CODAN
RADIO COMMUNICATIONS

MT-4E Analog and P25 Digital Radio Systems

USER GUIDE

www.codanradio.com

Codan MT-4E Analog and P25 Digital Radio Systems

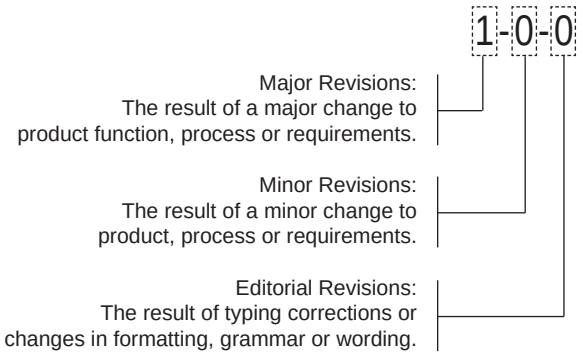
User Guide

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.

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 Maintenance Guide

The MT-4E Maintenance Guide is an aid to configuring and testing Codan MT-4E radios using an IFR 2975 Service Monitor by Aeroflex. The Guide is intended to be used with IFR 2975 Setup files that can be loaded into the Service Monitor.

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

Contents

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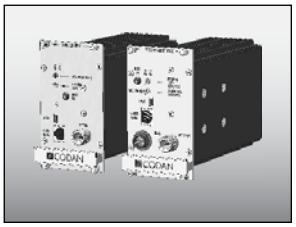

CHAPTER 1: INTRODUCTION

This document is written as an introduction to Codan MT-4E Analog and P25 Digital Radio Systems. The document assumes the reader is familiar with conventional Two-Way Radio Communications systems.

Project 25 is a standards initiative, to be amended, revised and added to as the users identify issues and as experience is gained.

MODEL NUMBERS

Daniels Electronics Ltd. has manufactured radio systems for more than 60 years. In the early years, Daniels manufactured AM and SSB radiotelephones for the marine industry, and more recently, the MT series of radios for mountain top repeaters and base station applications. Codan Radio Communications continues to manufacture the MT series of Land Mobile Radio (LMR) systems.

MT-2

The MT-2 series of radio modules were originally manufactured in the 1980s. This radio series was a crystal controlled analog radio system capable of wideband (25 KHz) operation. Although systems are still in operation throughout North America, this series of radio modules was discontinued in the 1990s and is no longer supported.

MT-3

The MT-3 series of radio modules were originally manufactured in the early 1990s. This radio series was available with both crystal controlled and synthesized analog radio modules capable of wideband (25 KHz) or narrowband (12.5 KHz) operation. The MT-3 radio modules were discontinued in 2006, with the exception of the VHF Lowband and AM products. For more information on the MT-3 series of radios, see the Codan MT-3 Analog Radio Systems User Guide.

MT-4

The MT-4 series of radio modules entered production during 2001. This radio series is the P25 compliant digital narrowband radio system, capable of analog (wideband and narrowband) or P25 digital operation.

As the MT-4 P25 products evolved, the hardware, firmware and software of the radio modules changed. In order to define these changes, the MT-4 product line is further described as:

MT-4R

The MT-4R series of P25 radios were manufactured from 2001 until the end of 2003.

MT-4D

The MT-4D series of P25 radios were manufactured from 2003 until the middle of 2006.

MT-4E

The MT-4E series are the current line of Analog and P25 modules.

ANALOG ONLY OR ANALOG / P25 DIGITAL FIRMWARE

The MT-4E radio modules are embedded with firmware that allows analog operation only. When the P25 firmware upgrade is purchased, the MT-4E family of receivers and transmitters may be configured for P25 digital operation, analog operation, or mixed mode operation.

All P25 digital information contained in this User Guide require the P25 firmware upgrade to function.

The P25 firmware upgrade can be purchased from the factory when ordering, or can be easily added in the future by the customer.

IDENTIFYING MT-4E MODEL NUMBERS

The model number of the MT-4E Receiver or Transmitter can be found on the bottom of the front panel of the receiver or transmitter module as shown in Figure 1-1. Figure 1-2 and 1-3 show the breakdown of the receiver and transmitter model numbers.

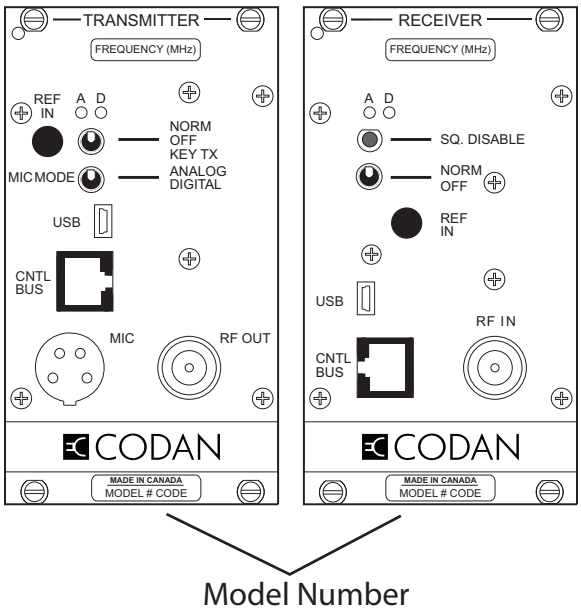

Figure 1-1: Model Number Location

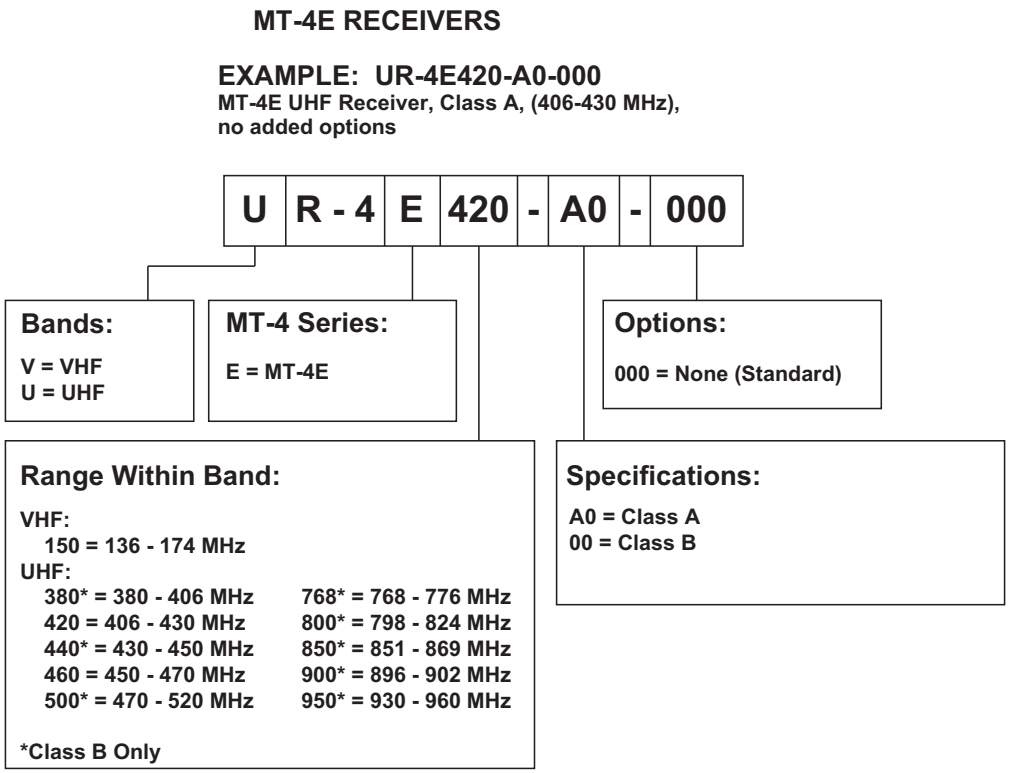

Figure 1-2: Receiver Model Numbers

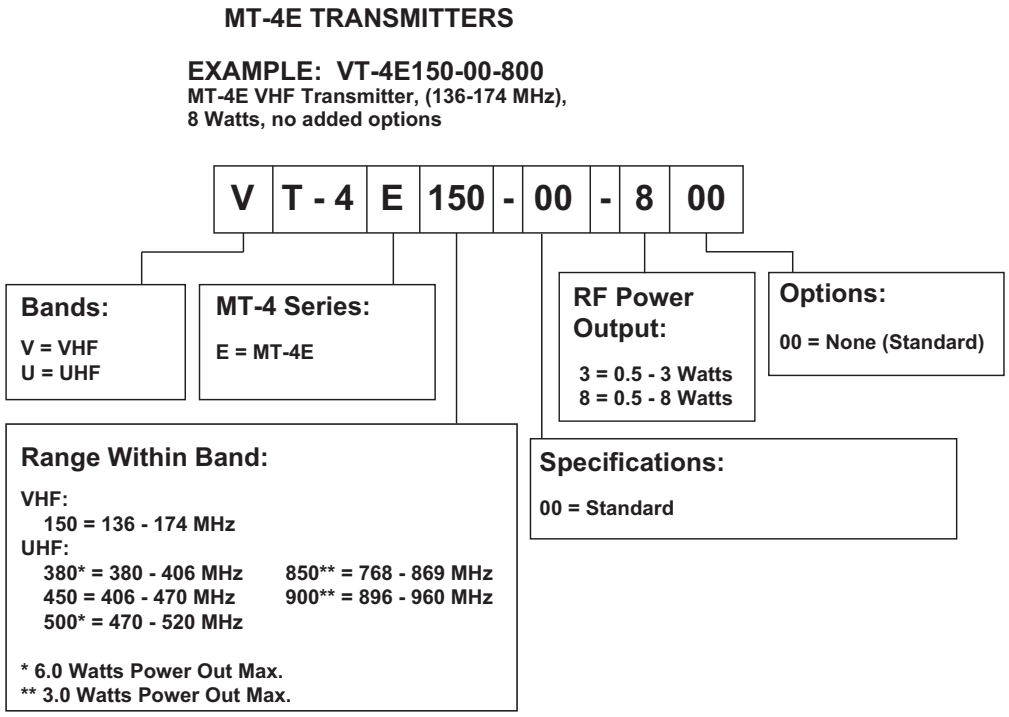

Figure 1-3: Transmitter Model Numbers

HARDWARE, FIRMWARE AND SOFTWARE DEFINITIONS

Hardware

The hardware is the radio module itself. The MT-4E Receiver module hardware is comprised of the Receiver Mainboard, the Synthesizer Module, the RF Preselector, and the Universal Daughter Board (UDB). An optional Decryption Board can be installed in the Receiver. The MT-4E Transmitter module hardware is comprised of the Transmitter Mainboard, the Synthesizer Module, RF Power Amplifier and Universal Daughter Board (UDB). An optional Encryption Board can also be installed in the Transmitter.

Firmware

The firmware is the programming that is contained within the radio module. The firmware resides within the DSP (located on the UDB) and is programmed at the factory. The RSS programming software can read the firmware version number of MT-4E modules.

Software

The Radio Service Software or RSS is used to program features and options. The RSS programs RF frequencies, modes of operation (analog, digital or mixed mode), CTCSS, NACs, etc. The RSS connects to a radio module using a type A to 5 pin mini-type B USB cable. USB drivers are installed from the RSS CD the first time a Receiver or Transmitter is connected.

AVAILABLE FREQUENCY BANDS

The MT-4E modules are available in the VHF (136 - 174 MHz) and UHF (380 - 520 MHz, 768 - 869 MHz and 896 - 960 MHz) frequency bands.

The 470 - 520 MHz band is not available in Canada.

The 380 - 406 MHz, 430 - 450 MHz, 470 - 520 MHz, 768 - 776 MHz, 798 - 824 MHz, 851 - 869 MHz, 896 - 902 MHz and 930 - 960 MHz Receivers are available in Class B only.

The 380 - 406 MHz and 470 - 520 MHz Transmitters have an RF power output of 0.5 to 6.0 Watts maximum. The 768 - 869 MHz and 896 - 960 MHz Transmitters have an RF power output of 0.5 to 3.0 Watts maximum.

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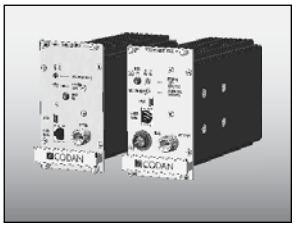

CHAPTER 2: TECHNICAL INFORMATION

FRONT PANEL RJ45 CONNECTOR JACK

Codan MT-4E Radio Equipment uses RJ45 jacks on the Receiver, Transmitter and controller cards. The jacks are used to connect the Receiver to the controller and the controller to the Transmitter through RJ45 interconnection cables. The interconnection cables carry Low Voltage Differential Signaling (LVDS) serial data as well as analog and digital COR and PTT signals. The RJ45 interconnection cables are specific to Codan Radio Communications equipment. Do not use Ethernet or other manufacturers cables.

The jacks are also used to connect to a Motorola® KVL 3000, KVL 3000 PLUS or KVL 4000 key loader, which loads encryption keys in the Receiver and Transmitter encryption modules. This connection uses a custom Codan cable from the key loader to the receiver and transmitter modules.

LVDS SERIAL DATA

Codan MT-4E radio modules use Low Voltage Differential Signaling (LVDS) serial data to communicate between receiver, controller and transmitter modules.

A conventional analog repeater uses analog audio to communicate between the different modules. Codan MT-4E radio systems use serial data between modules to allow for a completely transparent digital path between the modules. This means that all digital information is passed through the repeater system quickly and completely intact.

When an MT-4E Receiver receives a P25 digital transmission, the receiver samples the incoming information and then creates an LVDS serial data stream (of 257.8 kbps) that contains the same information as the Common Air Interface (with some overhead data). When an MT-4E Receiver receives an analog transmission, the receiver samples the incoming information and then creates a serial data stream (of 257.8 kbps) of the analog information. The incoming frequency and deviation is converted to serial data through an A/D converter. The MT-4E Transmitter uses this information to recreate the P25 digital or analog transmission.

ENCRYPTION

The MT-4E Receiver and Transmitter may be purchased with optional DES-OFB / AES encryption modules installed that will allow decoding and encoding of secure communications. The encryption modules are required at a base station only, and are not required to repeat an encrypted signal.

CHANNEL SWITCHING RANGE

Although the receiver or transmitter channels can be programmed for any frequency in their band, the Maximum Switching Range of the module must not be exceeded or the module will require hardware re-tuning. The maximum switching range of the Receiver modules is +/- 2 MHz (136 - 520 MHz) or Unlimited (768 - 960 MHz), and the Transmitter modules are Unlimited, unless the VSWR Alarm is used (+/- 0.5 MHz for VSWR Alarm). For example, a VHF receiver may be programmed for any frequency between 136 to 174 MHz, but the front end helical filter has a typical pass band of 5 MHz, requiring re-tuning if two frequencies are used that are outside of that pass band.

MIXED MODE OPERATION

Mixed mode operation is used to allow the receivers and transmitters to work in either analog or P25 digital mode without reprogramming the radio.

A mixed mode receiver will receive the incoming FM or C4FM transmission and will automatically detect and demodulate the signal to an analog or P25 digital signal. The receiver will then output either an analog or digital COR signal, as well as the appropriate serial data. A mixed mode transmitter will accept the incoming serial data and analog or digital PTT and will modulate the signal as either FM or C4FM, based on its input. This allows the repeater to repeat both analog and P25 digital signals.

UPGRADING FIRMWARE VERSIONS

Codan Radio Communications allows customers to upgrade the firmware of their MT-4E Receivers and Transmitters via the Firmware Flashing Software and Firmware Upgrade files, available at the Codan website www.codanradio.com under Support - Software & Firmware.

A type A to 5 pin mini-type B USB cable is used to connect the USB port of an IBM compatible computer to the USB port on the front panel of the Receiver or Transmitter module.

It is not necessary to upgrade the firmware if the equipment is installed and is operating satisfactory. A firmware upgrade is typically only needed to fix minor software bugs or to upgrade the functionality of the equipment.

Firmware versions earlier than 1.6.0 must be returned to the factory for upgrading. Contact the Codan service department for more information.

Table 2-1 shows the firmware versions for MT-4E modules.

Table 2-1: Firmware Versions

MT-4E Receiver

Version	Description / Notes
1.0.173	Initial product release
1.0.189	Minor factory bug fixes
1.0.204	Minor factory bug fixes
1.0.230	Minor factory bug fixes
1.0.257	Minor factory bug fixes
1.3.0	Fix audio / muting and P25 data issues
1.4.0	Receive TSBK data packets
1.5.0	Fix lock up issues
1.6.0	Improved CTCSS decoding
1.7.0	Added encryption capability for add-on encryption
2.0.0	Blank firmware - used during firmware upgrading
2.1.0	Added customer firmware flashing capability
2.1.1	Minor factory bug fixes
2.2.2	Added 800 MHz and improved CTCSS / DCS and squelch (do not use with status tone)
2.2.9	Fixed status tone issues and updated encryption capabilities
2.4.2	Enhanced RSSI, BER test, Status tone Supports FIPS certified encryption (non-FIPS not supported)
2.6.9	Enhanced synthesizer diagnostics
2.7.5	Supports new hardware in receiver
2.7.49	Improved diagnostics, digital adjacent channel rejection, DCS Added MPT1327 Trunking capability
2.7.50	Improved DCS decoding

MT-4E Transmitter

Version	Description / Notes
1.0.273	Initial product release
1.0.294	Minor factory bug fixes
1.0.335	Minor factory bug fixes
1.0.350	Minor factory bug fixes
1.3.0	Subtone input capability with LVDS Serial Data repeating
1.4.0	Transmit TSBK data packets
1.6.0	Remove noise at end of transmission
1.7.0	Added encryption capability for add-on encryption
2.0.0	Blank firmware - used during firmware upgrading
2.1.0	Added customer firmware flashing capability
2.2.2	Added 800 MHz and paging
2.2.7	Updated encryption capabilities
2.4.9	Lower standby current, added Status Symbol options Supports FIPS certified encryption (non-FIPS not supported)
2.6.7	Enhanced synthesizer diagnostics
2.7.8	Supports new hardware in transmitter
2.7.52	Improved diagnostics
2.9.11	FCC Part 90.203 compliance

REPEATING DIGITAL SIGNALS

A P25 digital signal is received and retransmitted by the repeater completely intact. The digital codes such as TGID, Source ID, Destination ID, Algorithm ID, Key ID, etc. all pass transparently through the repeater system.

The TGID and Unit ID programmed into the transmitter are normally overwritten with the incoming TGID and Source ID when the transmitter is used in a repeater. The TGID and Unit ID are only transmitted when the transmitter is keyed in a non-repeater mode (no input from the receiver) or in a repeating mode using the analog audio repeat path (where all digital information is stripped off from the receiver). A non-repeater mode would include keying by the front panel microphone or base station keying (eg. from a tone remote).

The Network Access Code (NAC) does not normally pass transparently through the repeater. NACs are similar to analog CTCSS tones. The NAC is typically programmed into the receiver and transmitter independently, allowing the user to program different receive and transmit NACs. To pass the NAC through the repeater transparently, program the receiver with the special NAC $F7F. This will allow any incoming NAC to unsquelch the receiver and will overwrite the NAC programmed into the transmitter with the incoming NAC, allowing transparent operation.

Status Symbols are not passed through the repeater transparently. Status Symbols are changed by the repeater to indicate inbound channel status (busy). In Base Station mode the Status Symbols are set to show unknown status of the inbound channel. Status Symbols are not programmable.

Talk Groups are typically used in subscriber units, but a repeater could also be programmed as part of a Talk Group. The receiver can be programmed to unsquelch on a specific NAC and TGID.

NOTE: If the receiver is programmed for use in a Talk Group, the NAC of that receiver must not be set to $F7E or $F7F, as the NAC unsquelch will take precedence over the TGID and the receiver will unsquelch on any incoming NAC (ignoring the TGID programmed setting).

Encrypted (AES or DES-OFB) voice signals will pass transparently through the repeater.

Packet Data Units (confirmed or unconfirmed data messages) such as Over The Air Rekeying (for encrypted systems) and GPS position information will pass transparently through the repeater.

For a more detailed explanation of the P25 protocol, signaling and terminology, please see the Codan P25 Training Guide.

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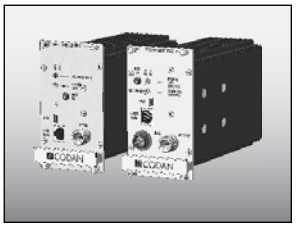


CHAPTER 3: MT-4E RADIO SYSTEM CONFIGURATIONS

REPEATER OPERATION

The MT-4E modules may be configured to operate as a repeater, a repeater with a link, a cross-band system or two independent repeaters using the **CI-RC-4L** repeater control card. The repeater system can be set for analog only, P25 digital only, or mixed mode operation. In mixed mode, the receiver determines the incoming signal (analog or digital) and transmits the same signal.

The receiver and transmitter modules connect to the CI-RC-4L repeater controller through RJ45 cables as shown in Figure 3-1.

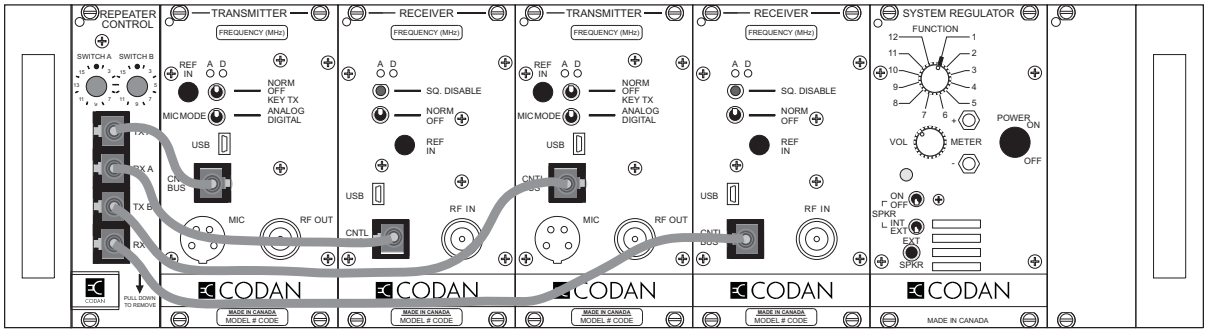


Figure 3-1: MT-4E Repeater System shown with two pairs of transceivers

The repeater controller is hardware jumpered to control the interconnection between the modules. This allows the user to select the operation of this system (single repeater, dual repeater, repeater with link, cross-band system, etc.) by setting jumpers. Receiver priority and simplex operation can also be jumpered for certain configurations.

The RJ45 cables carry the signals from the receiver, through the controller to the transmitter(s). The signals on the RJ45 cables are analog COR/PTT, digital COR/PTT and LVDS serial data. The LVDS serial data is the digitized analog or P25 digital information that is passed through the repeater.

COMPLEX REPEATER OPERATION

The MT-4E modules may be configured to operate in complex repeater configurations of up to four sets of transceivers using the CI-RC-4M-G2 multiple link controller.

The receiver and transmitter modules connect to the **CI-RC-4M-G2** repeater controller through RJ45 cables connected to the front panel of the transmitter and receiver modules. The CI-RC-4M-G2 repeater controller is a 1RU height controller that is installed separately from the radio subrack as shown in Figure 3-2.

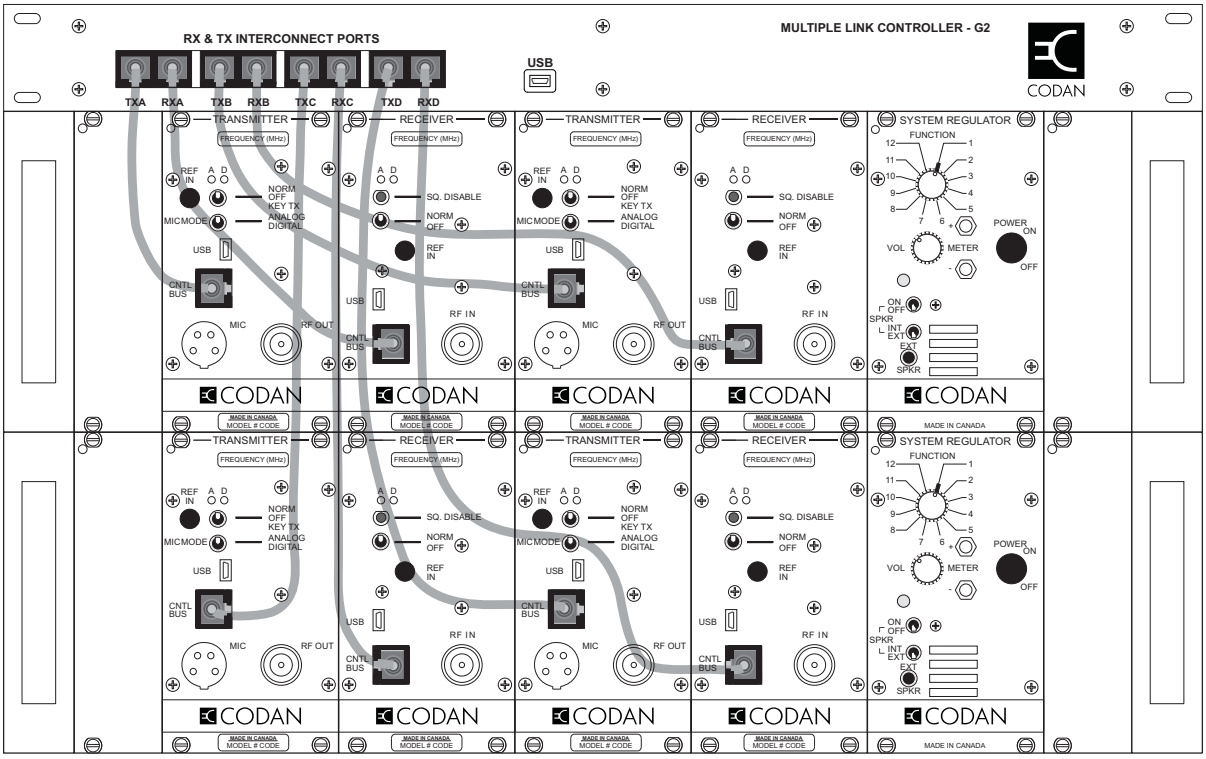


Figure 3-2: MT-4E Repeater System shown with four pairs of transceivers

The CI-RC-4M-G2 repeater controller is software programmable to allow flexible programming options for the radio system. The CI-RC-4M-G2 controller provides the following features:

- interconnection of up to four receiver and four transmitter modules in any configuration (repeater, repeater with links, cross-band systems, etc.).
- multiple CTCSS tones and NACs may be selected to operate each connection between receivers and transmitters (up to seven CTCSS/NAC for each link).
- DTMF control of receiver to transmitter links.
- setting of receiver priorities.
- transmitter channel switching based on received CTCSS or NAC.
- auxiliary E&M connection.
- two independent general purpose outputs that can be controlled by NAC, CTCSS or DTMF (open collector 750 mA / 30 Vdc max).

REPEATER OPERATION WITH EXTERNAL ANALOG WIRELINE CONTROL

The MT-4E modules have a 600 ohm balanced input / output for use with analog audio. The receiver modules also have a parallel analog audio output that is used to drive the speaker built in to the System Regulator module. To connect the analog audio from the receiver / transmitter modules to an external device (such as a tone remote adapter), the analog audio is routed through a **CI-BC-4E** base controller.

The RJ45 cables are connected directly from the receiver to the transmitter for the repeat path, and all external analog audio, COR and PTT routing is through the base controller auxiliary inputs and outputs. Figure 3-3 shows an MT-4E repeater system configured for wireline control.

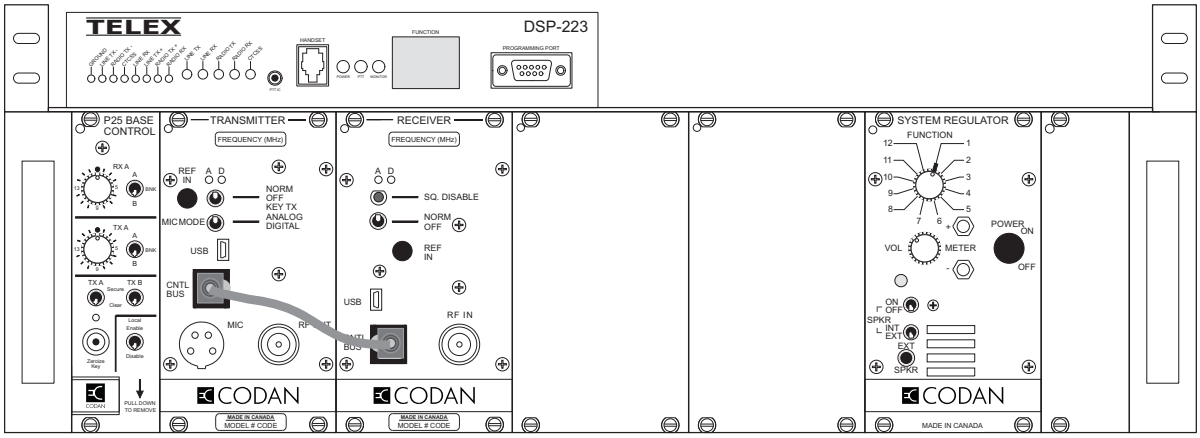


Figure 3-3: MT-4E Repeater System with Wireline Control

The Telex DSP-223 tone-remote adapter provides the means of remotely controlling Codan base stations and repeaters. The adapters can be used in conjunction with tone-remote control consoles which use the industry-standard sequential tone keying format. The DSP-223 adapters are interconnected to the distant remote control console(s) by any analog voice grade transmission medium such as a microwave link, a leased telephone line, or a twisted-pair 600-ohm line.

Alternate Configuration (Using Analog Audio)

Optionally, the user could set the repeat path through the base controller, and disconnect the RJ45 cable repeat path. The repeat path through the controller uses analog audio (not serial data as the RJ45 cables use). The analog audio repeat path is slower than the RJ45 path, and does not pass digital information (such as NAC, TGID, encryption and data packets) through the repeater.

ANALOG CONTROLLED BASE STATION OPERATION

The MT-4E modules operate in P25 clear mode or analog mode and may have optional DES-OFB / AES encryption modules installed in the receiver and transmitter to operate in P25 encrypted mode. The MT-4E modules are used with a **CI-BC-4E** base controller in order to properly connect the analog audio from the receiver / transmitter modules to an external device (such as a tone remote adapter). The base controller also has the ability to clear the encryption keys in the receiver and transmitter through a “Zeroize Key” button on the front of the base controller. No other module has the capability to zeroize encryption keys. Figure 3-4 shows an MT-4E analog controlled base station with a tone remote adapter.

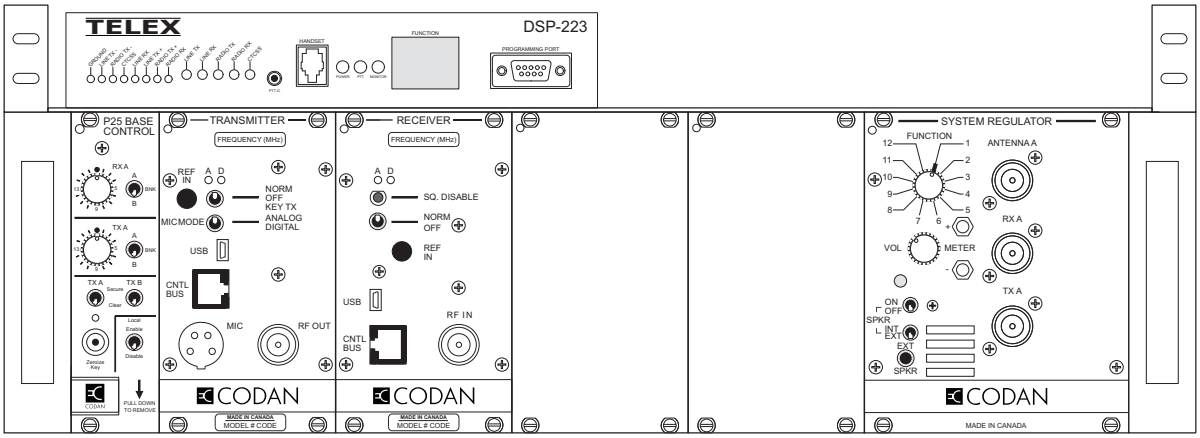


Figure 3-4: MT-4E Analog Controlled Base Station

The MT-4E modules used in a base station configuration may also be configured as a P25 clear mode / analog mode base station with repeat capability. See Repeater Operation with External Analog Wireline Control section for more information.

An analog controlled base station is compliant with the P25 Analog Fixed Station Interface (AFSI).

PAGING SYSTEM OPERATION

The MT-4E modules may be configured to operate in digital and/or analog paging configurations, such as base station paging, remote paging or simulcast paging using the **CI-PM-3** paging modulator. The CI-PM-3 is configured via the front panel switches and internal jumper settings.

The CI-PM-3 paging modulator supports both analog and digital paging formats, and can transmit POCSAG and other 2-level modulation schemes at transfer rates of 512, 1200 and 2400 baud. It can also be configured for use as a data repeater, whereby 2-level paging data is recovered, re-shaped and then re-transmitted to an additional repeater/paging transmitter.

The CI-PM-3 supports 4-level modulation formats at data transfer rates up to 6400 bps. Each of the four modulation deviation levels can be independently set, making the CI-PM-3 suitable for use in such pager signaling schemes as Motorola's FLEX™ paging protocol.

The receiver, transmitter and CI-PM-3 paging modulator are shown in Figure 3-5.

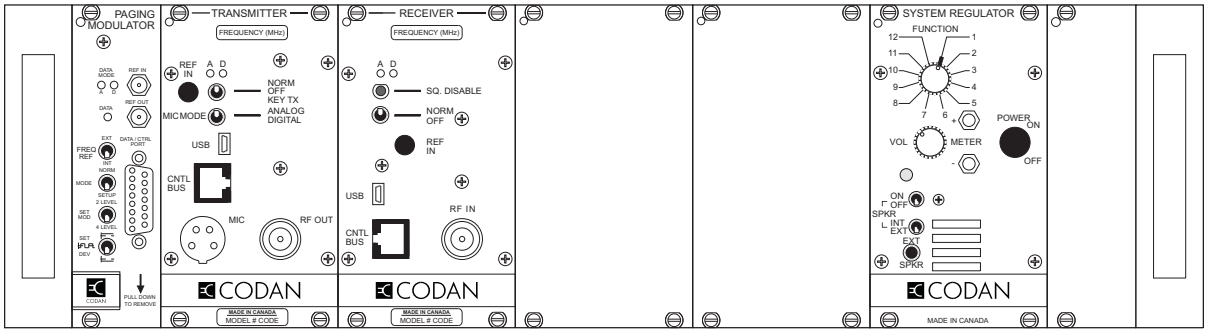


Figure 3-5: MT-4E Analog / Digital Paging System shown with one pair of transceivers

The CI-PM-3 uses an on-board frequency reference source consisting of a 10 MHz OCXO with a frequency stability of +/- 0.35 ppm from -30 C to +60 C. For high stability applications (such as Simulcast), the CI-PM-3 paging modulator may be configured to use an external high stability reference source (i.e. rubidium, GPS or WWV) with a standard stability greater than or equal to 0.002 ppm, to discipline the on-board phase-locked loop OCXO oscillator.

The CI-PM-3 has a current draw of less than 250 mA.

DIGITAL ETHERNET BASE STATION OPERATION

The MT-4E modules may be configured to operate as a digital Ethernet controlled base station using the **UIC-4-00** Universal Interface Card (UIC). The UIC supports the DFSI as published in the P25 standard document TIA-102.BAHA. The UIC provides a fully end-to-end digital link between consoles and subscriber units and supports analog-mode calls as well as P25 calls. The UIC transports digital P25 audio data packets (IMBE™) between the console and the transmitter and receiver radio modules without any conversion to or from baseband audio. This Ethernet interface allows digital signals (such as NAC, TGID, Source ID) to be passed through the network to and from web based applications and digital consoles. Figure 3-6 shows the UIC card used in the fixed station Ethernet interface system.

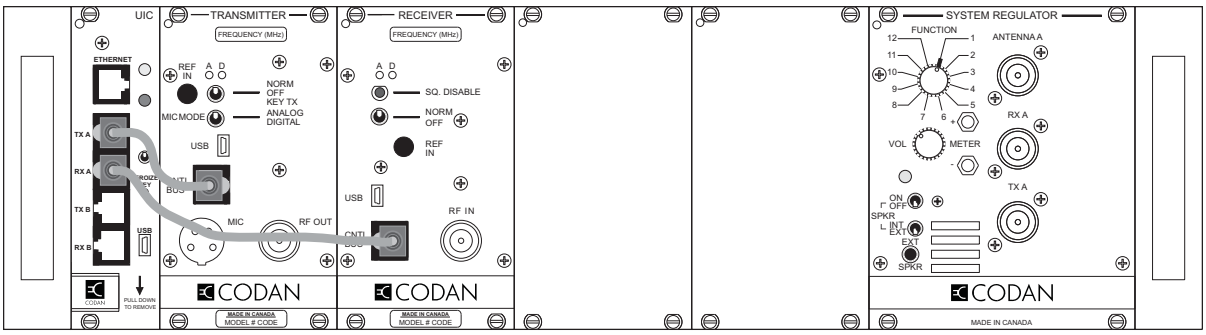
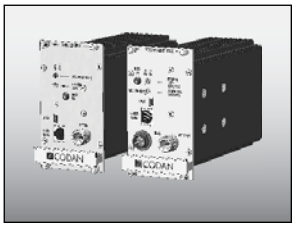


Figure 3-6: MT-4E Digital Ethernet Base Station

The UIC uses Codan LVDS serial data to transport digital information between the UIC and the receiver and transmitter modules. This preserves a fully end-to-end digital link, including audio encryption. Analog voice is carried via the DFSI as digitized u-law pulse-code modulation (PCM) audio data.

The UIC supports all of the following features:

- Audio Reception and Transmission using IMBE™ (P25) or u-law PCM (analog).
- Passes all received P25 data to the console (NAC, TGID, MFID, ALGID, KID, etc.).
- Full end-to-end digital encryption if supported by the console and subscribers.
- Outbound audio buffering when transmitting P25 mode calls, with a programmable buffer length.
- Channel and Bank control of receiver and transmitter modules (2 banks of 16 channels each).
- Detect the mode (analog or P25) of an inbound call on the receiver and report to the console.
- Receiver squelch selection (muted or unsquelched) controlled by the console.
- Monitors the states of the transmitter's forward and reverse alarm signals and report to the console.
- Clear the encryption keys from all encryption-equipped radio modules through the UIC's front panel Zeroize Key push button or from the console.
- Control and monitoring of 8 digital general purpose input and output (GPIO) signals from the console. The 4 inputs are 10 mA max., 0 to +1 Vdc low / +2 to +13.8 Vdc high. The 4 outputs are 20 mA max., 0 Vdc low / +5 Vdc high.
- Control and monitoring of 8 analog GPIOs for use with external equipment. The 4 inputs are 0 to +3.3 Vdc, 3 kΩ impedance. The 4 outputs are 20 mA max., 0 to +3.3 Vdc.
- Monitoring power supply voltage levels and reporting to the console.
- Programmable simplex mode operation.
- Local repeating under the control of the console, or automatically when the UIC is not connected to a console.
- Current draw of 128 mA maximum.



CHAPTER 4: MT-4E RADIO SYSTEM BLOCK DIAGRAMS

This chapter contains sample block diagrams of P25 mixed mode repeater and base station systems. These blocks are shown to give a basic understanding of the signal flow through a Codan repeater or base station. Although mixed mode systems are shown, analog only or P25 digital only can be programmed in the receiver or transmitter.

REPEATER BLOCK DIAGRAM

Figure 4-1 shows a block diagram of an MT-4E mixed mode repeater system using a CI-RC-4L or CI-RC-4M-G2 repeater controller.

The incoming FM or C4FM transmission is routed through the RF Preselector where the RF signal:
• is filtered with a high selectivity multiple pole, helical resonator or ceramic filter
• is amplified through a low noise amplifier
• is filtered again by a low pass, high pass or band pass filter
• is mixed, with a local oscillator supplied by the synthesizer
• produces an IF frequency of 21.4 MHz (136 - 520 MHz) or 73.35 MHz (768 - 960 MHz) that is output to the Receiver Mainboard.

The Receiver Mainboard processes the low level 21.4 MHz or 73.35 MHz IF signal from the RF Preselector through selective crystal filtering and IF amplification. The signal is then passed through the IQ Demodulator and Digitizing Stage for demodulation to two quadrature-related baseband outputs.

These outputs are represented in a digital stream which is passed to the UDB Board, where DSP techniques are used to further process the incoming sampled signal to detect and extract P25 digital voice signals and analog voice signals and is then routed through either the analog or P25 digital settings programmed into the receiver.

Analog signal settings include:
• CTCSS or DCS decoding
• de-emphasis or flat audio selection
• wide or narrowband selection

P25 digital settings include NAC and/or TGID decoding.

The digitally sampled analog or P25 digital signal is then split and routed out of the receiver as both LVDS serial data out the front panel and analog audio out the subrack / motherboard. If a P25 digital signal is sent out as analog audio, the signal must first be de-vocoded before it can be converted to analog audio. An analog or digital COR signal is also routed out the front panel.

The analog and digital COR signals and LVDS serial data are then routed through the repeater controller (CI-RC-4L Repeater Controller or CI-RC-4M-G2 Multiple Link Controller) and are sent to the transmitter as analog and digital PTT signals and LVDS serial data.

The transmitter will accept the incoming LVDS serial data and route it through the analog or P25 digital settings programmed into the transmitter. Analog signal settings include:
• CTCSS or DCS encoding
• pre-emphasis or flat audio selection
• wide or narrowband selection

P25 digital settings include NAC encoding (unless the receiver is set to a NAC of $F7F to pass the NAC through the repeater).

The digitally sampled analog or P25 digital signal is then converted back to a baseband signal and is then modulated as either an FM or C4FM transmission based on the analog or digital PTT input. The modulated carrier is then amplified by the RF Power Amplifier sub-module.

The analog audio input to the transmitter is not used in a repeater configuration.

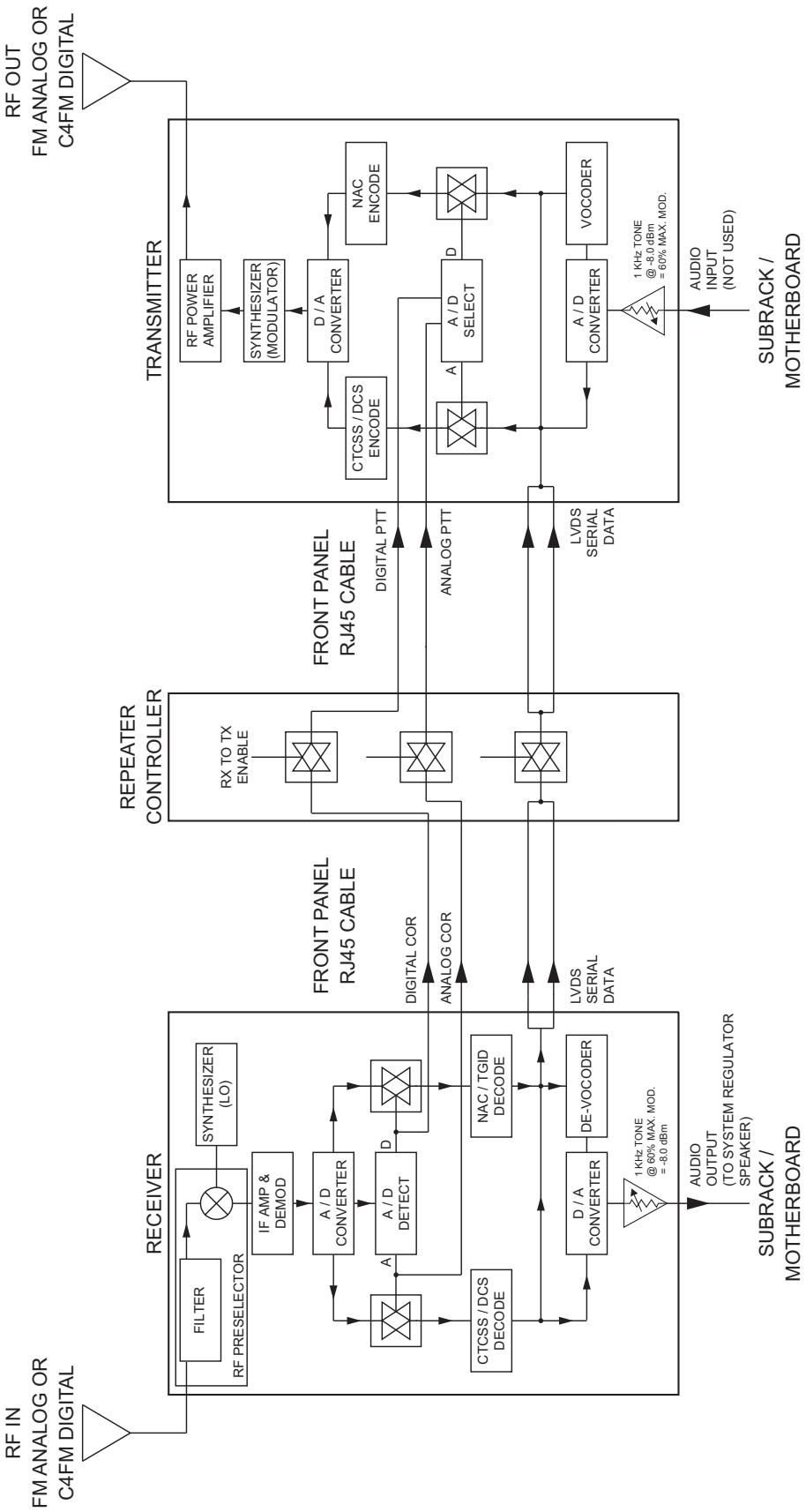


Figure 4-1: MT-4E Repeater Block Diagram

BASE STATION BLOCK DIAGRAM

Figure 4-2 shows a block diagram of an MT-4E analog controlled base station system using a CI-BC-4E base controller.

The incoming FM or C4FM transmission is routed through the RF Preselector where the RF signal:
• is filtered with a high selectivity multiple pole, helical resonator or ceramic filter
• is amplified through a low noise amplifier
• is filtered again by a low pass, high pass or band pass filter
• is mixed, with a local oscillator supplied by the synthesizer
• produces an IF frequency of 21.4 MHz (136 - 520 MHz) or 73.35 MHz (768 - 960 MHz) that is output to the Receiver Mainboard.

The Receiver Mainboard processes the low level 21.4 MHz or 73.35 MHz IF signal from the RF Preselector through selective crystal filtering and IF amplification. The signal is then passed through the IQ Demodulator and Digitizing Stage for demodulation to two quadrature-related baseband outputs.

These outputs are represented in a digital stream which is passed to the UDB Board, where DSP techniques are used to further process the incoming sampled signal to detect and extract P25 digital voice signals and analog voice signals and is then routed through either the analog or P25 digital settings programmed into the receiver.

Analog signal settings include:
• CTCSS or DCS decoding
• de-emphasis or flat audio selection
• wide or narrowband selection

P25 digital settings include NAC and/or TGID decoding.

The digitally sampled signal is then converted back to baseband and then routed out of the receiver as analog audio out the subrack / motherboard to the base controller. If a P25 digital signal is sent out as baseband analog audio, the signal must first be de-vocoded before it can be converted to baseband analog audio. MT-4E receivers may have an optional AES / DES-OFB decryptor module.

The analog audio is then routed through the base controller (CI-BC-4E Base Controller) and is sent to the auxiliary audio output for connection to an external device such as a tone remote adapter. The auxiliary audio input from the external device is routed through the base controller and is sent to the transmitter. Internal audio levels between the receiver, base controller and transmitter are typically set at -8.0 dBm for 60% of maximum modulation. Independent audio level controls in the base controller allow the auxiliary input and output levels to be adjusted separately (default is 0 dBm for 60% maximum modulation). For external control, the CI-BC-4E also has optically isolated COR and PTT inputs and outputs for connecting external equipment with high voltage control signals such as E&M.

The transmitter will accept the incoming analog audio, convert it to a digitally sampled signal, and then route it through the analog or P25 digital settings programmed into the transmitter. Analog signal settings include:
• CTCSS or DCS encoding
• pre-emphasis or flat audio selection
• wide or narrowband selection

P25 digital settings include NAC, TGID and Unit / Source ID encoding. MT-4E transmitters may have an optional AES / DES-OFB encryptor module. The signal is then converted back to a baseband signal and is then modulated as either an FM or C4FM transmission based on the analog or digital software settings, or the front panel switch. The modulated carrier is then amplified by the RF Power Amplifier sub-module.

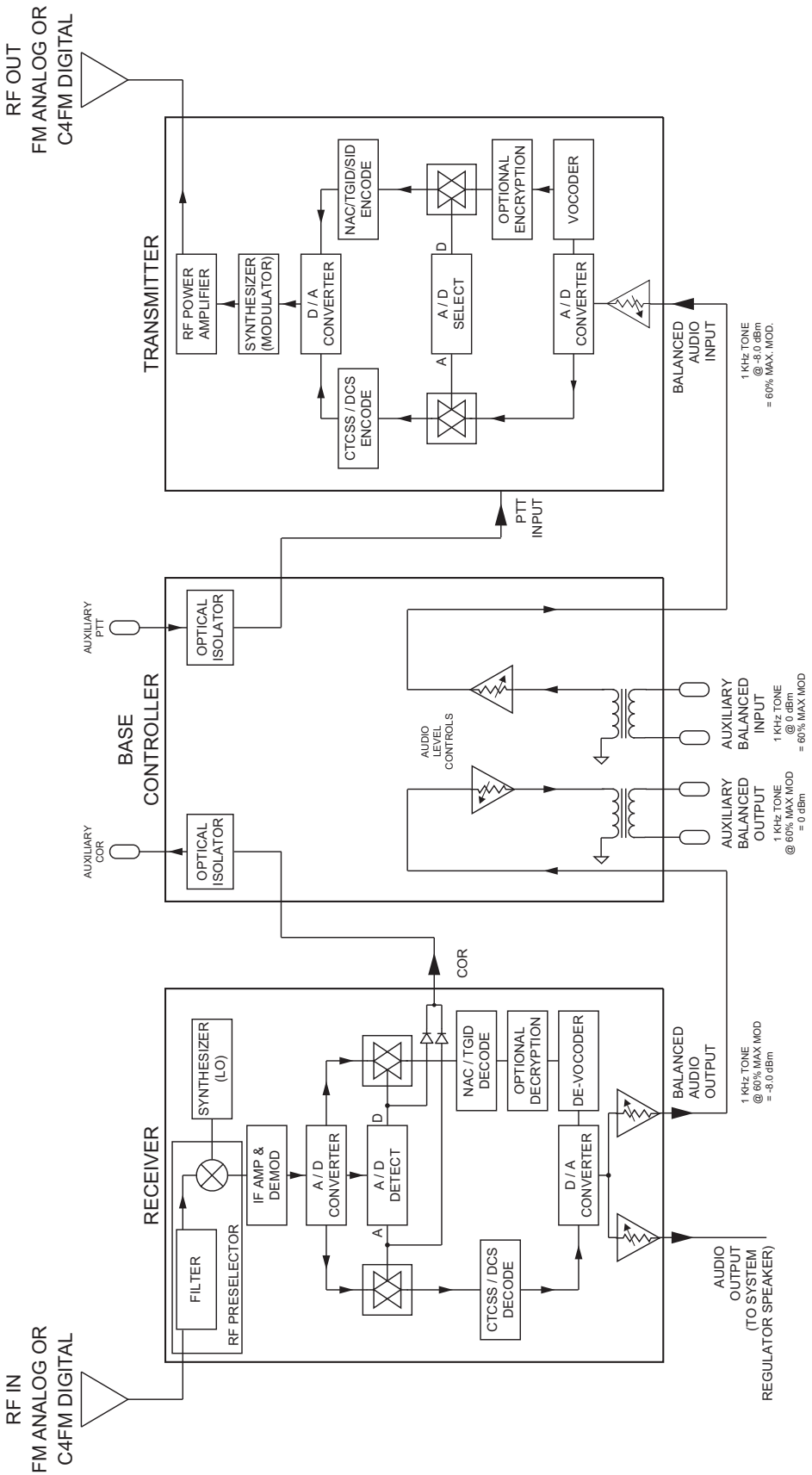


Figure 4-2: MT-4E Base Station Block Diagram

PAGING TRANSMITTER BLOCK DIAGRAM

Figure 4-3 shows a block diagram of an MT-4E digital or analog paging transmitter using a CI-PM-3 Paging Modulator Card.

The paging encoder can be connected to the CI-PM-3 through auxiliary connections on the subrack / motherboard or through a front panel DB-15 located on the front panel of the paging modulator card.

The analog / digital select control line of the paging encoder is fed to the transmitter and is used to control the signal path in the transmitter.

Analog audio is fed directly through the paging card to the balanced audio input of the transmitter.

The incoming paging data from the paging encoder is connected to the appropriate 2 or 4 level input. These signals are fed to control circuits that will turn on or off the appropriate pre-set control voltages, which are then routed to the modulation input of a high stability reference oscillator (OCXO). The modulated 10 MHz signal is fed to the reference in put of the transmitter's synthesizer. A component of the digital page is also sent to the modulation input of the transmitter synthesizer through the direct modulation input of the transmitter.

If the system requires a great amount of frequency stability, as required in simulcast transmissions, an external high stability reference can be connected to the external reference input of the paging card. The reference signal in combination with the paging cards phase lock loop (PLL) circuit will condition the OCXO to +/-0.002ppm.

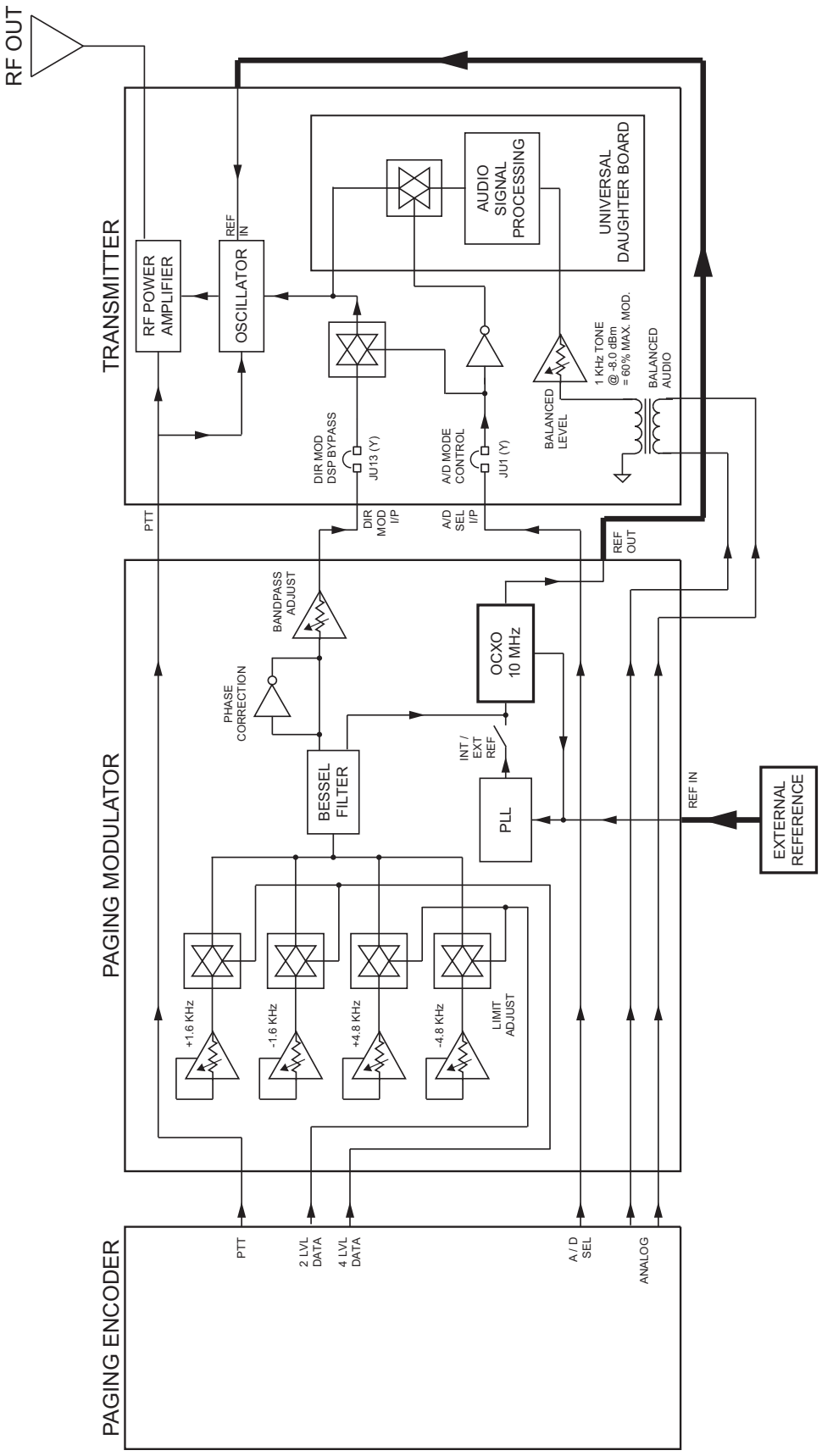


Figure 4-3: MT-4E Paging Transmitter Block Diagram

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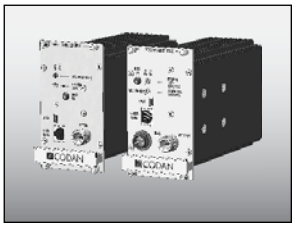


CHAPTER 5: SOFTWARE

CONNECTING THE PC TO THE RADIO

The RSS programming software will run on a PC with Windows 98, 2000, XP, Vista and 7 (32 or 64 bit) operating systems. A type A to 5 pin mini-type B USB cable is used to connect the USB port of the computer to the USB port on the front panel of the Receiver or Transmitter module as shown in Figure 5-1.

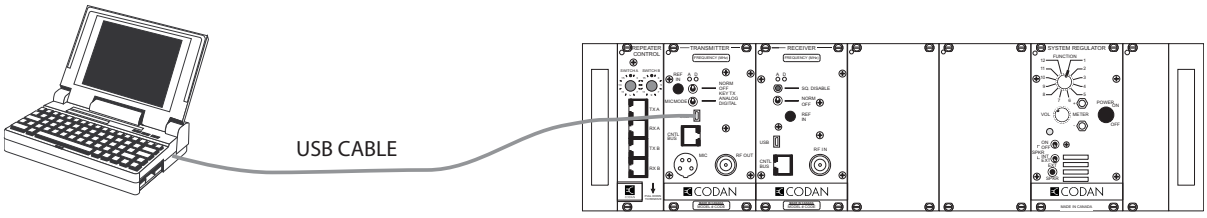


Figure 5-1: PC to Radio RSS software connection

STARTING THE RADIO SERVICE SOFTWARE

The opening screen is shown in Figure 5-2.

Figure 5-2: RSS Program Example

RSS Version Number

The Version number of the RSS can be found by clicking on Help > About from the main title screen. See Figure 5-3.

Figure 5-3 RSS Version Number Example

Newer versions of the RSS can be downloaded directly from Codan website. To determine if an upgrade is available, click on Help > Check for upgrades in the main title screen. You will be automatically redirected to the Codan website location for RSS.

RECEIVER AND TRANSMITTER PROGRAMMING

The RSS programs the Receiver and Transmitter modules independently. The programming cable must be connected to the module being programmed. See Figure 5-1.

The MT-4E Receiver programming screen is shown in Figure 5-4.

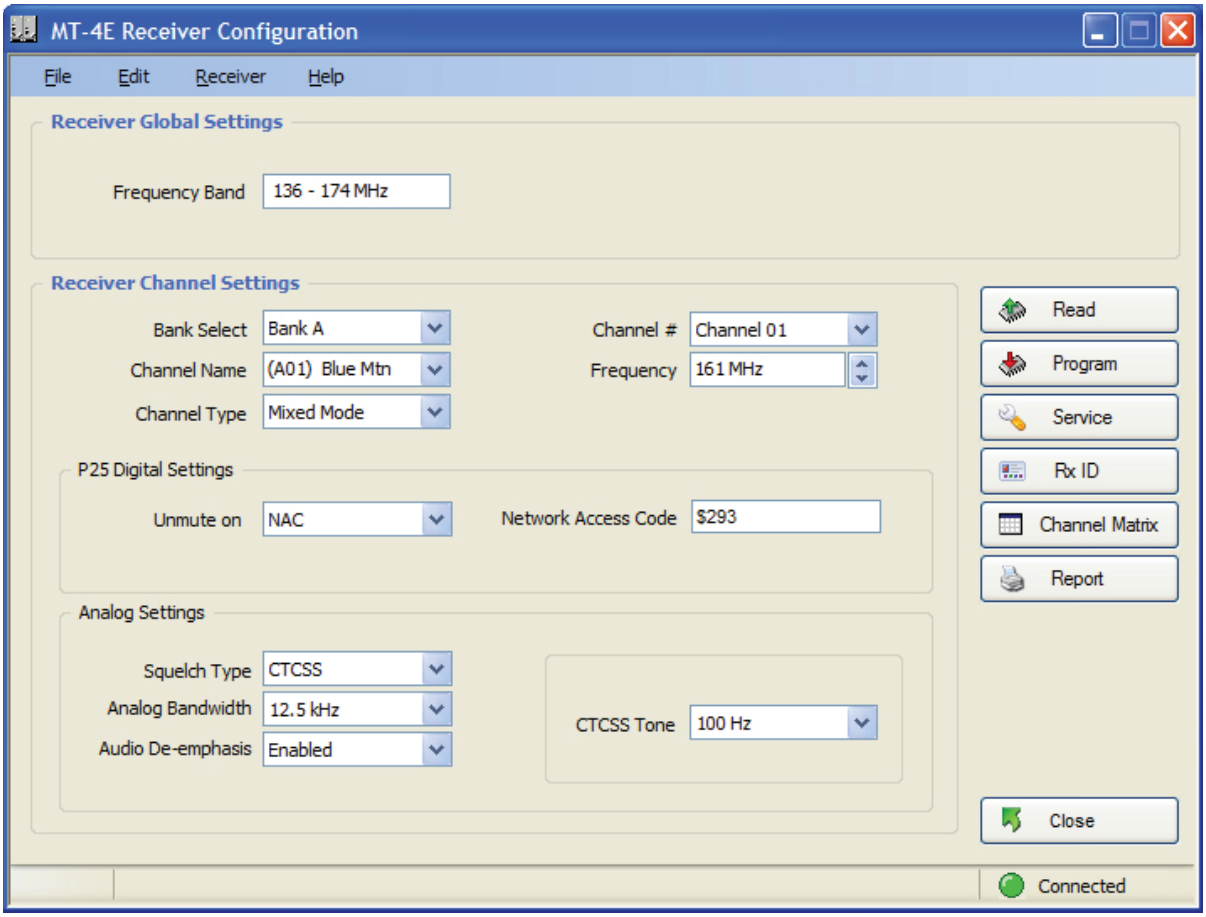


Figure 5-4: MT-4E Receiver Program Example

The MT-4E Transmitter programming screen is shown in Figure 5-5.

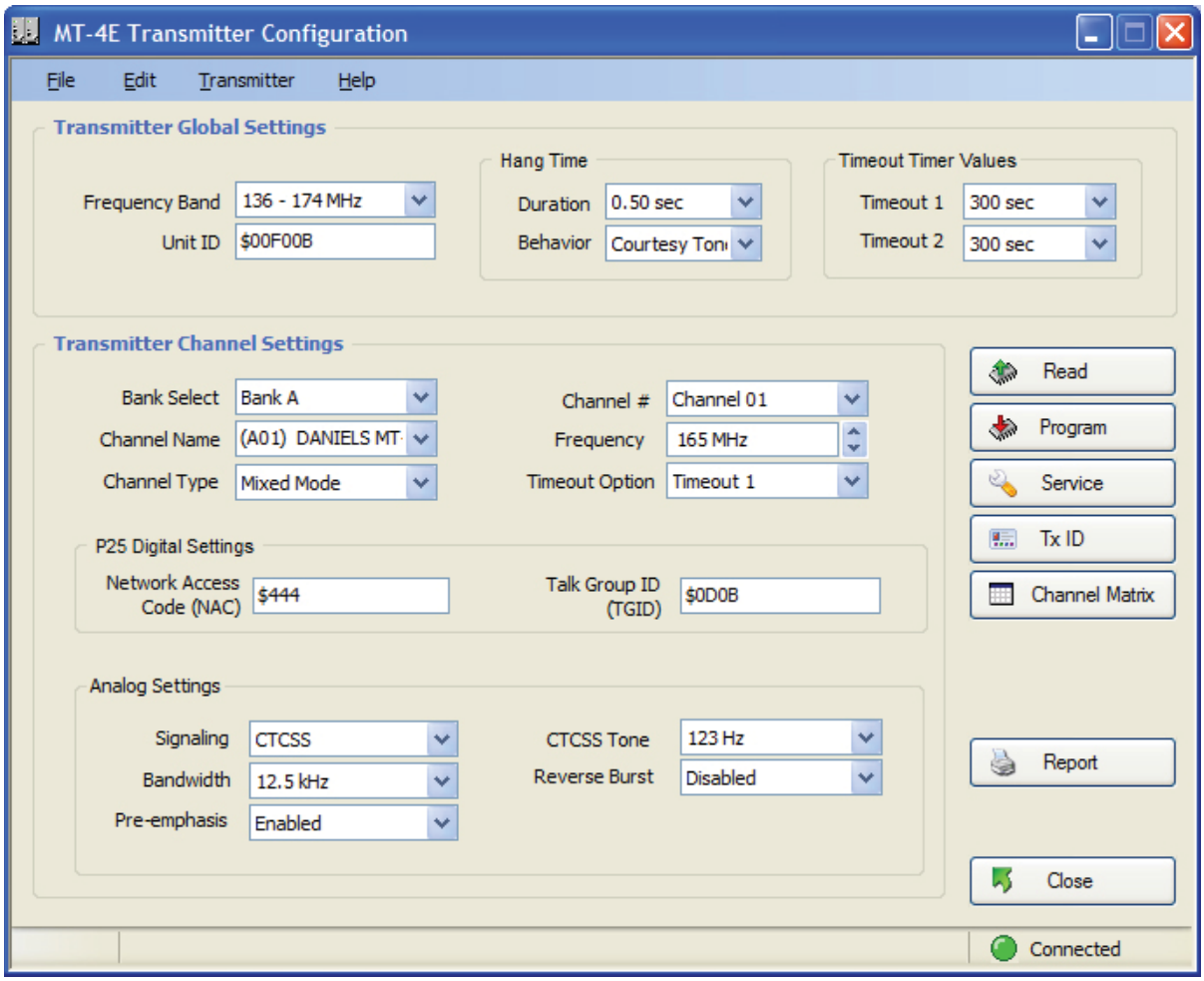
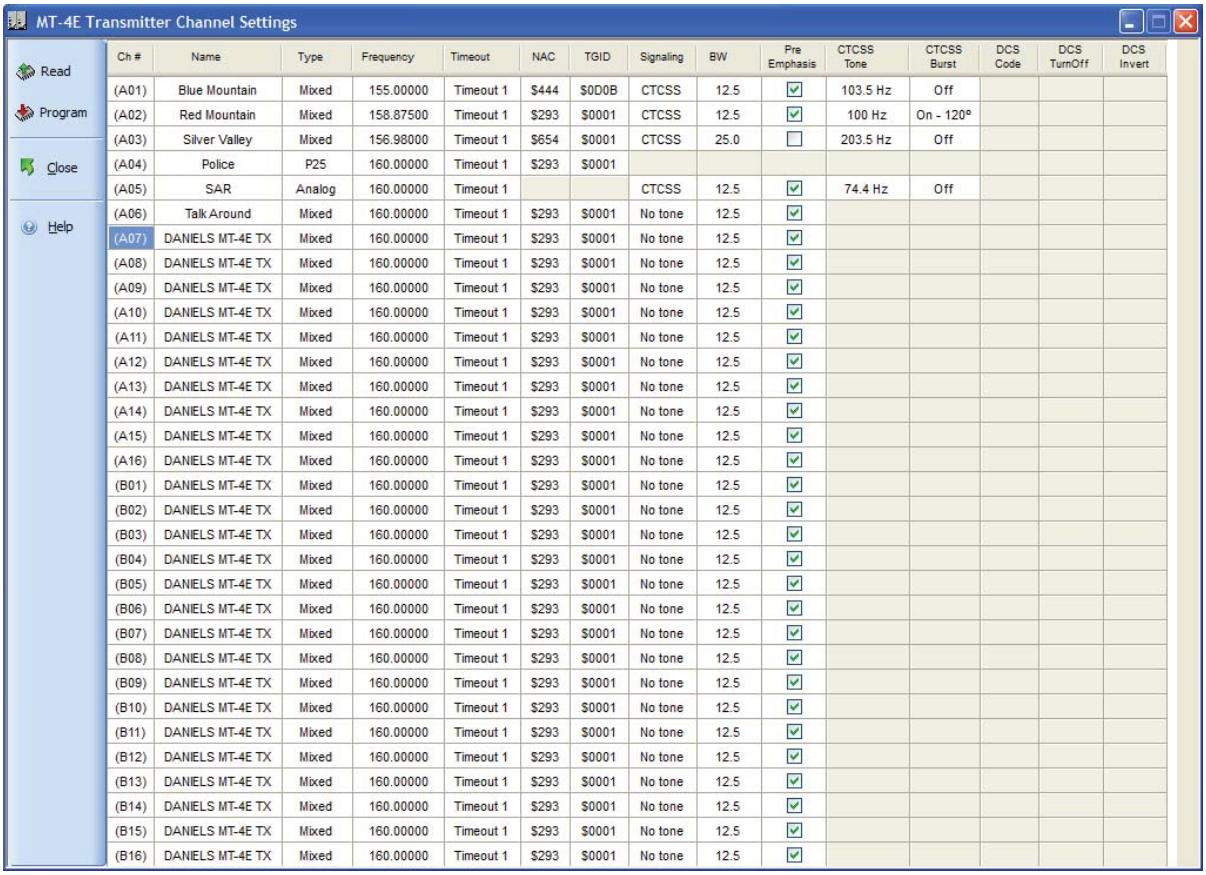


Figure 5-5: MT-4E Transmitter Program Example

A Channel Matrix screen can be opened to view and program frequencies, tones, codes, etc in one window.

The Transmitter Channel Matrix screen is shown in Figure 5-6.



Ch #	Name	Type	Frequency	Timeout	NAC	TGID	Signaling	BW	Pre Emphasis	CTCSS Tone	CTCSS Burst	DCS Code	DCS TurnOff	DCS Invert
(A01)	Blue Mountain	Mixed	155.00000	Timeout 1	$444	$0D0B	CTCSS	12.5	☑	103.5 Hz	Off			
(A02)	Red Mountain	Mixed	158.87500	Timeout 1	$293	$0001	CTCSS	12.5	☑	100 Hz	On - 120°			
(A03)	Silver Valley	Mixed	156.98000	Timeout 1	$654	$0001	CTCSS	25.0	☐	203.5 Hz	Off			
(A04)	Police	P25	160.00000	Timeout 1	$293	$0001								
(A05)	SAR	Analog	160.00000	Timeout 1			CTCSS	12.5	☑	74.4 Hz	Off			
(A06)	Talk Around	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(A07)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(A08)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(A09)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(A10)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(A11)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(A12)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(A13)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(A14)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(A15)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(A16)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B01)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B02)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B03)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B04)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B05)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B06)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B07)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B08)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B09)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B10)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B11)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B12)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B13)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B14)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B15)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					
(B16)	DANIELS MT-4E TX	Mixed	160.00000	Timeout 1	$293	$0001	No tone	12.5	☑					

Figure 5-6: Channel Matrix Example

FIRMWARE VERSION NUMBER

Information on the Receiver or Transmitter serial number, firmware version, model number, synthesizer information and user names can be found by clicking on Rx ID or Tx ID in the Receiver or Transmitter configuration screen.

The Receiver ID screen is shown in Figure 5-7.

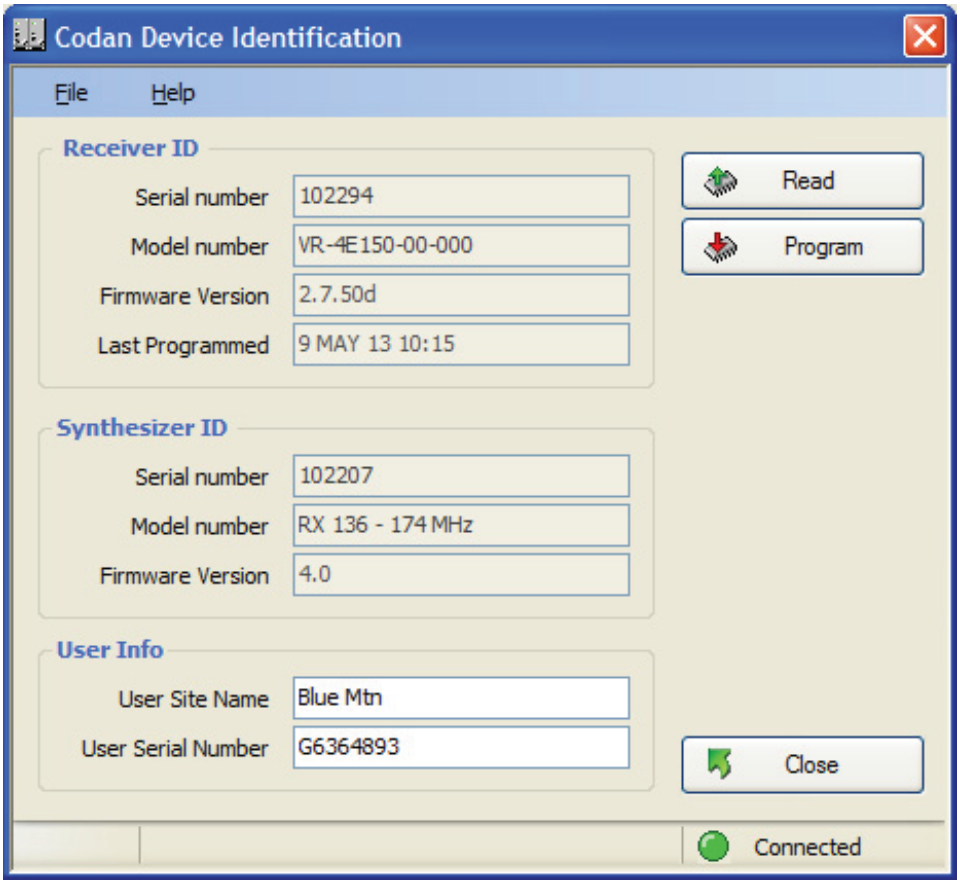


Figure 5-7: Receiver ID Example

CI-RC-4M-G2 MULTIPLE LINK CONTROLLER PROGRAMMING

The CI-RC-4M-G2 Multiple Link Controller is a software programmable controller. The Multiple Link Controller Software connects to the CI-RC-4M-G2 through a type A to 5 pin mini-type B USB cable from the computer to the front panel of the controller.

The system settings screen is shown in Figure 5-8.

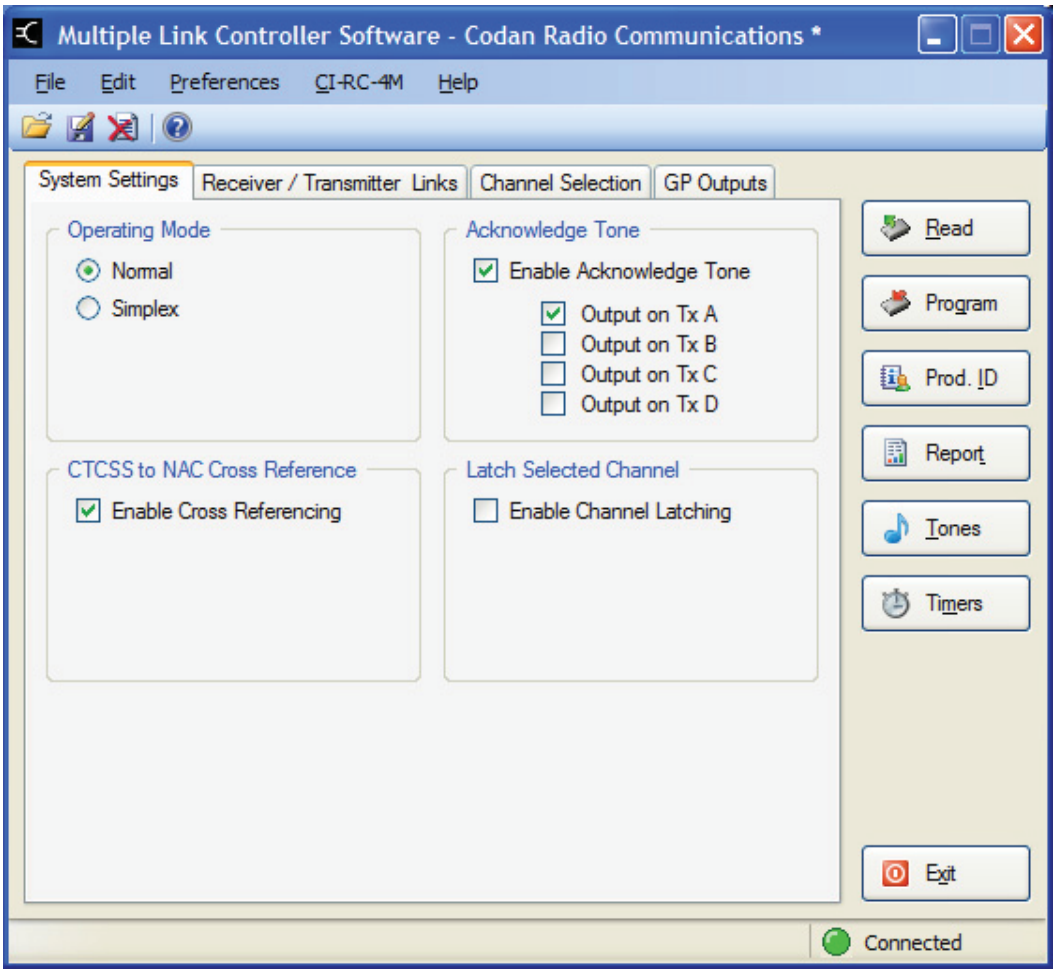


Figure 5-8: CI-RC-4M-G2 System Settings

The configuration screen allows for a wide variety of complex repeater configurations using a link configuration grid as shown in Figure 5-9. The grid uses color coding to indicate different connection settings.

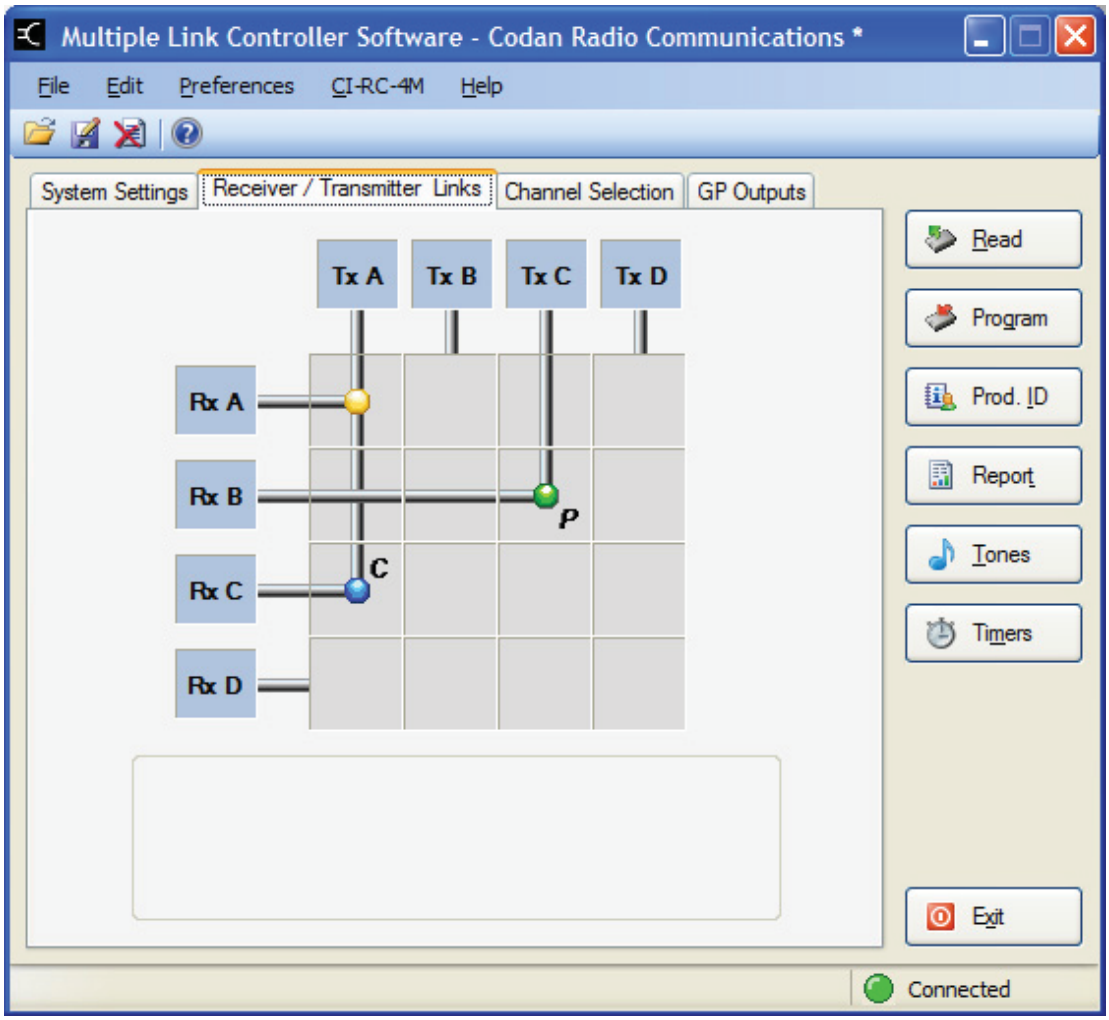


Figure 5-9: CI-RC-4M-G2 Program Link Configuration Grid

UIC-4-00 UNIVERSAL INTERFACE CARD PROGRAMMING

The UIC Configuration Software is used to read and to modify various static configuration settings in the UIC-4-00. The application can be used to configure the UIC locally by connecting to it via its USB port, or remotely by connecting via Ethernet.

The UIC configuration screens are shown in Figures 5-10 and 5-11.

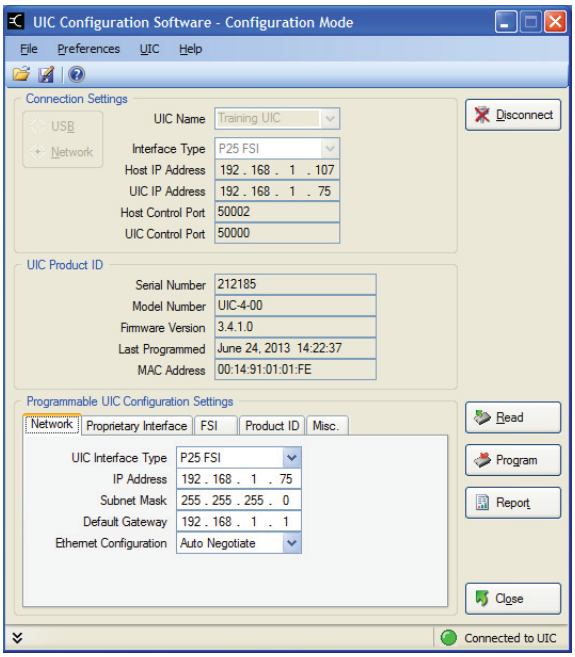


Figure 5-10: UIC Configuration (Network)

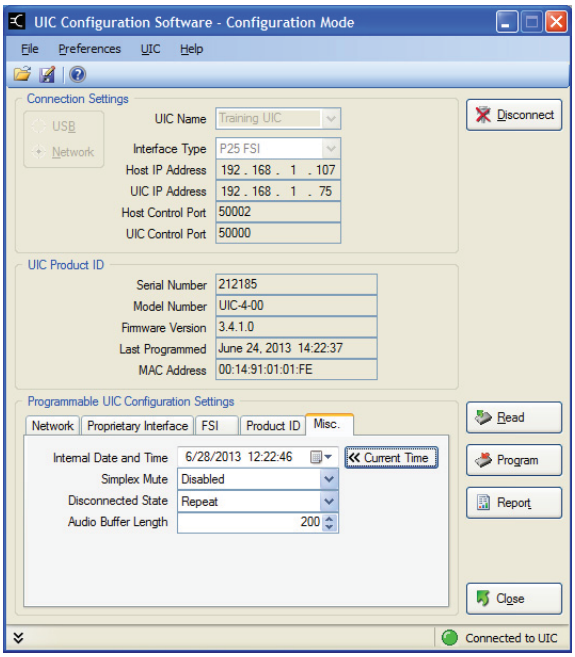


Figure 5-11: UIC Configuration (Misc.)

The UIC Configuration Software can also be used to test Radio Functions and General Purpose Inputs / Outputs when connected via Ethernet.

The Radio Functions and UIC-Specific Functions are shown in Figures 5-12 and 5-13.

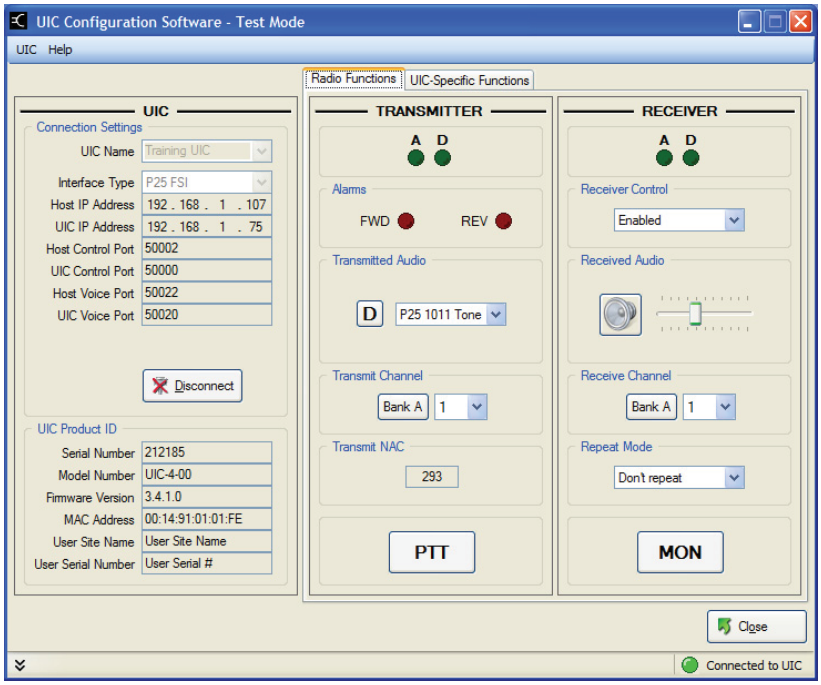


Figure 5-12: UIC Radio Functions

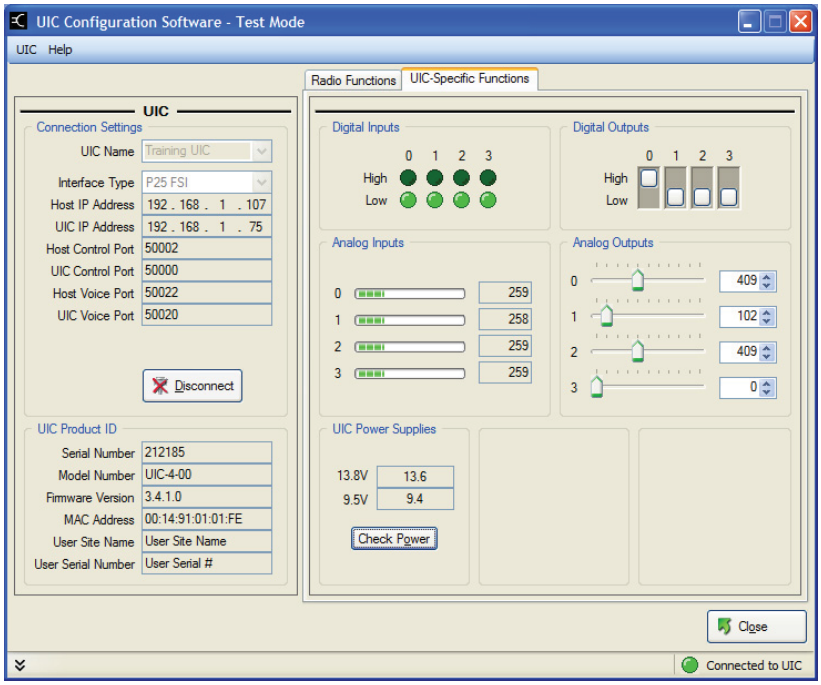


Figure 5-13: UIC-Specific Functions

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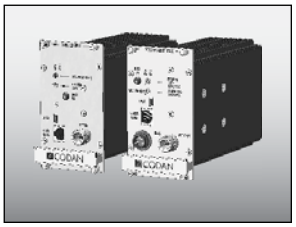

CHAPTER 6: RADIO SYSTEM COMPONENTS

CODAN RADIO SYSTEM COMPONENTS

A Codan Radio System consists of:

- MT-4E Receiver and Transmitter Modules
- Controller (CI-RC-4L, CI-RC-4M-G2, CI-BC-4E, UIC-4-00)
- RSS with Programming Cable (and other programming software)
- Subrack (with Optional Auxiliary Connector)
- System Regulator
- Power Amplifiers
- Tuning and Maintenance Tools

The Receiver, Transmitter, Controller, Software and Programming cable were discussed previously. The other radio system components are further explained in greater detail in this chapter.

All Codan modules are hot swappable. There is no need to disconnect the power supply when inserting or removing the modules from the subrack.

SUBRACK

The SR-39-1 subrack is designed to hold and interconnect the MT-4E series of receiver, transmitter and control modules on one universal motherboard. The subrack has room for two receiver and transmitter pairs. The left side connectors are reserved for transmitter A and receiver A, while the right side connectors are reserved for transmitter B and receiver B. See Figure 6-1.

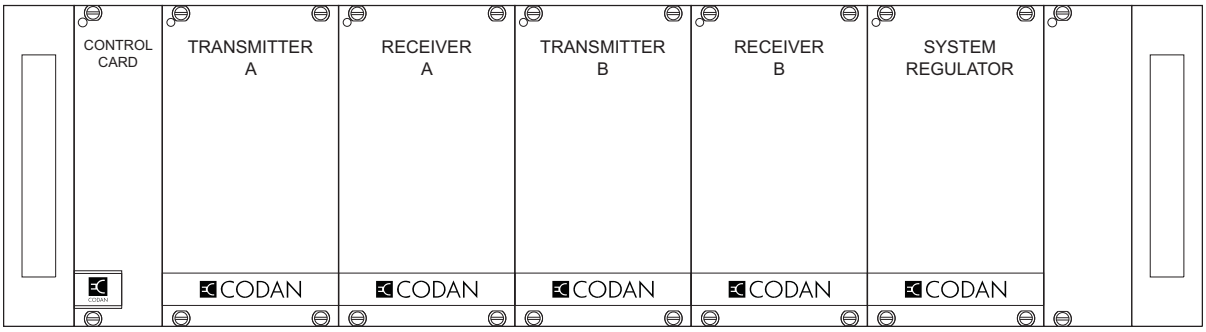

Figure 6-1: Standard Subrack Configuration

If a VHF or UHF 30 Watt power amplifier is installed, only one transmitter and receiver pair can be installed. The power amplifier takes up two slots as shown in Figure 6-2.

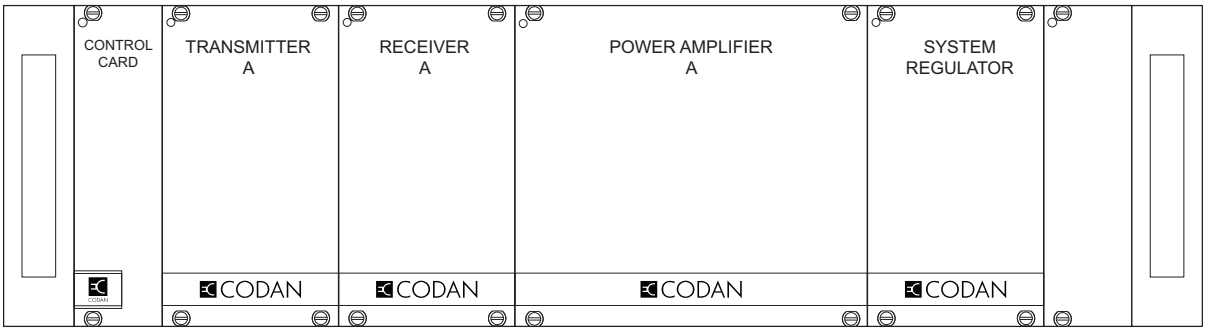

Figure 6-2: Standard Subrack with Power Amplifier

Power Input

The main power input (+10 to +17 Vdc; +13.8 Vdc nominal) connector is located at the back of the subrack, on the motherboard. There is an identical +9.5 Vdc power output connector on the motherboard that is used to power other Codan equipment at +9.5 Vdc (the CI-RC-4M-G2 controller for example).

NOTE: Do not connect the main power input to the +9.5 Vdc power output connector, as a transient suppressor (over voltage protection) will short to ground to protect the equipment.

Reverse voltage protection and over voltage protection (transient suppressor) is provided at the main power 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. Figure 6-3 shows the subrack / motherboard rear view.

Channel and Bank Selection

The MT-4E radio modules are capable of 16 channel operation in 2 banks (32 channels total). The 16 channels are controlled via four CSEL signal lines connected to each receiver and transmitter module. The CSEL signal lines are set as either a 0 (0 Vdc) or a 1 (+9.5 Vdc). Table 6-1 shows the channel selected for the CSEL input settings.

Table 6-1: Channel Selection Settings

Channel	Decimal	CSEL3	CSEL2	CSEL1	CSEL0
1	0	0	0	0	0
2	1	0	0	0	1
3	2	0	0	1	0
4	3	0	0	1	1
5	4	0	1	0	0
6	5	0	1	0	1
7	6	0	1	1	0
8	7	0	1	1	1
9	8	1	0	0	0
10	9	1	0	0	1
11	10	1	0	1	0
12	11	1	0	1	1
13	12	1	1	0	0
14	13	1	1	0	1
15	14	1	1	1	0
16	15	1	1	1	1

The Receiver and Transmitter Bank A/B select lines are set as either a B (0 Vdc) or an A (+9.5 Vdc). The logic for the Bank A/B select lines is different from the CSEL signal lines. If the Bank A/B select line is pulled high (+9.5 Vdc), or left floating, Bank A is selected. If the Bank A/B select line is pulled low (0 Vdc), Bank B is selected.

There are 3 different ways to change the channel and bank of a transmitter / receiver module:

1. The user can set jumpers mounted on the motherboard for each Channel Select signal line (set of four for each Tx / Rx module) and Bank A/B select line. These jumpers can be used to permanently set a subrack slot at a specific channel and bank.
   - Jumpers can be set for 0 (0 Vdc) “down” or 1 (+9.5 Vdc) “up”.
   - Pull-up resistor jumpers to +9.5 Vdc must be installed.
2. CSEL signal lines and Bank A/B select lines can be controlled externally by a tone remote adapter, a CI-RC-4M-G2 multiple link controller, or other third party devices.
3. Sixteen-position rotary select switches mounted on the CI-BC-4E base controller can control the CSEL lines and toggle switches can control the Bank A/B select line. Optionally the CI-RC-4L repeater controller can have a rotary switch added for control of the CSEL signal lines.

The pull-up resistor jumpers to +9.5 Vdc must be removed and all channel select and bank select jumpers must be installed in the 1 or “up” position for both external control and rotary switch control of channel selection. The locations of the channel select and pull-up jumpers are shown in Figure 6-3.

Antenna Relay Activation

The motherboard on the subrack contains a set of jumpers that are used to activate the optional antenna relays in the System Regulator module from the Transmitter PTT IN and PTT OUT signal lines. Figure 6-3 shows the location of these jumpers.

JU36	TXA PTT OUT activates Relay A	JU37	TXA PTT IN activates Relay A
JU39	TXA PTT OUT activates Relay B	JU40	TXA PTT IN activates Relay B
JU42	TXB PTT OUT activates Relay A	JU43	TXB PTT IN activates Relay A
JU45	TXB PTT OUT activates Relay B	JU46	TXB PTT IN activates Relay B

Simplex Operation

The motherboard on the subrack contains a set of jumpers that are enabled when the radio system is operated in simplex mode (simplex base station or simplex links). The jumper connects the Transmitter PTT OUT signal line to the RX MUTE. This jumper will cause the receiver to mute when the transmitter is keyed.

JU38	TXA PTT OUT mutes RXA	JU41	TXA PTT OUT mutes RXB
JU44	TXB PTT OUT mutes RXA	JU47	TXB PTT OUT mutes RXB

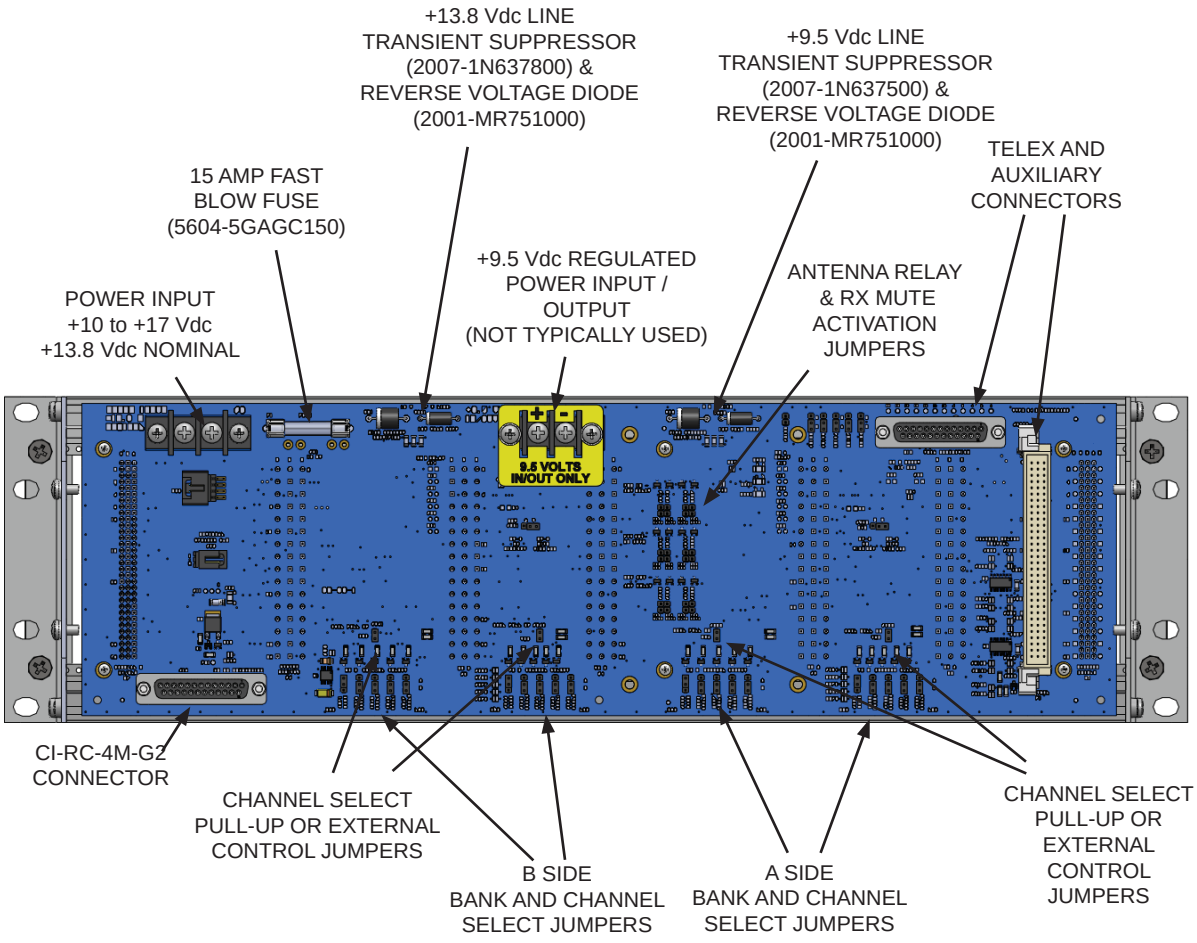

Figure 6-3: Subrack / Motherboard Rear View

Auxiliary Connectors

The motherboard on the subrack has three auxiliary connectors available, a DB25 connector for direct connection to a Telex DSP-223 or IP-223, a DB25 connector for direct connection to a CI-RC-4M-G2 Multiple Link Controller and a 96 pin connector typically used to connect to the A-PNL-AUX96-3.

DB25 Connector to DSP-223 or IP-223

Connector J10 is a female DB25 connector which can be used for basic base connections. When connected to a Telex DSP-223 or IP-223, a standard straight-through male-to-male DB25 extender cable can be used with some motherboard jumper changes. 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

DB25 Connector to CI-RC-4M-G2

Connector J12 is a female DB25 connector which can be used for connecting audio, channel select and control signal lines to a CI-RC-4M-G2 (second generation) multiple link controller. When connecting to a CI-RC-4M-G2, a standard straight-through male-to-male DB25 cable can be used.

A-PNL-AUX96-3 Auxiliary Connector

An optional component that can be added to the subrack is the A-PNL-AUX96-3 Auxiliary Connector. The auxiliary connector mounts on the back wrap-around cover of the subrack and connects to the auxiliary connector on the motherboard. The A-PNL-AUX96-3 brings all of the auxiliary connector signal lines out to screw terminals for easy connection. These connections are ideal for interfacing external equipment and allowing easy access for testing and tuning points. The A-PNL-AUX96-3 Auxiliary Connector and the back wrap-around cover are shown in Figure 6-4.

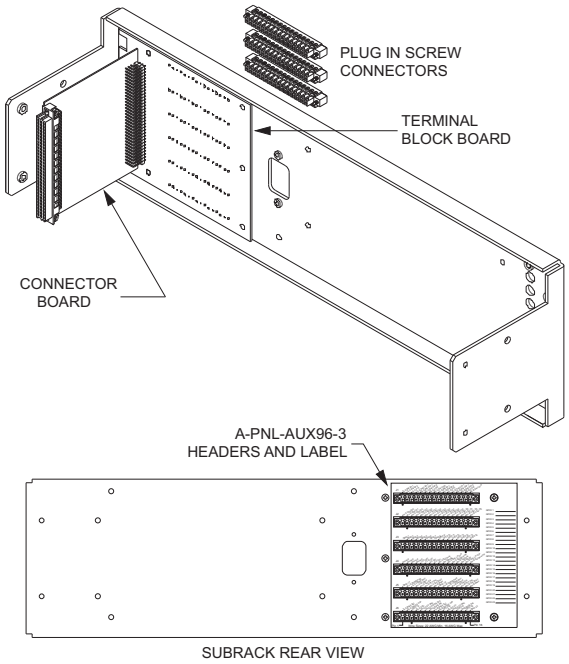

Figure 6-4: Auxiliary Panel Diagram

A close-up view of the auxiliary connector label, as shown in Figure 6-5, indicates the short signal name for each connection point. Definitions for these signals can be found in the SR-39-1 subrack manual. Extra General Purpose Input / Output connectors (GPIO) that can be used for different functions depending on the control card are listed to the right of the connectors. For example, the CI-BC-4E base controller uses these lines for auxiliary audio inputs / outputs and auxiliary COR / PTT connections. The CI-PM-3 paging modulator uses these signal lines for connecting A/D select lines, 2-level and 4-level data, etc. The custom functions of these connectors will be marked in the blank space next to the signal name.

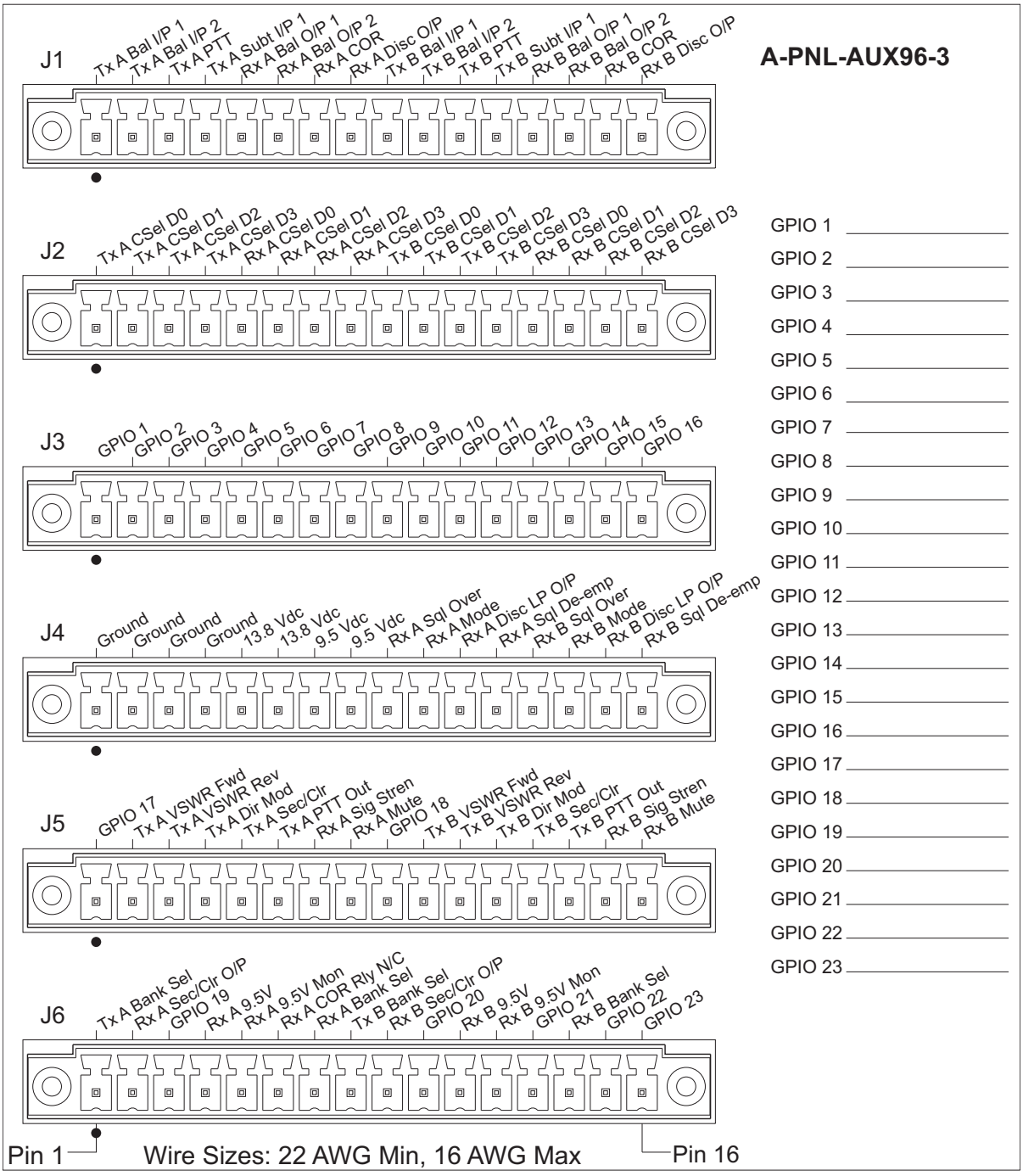

Figure 6-5: Auxiliary Panel Pin-Out

SYSTEM REGULATOR

The SM-3 system regulator is a plug-in module which provides voltage regulation, system metering and audio monitoring for an MT-4E radio system. The SM-3 includes the following features:

- High current +9.5 Vdc voltage regulator with an anti-latchup hysteresis circuit.
- Front panel switch selectable meter outputs to check supply voltages, regulated voltages, etc.
- Audio amplifier and loudspeaker.
- Relay drivers for optional antenna relays.

There are several different models of System Regulators as shown in Figure 6-6. The basic SM-3 is the same size as a transmitter or receiver module. The System Regulator can also be purchased with 1 or 2 optional antenna relays.

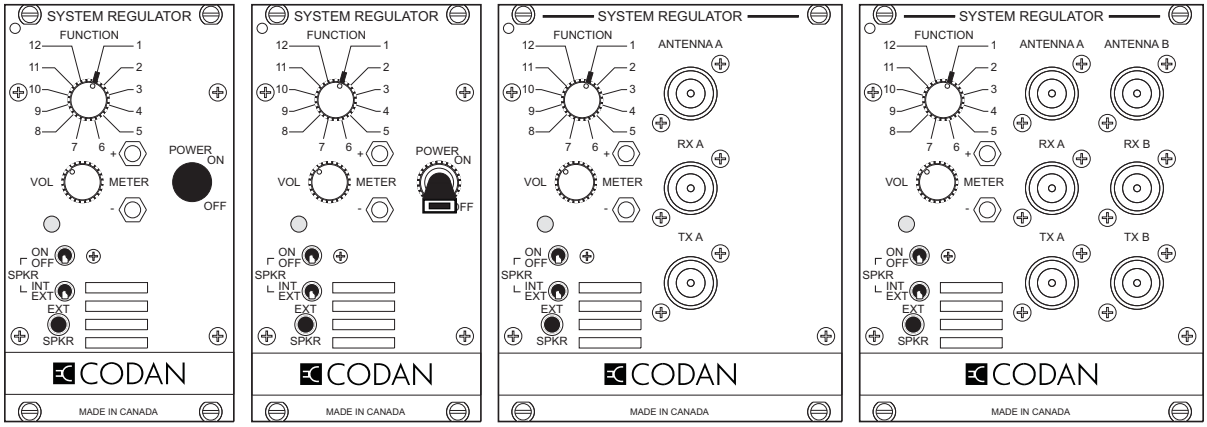

Figure 6-6: System Regulators

Backwards Compatibility

The SM-3 System Regulator is a direct replacement for the SM-3 System Monitor, however, the rotary switch positions for the front panel test points have been changed.

The simplex mode jumpers to connect the Transmitter PTT OUT signal line to the RX MUTE are now located on the new motherboard, but the System Regulators still contain the simplex mode jumpers for backwards compatibility with older motherboards.

System Regulator Testing

The System Regulator module is designed with a convenient and easy test point built in to 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 6-7. Turn the rotary switch to the desired position to measure the supply voltage, regulated voltage or audio output as shown in Table 6-2. Note that the RSSI requires a carrier and the audio output requires an audio tone injected into the receiver.

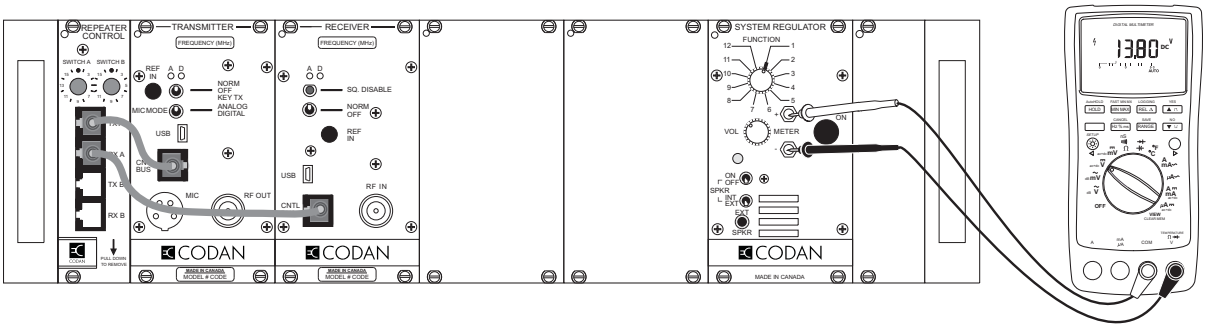

Figure 6-7: System Regulator Testing

Table 6-2: System Regulator Rotary Switch Functions

Position	Function	Parameter
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)

POWER AMPLIFIERS

Table 6-3 shows the RF Power outputs for the transmitter modules in each frequency band.

Table 6-3: RF Power Outputs

Band	Frequency	Transmitter
VHF Highband	136 - 174 MHz	0.5 to 8.0 Watts
UHF 400 MHz	406 - 470 MHz	0.5 to 8.0 Watts
UHF T-Band	470 - 520 MHz	0.5 to 6.0 Watts
UHF 700 / 800 MHz	768 - 869 MHz	0.5 to 3.0 Watts
UHF 900 MHz	896 - 960 MHz	0.5 to 3.0 Watts

If a higher RF power output is required, the transmitter may be used as an exciter to drive a power amplifier. Codan Radio Communications manufactures a 30 Watt power amplifier for VHF highband and UHF 400 MHz, shown in Figure 6-8, that will fit into a standard subrack.

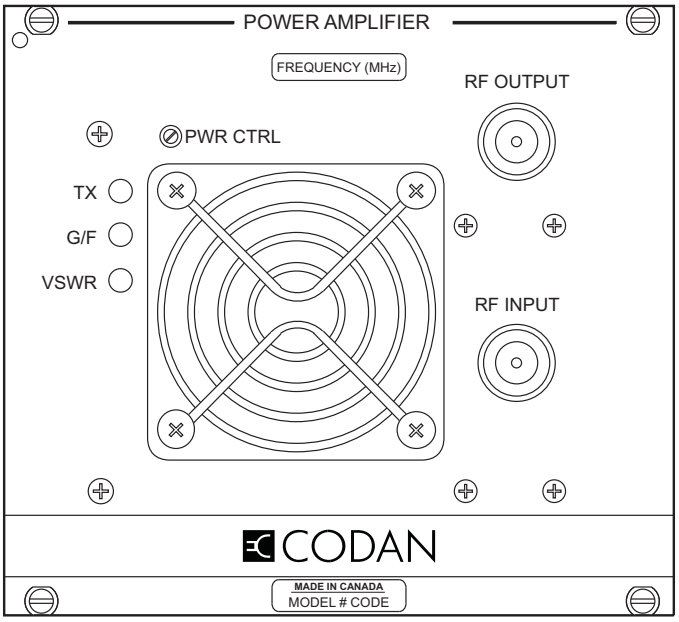

Figure 6-8: 30 Watt Power Amplifier

Codan Radio Communications can also supply higher power amplifiers (60 W, 100 W, 250 W) that are 19” rack mountable. All transmitters and power amplifiers are rated for 100% continuous duty.

TUNING AND MAINTENANCE TOOLS

To facilitate testing, alignment and maintenance for the MT-4E radio systems, extender cards can be used to extend the individual modules out from the subrack. Extender kits (extender card plus a four-foot cable) allow the modules to be extended out to a bench for servicing.

The following extender cards and kits are available:

EC-96D1 (direct connect) or **EC-96K-1.22** (card and cable)
Used for the 96 pin control cards (CI-RC-4L and CI-BC-4E).

EC-48RD (direct connect) or **EC-48RK-1.22** (card and cable)
Used for all receiver, transmitter, power amplifier and system regulator modules.

Figure 6-9 shows the 96 pin and 48 pin direct connect extender cards.

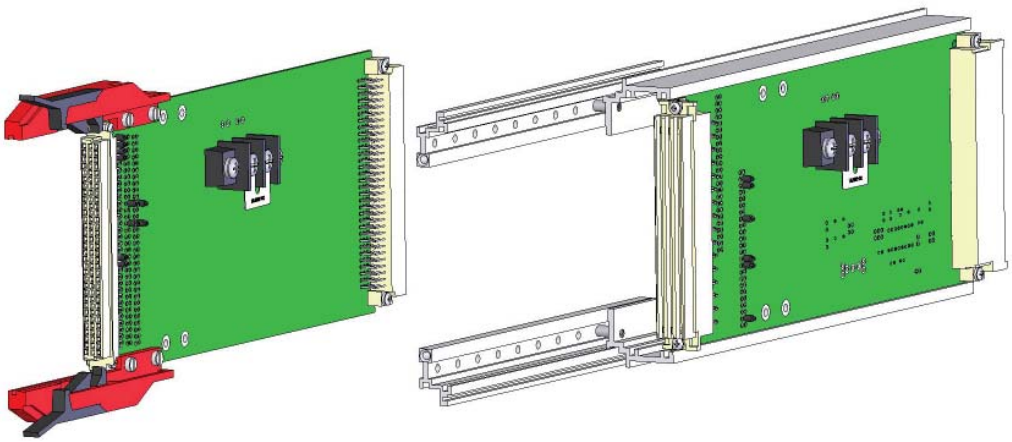

Figure 6-9: EC-96D1 and EC-48RD Direct Connect Extender Cards

The **A-TK-04** tool kit includes a number of spare parts for the MT-4 radio system, including tuning tools, guide rails, transient suppressors, diodes, a fuse, dust caps, shunt jumpers, ESD wrist strap, and various screws and hardware.

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