 5-42.

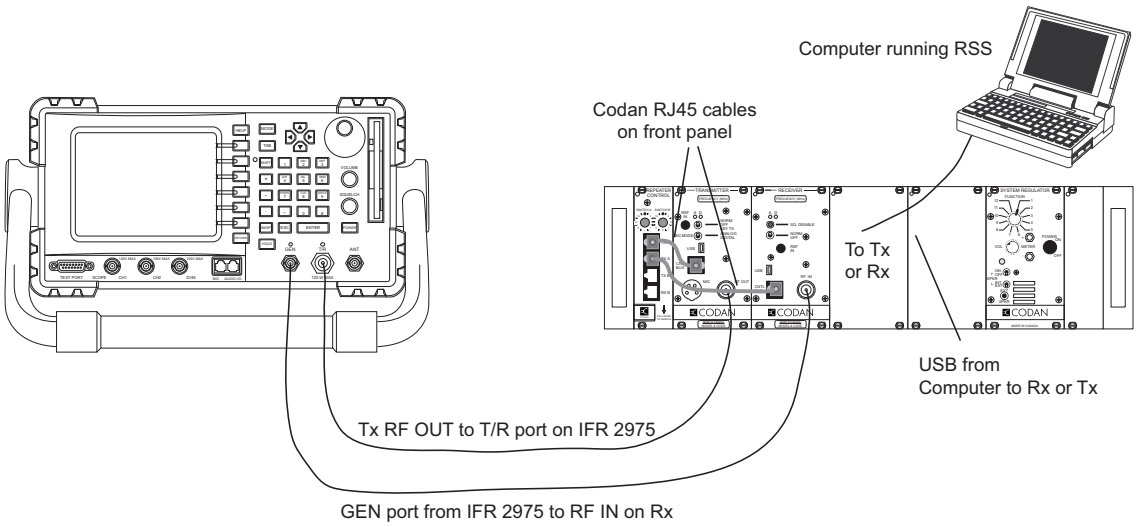


Figure 5-42: System Duplex Digital Testing

On the IFR 2975, recall Codan setup 12 (Dup_Dig) from your internal drive as shown in Figure 5-43. Enter the correct RF frequencies for the receiver and transmitter, select the MOD TYPE to P25 and set it for the SPEECH test pattern (or optionally the 1011 test pattern). Inject the correct NAC (and TGID if programmed) in the DOWNLINK DATA section. Set the receiver and transmitter front panel switch to NORM. The MIC MODE switch on the transmitter front panel can be set to either Digital or Analog (this test does not make use of the front panel switch).

Ensure that the receiver and transmitter are connected to the repeater controller via the RJ45 cables on the front panel. In some systems, the receiver and transmitter may be connected directly together using the RJ45 cables.

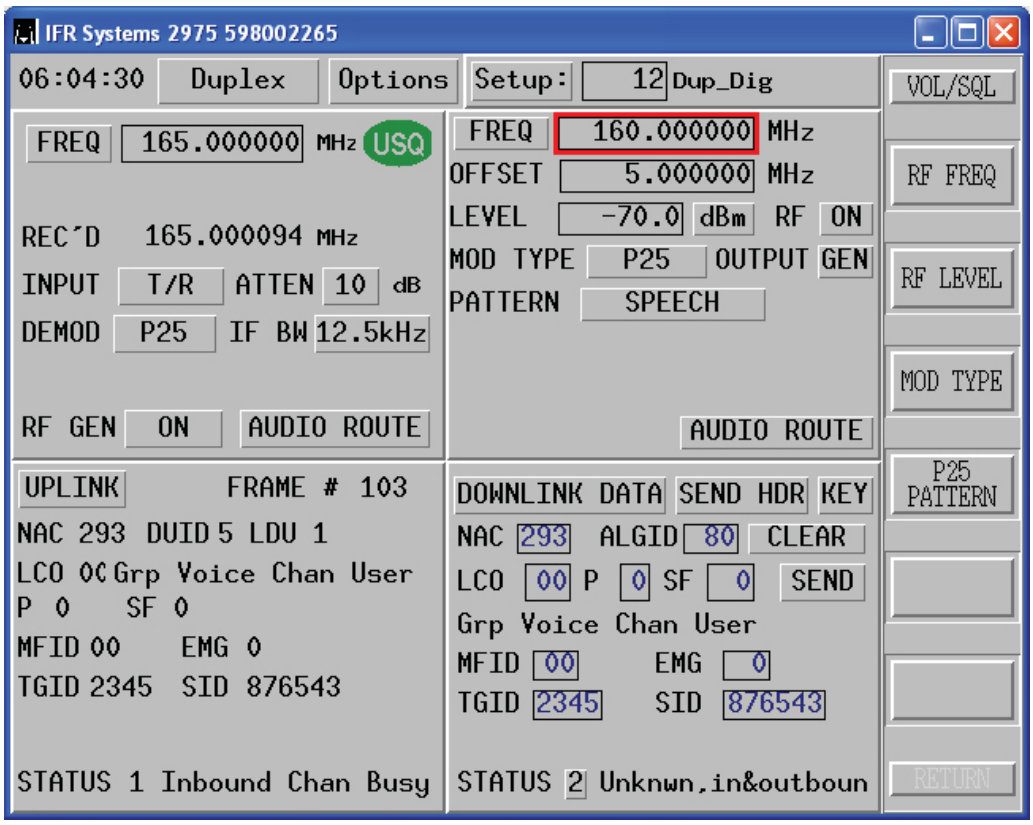


Figure 5-43: System Digital Duplex Check

There are no specific measurements to make on this test, just verify that the system is operating correctly.

NAC:

Check to make sure your receiver unsquelches on the proper NAC. If the NAC is set for $F7F in the receiver, ensure that the system transmits the NAC it receives.

TGID:

Check to make sure your receiver unsquelches on the proper TGID code (if used). Ensure that the system transmits the TGID code it receives.

Unit ID (SID):

Ensure that the system transmits the Unit ID code it receives.

*After changing the TGID or Unit ID the SEND button in the DOWNLINK DATA window must be clicked to send the information.

*The TGID and Unit ID programmed into the transmitter via the RSS are only transmitted when keying the transmitter in a non-repeater mode (see the Transmitter Digital Testing). In repeater mode the system transmits the TGID and Unit ID it receives.

Emergency Bit (EMG):

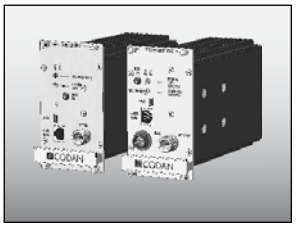
Ensure that the system transmits the Emergency Bit it receives.

Algorithm ID:

The Algorithm ID is typically set for 80 for CLEAR operation.

To ensure encrypted signals will pass through the repeater:

1. Click on the DOWNLINK DATA window to open the full window.
2. Set the ALGID to 81 or select the DES option in the box to the right (this will change the ALGID to 81).
3. Ensure the KEY ID is set to 0000.
4. Click on the UPLINK window to open the full window. In the ES DATA portion of the window the KID will read 0000, the ALGID will read 81, and the MI data will be constantly changing.
5. Check the P25 Digital Repeat Capability Checked box on the MT-4E Test Sheet.



CHAPTER 6: ADDITIONAL RADIO SYSTEM TESTS

A number of additional radio system tests can be performed on the Codan MT-4E radio system at the radio site with the full radio system. In this chapter, testing of the radio system is typically done as an entire system with the antenna and filtering equipment connected.

Filtering equipment is defined as duplexers, multicouplers, combiners, or in some cases, an antenna relay.

RADIO SYSTEM TESTING THROUGH FILTERING EQUIPMENT

The Transmitter RF power output and Receiver sensitivity tests can be performed by injecting and measuring the RF signals through the filtering equipment. Connect the test set to the antenna port of the filtering equipment as shown in Figure 6-1. When testing through this equipment, the test results will be noticeably lower as the filtering equipment typically has 1 to 3 dB of insertion loss associated with it.

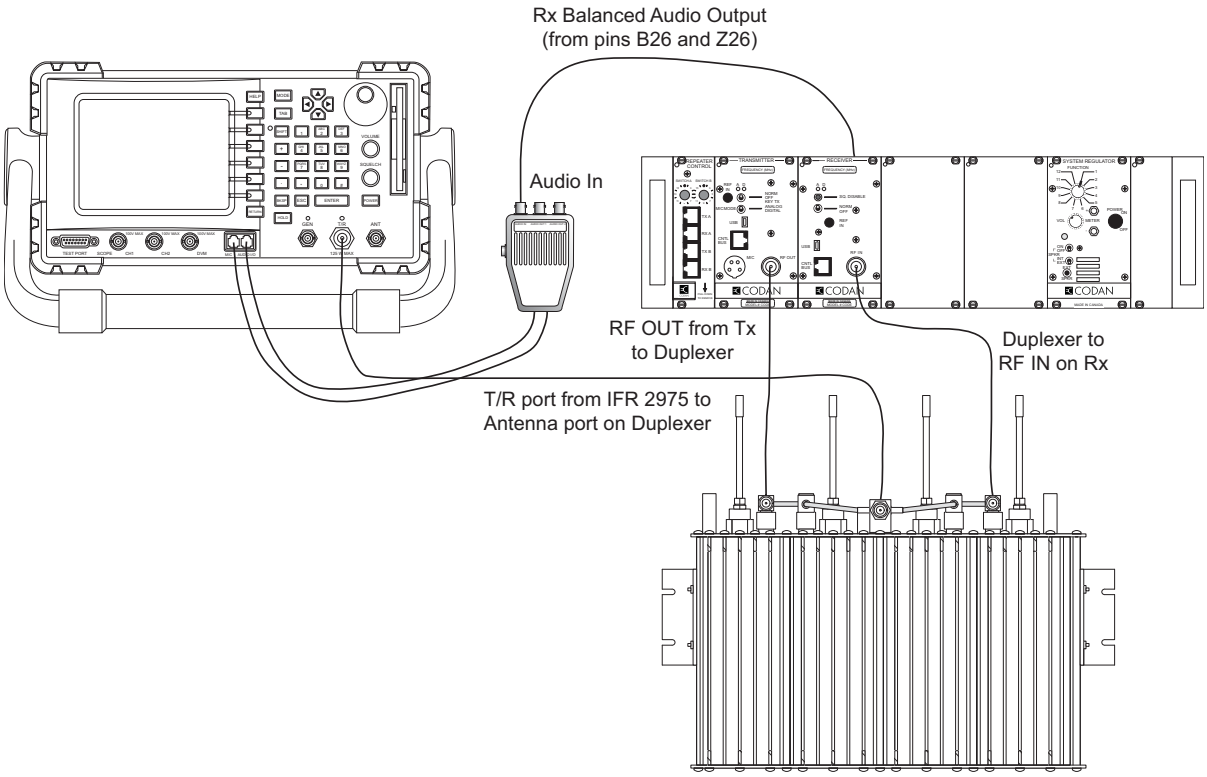


Figure 6-1: Transmitter and Receiver Testing Through Filtering Equipment

RADIO SYSTEM TESTING WITH THE ANTENNA CONNECTED

VSWR

An antenna system VSWR test can be performed by connecting a Wattmeter such as the Bird Model 43 Wattmeter between the antenna port of the filtering equipment and the antenna as shown in Figure 6-2. Measure the forward power and the reflected power using the Wattmeter and calculate the VSWR. The Wattmeter can also be placed between the transmitter and power amplifier or between the transmitter or power amplifier and duplexer to measure the VSWR at these locations.

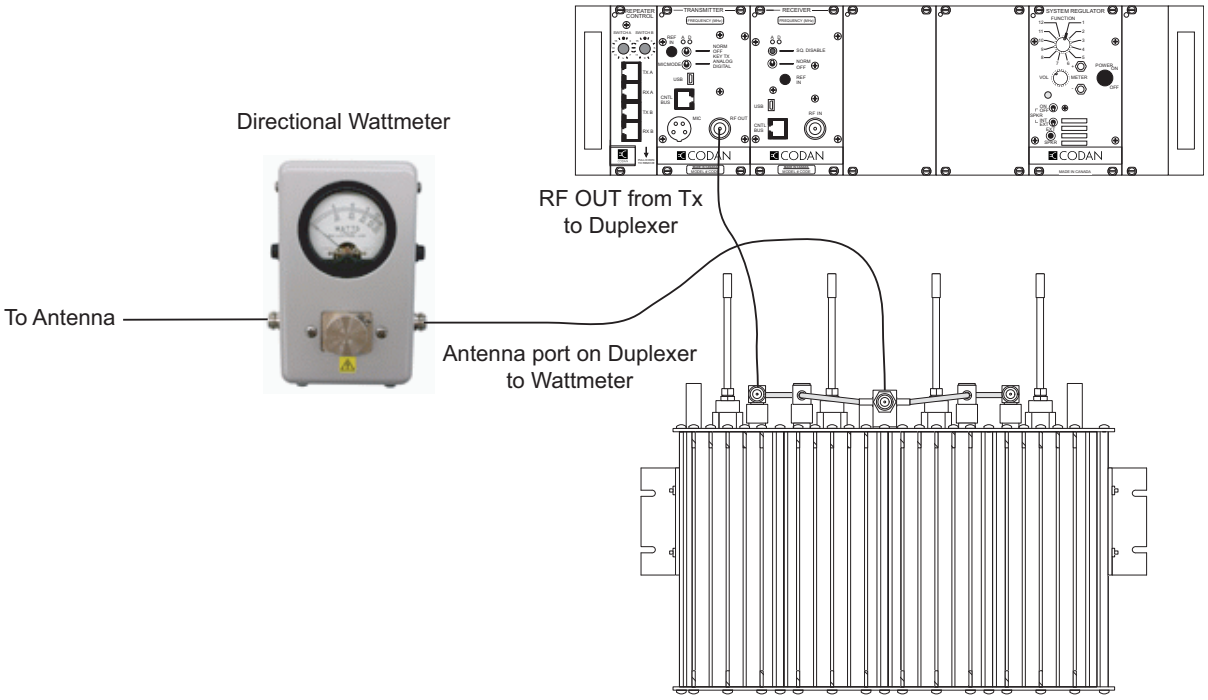


Figure 6-2: Transmitter VSWR Testing

Receiver Desense

A Receiver desense test can be performed by connecting an RF Signal Sampler such as the Bird Model 4275 Variable RF Signal Sampler between the receive port of the filtering equipment and the receiver RF IN as shown in Figure 6-3. Ensure the transmitter is connected to the filtering equipment and the transmitter is turned OFF.

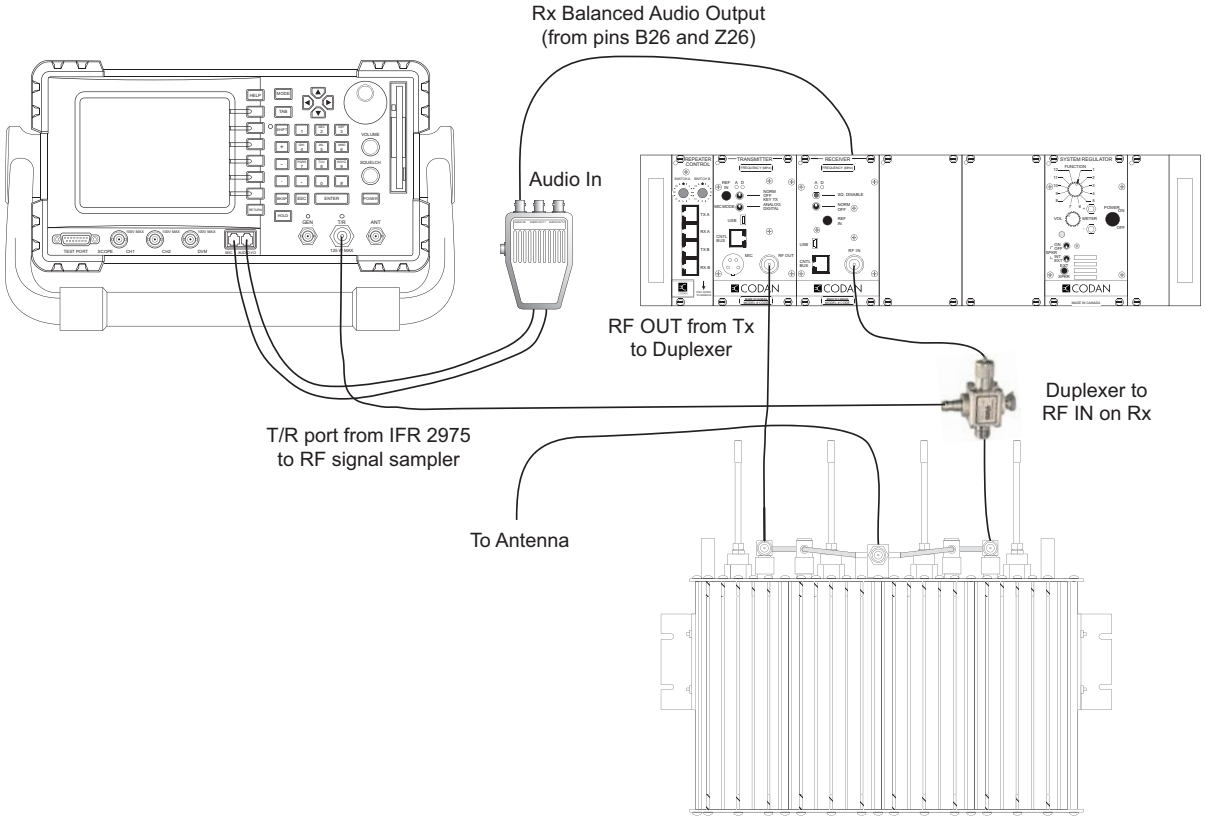


Figure 6-3: Receiver Desense Testing

On the IFR 2975, recall Codan setup 1 (Rx_Ana) from your internal drive. Enter the correct RF frequency, select the MOD TYPE to FM and set it for a 1.0 KHz tone and ensure that the deviation level is set correctly for your receiver (wide / narrow). Enter the CTCSS tone (if used) and deviation level. In the System Setup; Jumper Settings area of the Service section on the RSS ensure that the “Subtones on audio path” selection is set to “Don’t pass”.

Monitor the SINAD meter while slowly reducing the RF carrier level. The RF carrier level can be reduced on the IFR 2975 and also through the variable RF signal sampler. Note the 12 dB SINAD point. Now, turn the transmitter to KEY TX and check the SINAD meter for any noticeable drop in sensitivity. If the sensitivity does drop, increase the RF carrier level on the IFR 2975 until the 12 dB SINAD point is reached. Receiver desense is the difference between this RF carrier level and the RF carrier level noted when the transmitter was OFF. The receiver desense gives a relative idea of the additional isolation required by filtering equipment.

Note: other transmitters located at the site can also cause desense.

RF Carrier Signal Levels on Links between Sites

When linking two radio systems together it is advantageous to test the RF signal strength between the linked sites. A carrier signal level test can be performed by keying up the transmitter that links to the radio site under test and measuring the RF carrier level at the receive antenna. Keying up the transmitter at the other site can be done with a portable radio at your location, or by having someone else key that link with a portable or base station. Measurement of the RF carrier level can be performed by two different methods.

The first method to measure the RF carrier signal level is by connecting a switched RF attenuator between the antenna port of the filtering equipment and the antenna as shown in Figure 6-4. Switch the attenuator just until the receiver squelches and note the amount of attenuation. This is the fade margin of the RF carrier signal on that link.

The second method to measure the RF carrier signal level is to measure the RSSI of the Receiver (either by the voltage output on the System Regulator or the RSSI meter built into the Service section of the RSS). Note the RSSI level, then connect a test set to the antenna port of the filtering equipment and adjust the RF carrier level until the noted RSSI level is achieved. This is the received RF carrier level on that link.

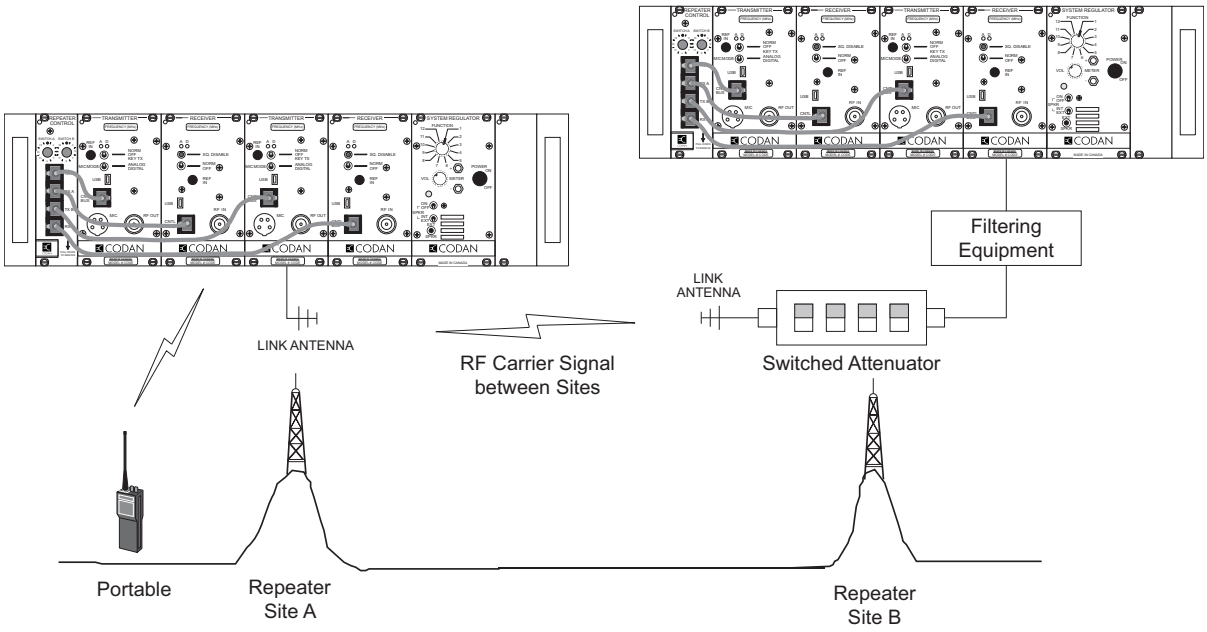


Figure 6-4: RF Carrier Level on Link Test

Spurious Signals over the Air

A spurious signal test can be performed by keying up the transmitter over the air and observing the spectrum using a Spectrum Analyzer with an antenna on the input port as shown in Figure 6-5.

On the Spectrum Analyzer, attenuate the incoming RF signal so that the RF carrier does not extend beyond the range of the display on the Spectrum Analyzer (this will overdrive the receiver of the analyzer causing erroneous spurs to be shown in the spectrum).

Look at the spectrum and ensure there are no large spurs being generated by the radio system.

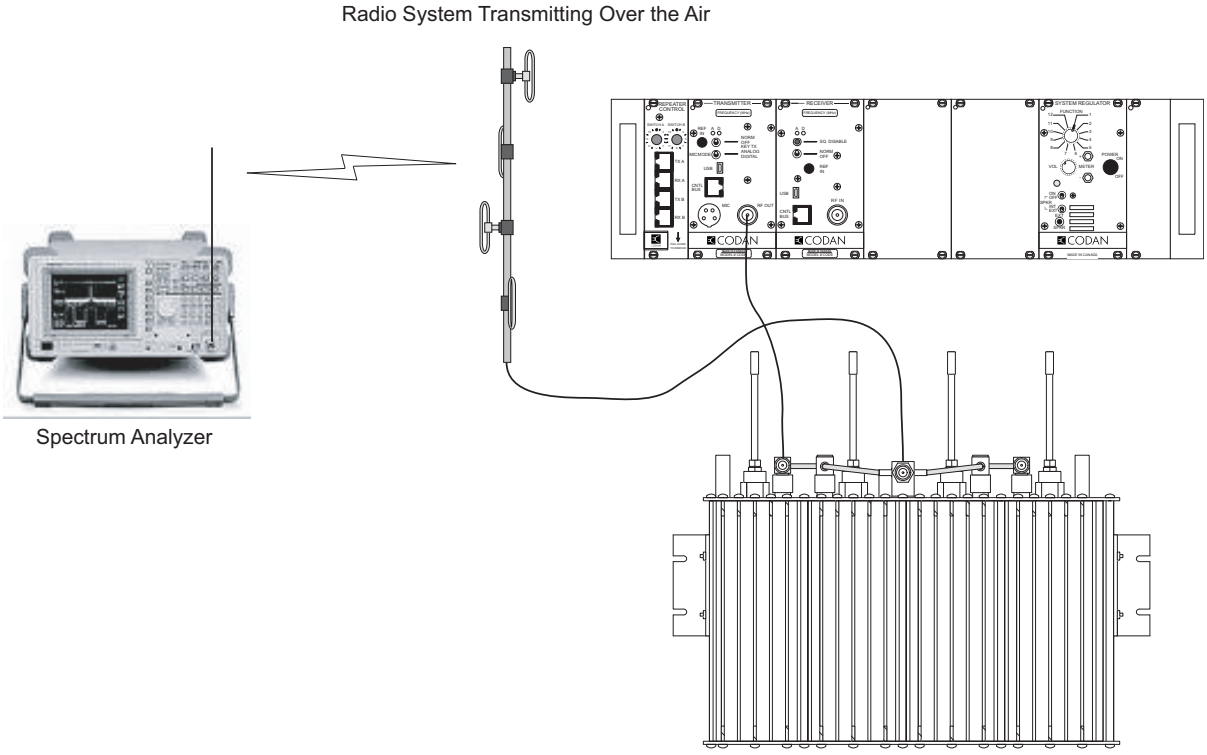


Figure 6-5: Spurious Signals over the Air Test

CODAN
RADIO COMMUNICATIONS

Radio Site Checklist

Date (D/M/Y)	Technician	Radio Site Name

Preparation for a Site Survey

Communications Service Monitor	☐	Paper and pencils	☐
Multimeter	☐	Soldering iron	☐
Spare radio equipment	☐	Portable Radio	☐
Standard tool box	☐	Survival Gear, Food and Drink	☐
Extra RF cabling	☐	Camera	☐
Adapters	☐	Keys	☐
Extender cards	☐	System / Site Documentation	☐
A-TK-04 Tool Kit	☐	Wildlife deterrent	☐

Exterior Site Survey

Building Condition	☐	Site Photographs	☐
Antennas and structure	☐		
RF cables and connectors	☐		
Leased lines and power cables	☐		
Lightning protection	☐		
Obstructions	☐		

Interior Site Survey

Building Condition	☐	Site Photographs	☐
Cabinet / Equipment Rack	☐		
RF cables and connectors	☐		
Duplexers / Combiners / Mutlicouplers	☐		
Leased lines and power cables	☐		
Power supply / batteries / solar panels	☐		

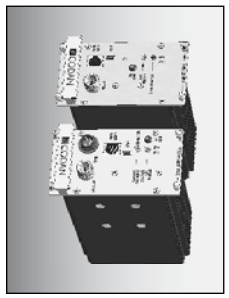
Radio System Testing

Radio system tested	☐	**Radio Site Inventory** Inventory completed	☐

Departure

RF cables / filtering / antennas	☐
Power supply connected and operational	☐
Switches in correct position	☐
RJ45 Interconnect cable plugged in	☐
Lights off / Tower lights on	☐
Radio system check performed	☐
Door is closed and locked	☐

CHAPTER 7: BLANK WORKSHEETS



CODAN
RADIO COMMUNICATIONS

Radio Site Inventory

Date (D/M/Y)	Technician	Radio Site Name

Description	Model Number	Serial Number	Additional Information
Codan Radio System			
Subrack			96 pin Auxiliary Connector on back ___
System Regulator			One Antenna Relay ___ Two Antenna Relays ___
Control Card			CI-RC-4L ___ CI-BC-4E ___ CI-RC-4M ___
Receiver A			VHF ___ UHF ___ Links to: _____
Transmitter A			VHF ___ UHF ___ Links to: _____
Receiver B			VHF ___ UHF ___ Links to: _____
Transmitter B			VHF ___ UHF ___ Links to: _____
30 Watt Power Amplifier			VHF ___ UHF ___ Links to: _____
Power Converter			AC-DC ___ DC-DC ___
Additional Equipment			
Duplexer			VHF ___ UHF ___
Duplexer			VHF ___ UHF ___
Combiner			
Mulitcoupler			
Power Supply			
Cabinet / Rack			
Antenna			VHF ___ UHF ___
Antenna			VHF ___ UHF ___

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RADIO COMMUNICATIONS

MT-4E Radio System Test Sheet

Date (D/M/Y)	Firmware Versions Rx:_____ Tx:_____	Serial Numbers Receiver:_____ Transmitter:_____

Description		Measurement	Parameters
System Regulator Testing			
Supply Voltage		Vdc	+10 Vdc to +17 Vdc (+13.8 Vdc nominal)
+9.5 Volts Regulated		Vdc	+9.5 Vdc (± 0.1 Vdc)
Receiver RSSI @ -100 dBm		Vdc	0 Vdc to +5 Vdc
Receiver Testing			
Audio Distortion (1 KHz Tone @ 60% max dev)		%	≤ 2.0% (VHF & UHF) / ≤ 3.0% (700/800/900 MHz)
Reference Sensitivity (12 dB SINAD)		dBm	≤ -118 dBm (VHF & 420/460) / ≤ -116 dBm (all other)
Squelch Thresholds	Squelch	dBm	No parameter (typically squelch / unsquelch points are centered
	Unsquelch	dBm	around 12 dB SINAD point with 6 dB of hysteresis)
Balanced Audio Output Level		dBm	-8.0 dBm (308 mVrms @ 600 ohms) ± 0.5 dBm
Reference Sensitivity (5% BER)		dBm	≤ -118 dBm (VHF & 420/460) / ≤ -116 dBm (all other)
L.O. Reference Oscillator Offset		Hz	± 1.0 ppm (VHF) / ± 0.5 ppm (UHF) / ± 0.1 ppm (700/800/900 MHz)
Transmitter Testing			
Audio Distortion (1 KHz Tone @ 60% max dev)		%	≤ 3.0%
Transmitter RF Power Output		W	0.5 to 6.0 or 8.0 W (VHF & UHF) / 0.5 to 3.0 W (700/800/900 MHz)
Amplifier RF Power Output		W	No parameter (system dependent)
Deviation Level (-8.0 dBm audio input)		KHz	± 1.5 KHz (12.5 KHz) or ± 3.0 KHz (25 KHz) ± 0.1 KHz
Maximum Deviation (1.3 KHz tone @ +10 dBm)		KHz	≤ 2.5 KHz (12.5 KHz) or ≤ 5.0 KHz (25 KHz)
CTCSS Encode Tone Deviation		Hz	± 350 Hz (12.5 KHz) or ± 500 Hz (25 KHz) ± 50 Hz
C4FM Modulation Fidelity		%	≤ 5.0%
Carrier Reference Oscillator Offset		Hz	± 1.0 ppm (VHF) / ± 0.5 ppm (UHF) / ± 0.1 ppm (700/800/900 MHz)
System Testing			
Standby Current Draw		mA	No parameter (system dependent)
Transmit Current Draw		A	No parameter (system dependent)
Auxiliary Audio Output Level		dBm	0 dBm (775 mVrms @ 600 ohms) ± 0.5 dBm
Auxiliary Deviation Level (0 dBm auxiliary input)		KHz	± 1.5 KHz (12.5 KHz) or ± 3.0 KHz (25 KHz) ± 0.1 KHz
Repeat Deviation Level		KHz	± 1.5 KHz (12.5 KHz) or ± 3.0 KHz (25 KHz) ± 0.1 KHz
System Distortion		%	No parameter (typically ≤ 4.0%)
P25 Digital Repeat Capability Checked			Check mark

* The Parameters as shown are for room temperature (25 °C) testing. Results over the entire temperature range (-30°C to +60°C) may vary.

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