DANIELS™
ELECTRONICS LTD.

MT-4E VHF & UHF RECEIVER & TRANSMITTER INSTRUCTION MANUAL

136-174 MHz / 406-470 MHz / 470-520 MHz / 799-869 MHz

Covers Models:

UR-4E420-00-000	UT-4E450-00-800
UR-4E420-A0-000	UT-4E500-00-800
UR-4E460-00-000	UT-4E850-00-300
UR-4E460-A0-000	VR-4E150-00-000
UR-4E500-00-000	VR-4E150-A0-000
UR-4E800-A0-000	VT-4E150-00-800
UR-4E850-A0-000	

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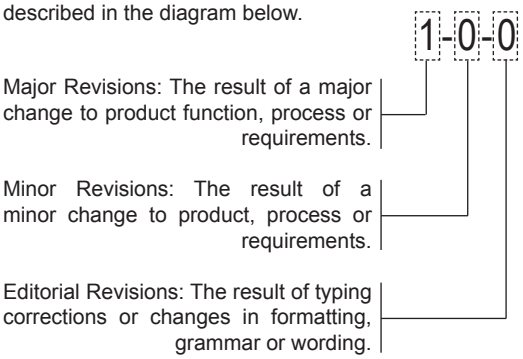
DOCUMENT CONTROL

This document has been produced, verified and controlled in accordance with Daniels Electronics' Quality Management System requirements. Please report any errors or problems to Daniels Electronics' Customer Service Department.

DOCUMENT REVISION DEFINITION

Daniels Electronics Ltd. utilizes a three-level revision system. This system enables Daniels to identify the significance of a revision. 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

The complete revision history is provided at the back of the document.

NOTE

The user's authority to operate this equipment could be revoked through any changes or modifications not expressly approved by Daniels Electronics Ltd.

The AMBE+2™ voice coding Technology embodied in this product is protected by intellectual property rights including patent rights, copyrights and trade secrets of Digital Voice Systems, Inc. This voice coding Technology is licensed solely for use within this Communications Equipment. The user of this Technology is explicitly prohibited from attempting to extract, remove, decompile, reverse engineer, or disassemble the Object Code, or in any other way convert the Object Code into a human-readable form. U.S. Patent Nos. #5,870,405, #5,826,222, #5,754,974, #5,701,390, #5,715,365, #5,649,050, #5,630,011, #5,581,656, #5,517,511, #5,491,772, #5,247,579, #5,226,084 and #5,195,166.

The design of this equipment is subject to change due to continuous development. This equipment may incorporate minor changes in detail from the information contained in this manual.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules and ICES 03. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio / TV technician for help.

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

RF Exposure Warning

Exposure to radio frequency (RF) energy has been identified as a potential environmental factor that must be considered before a radio transmitter can be authorized or licensed. The FCC and IC have therefore developed maximum permissible exposure (MPE) limits for field strength and power density, listed in FCC 47 CFR 1.1310 and IC RSS-102 Issue 2 Sect 4. The FCC has furthermore determined that determination of compliance with these exposure limits, and preparation of an Environmental Assessment (EA) if the limits are exceeded, is necessary only for facilities, operations and transmitters that fall into certain risk categories, listed in FCC 47 CFR 1.1307 (b), Table 1. All other facilities, operations and transmitters are categorically excluded from making such studies or preparing an EA, except as indicated in FCC 47 CFR 1.1307 (c) and (d).

Revised FCC OET Bulletin 65 (Edition 97-01) and IC RSS-102 Issue 2 provide assistance in determining whether a proposed or existing transmitting facility, operation or device complies with RF exposure limits. In accordance with OET Bulletin 65, FCC 47 CFR 1.1307 (b) and RSS-102 Issue Sect 2.5, this Daniels Electronics Ltd. transmitter is categorically excluded from routine evaluation or preparing an EA for RF emissions and this exclusion is sufficient basis for assuming compliance with FCC/IC MPE limits. This exclusion is subject to the limits specified in FCC 47 CFR 1.1307 (b), 1.1310 and IC RSS-102 Issue 2 Sect 4. Daniels Electronics Ltd. has no reason to believe that this excluded transmitter encompasses exceptional characteristics that could cause non-compliance.

Notes:

- The FCC and IC's exposure guidelines constitute exposure limits, not emission limits. They are relevant to locations that are accessible to workers or members of the public. Such access can be restricted or controlled by appropriate means (i.e., fences, warning signs, etc.).
- The FCC and IC's limits apply cumulatively to all sources of RF emissions affecting a given site. Sites exceeding these limits are subject to an EA and must provide test reports indicating compliance.

RF Safety Guidelines and Information

Base and Repeater radio transmitters are designed to generate and radiate RF energy by means of an external antenna, typically mounted at a significant height above ground to provide adequate signal coverage. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication. The following antenna installation guidelines are extracted from Appendix A from OET Bulletin 65 and must be adhered to in order to ensure RF exposure compliance:

Non-building-mounted Antennas:

Height above ground level to lowest point of antenna ≥ 10 m or
Power ≤ 1000 W ERP (1640 W EIRP)

Building-mounted Antennas:

Power ≤ 1000 W ERP (1640 W EIRP)

The following RF Safety Guidelines should be observed when working in or around transmitter sites:

- Do not work on or around any transmitting antenna while RF power is applied.
- Before working on an antenna, disable the appropriate transmitter and ensure a "DO NOT USE" or similar sign is placed on or near the PTT or key-up control.
- Assume all antennas are active unless specifically indicated otherwise.
- Never operate a transmitter with the cover removed.
- Ensure all personnel entering a transmitter site have electromagnetic energy awareness training.

For more information on RF energy exposure and compliance, please refer to the following:

1. FCC Code of Regulations; 47 CFR 1.1307 and 1.1310.
2. FCC OET Bulletin 65, Edition 97-01, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields."
3. http://www.fcc.gov/oet/rfsafety/.
4. IC RSS-102 Issue 2, "Radio Frequency Exposure Compliance of Radio Communication Apparatus."

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GENERAL INFORMATION

INTRODUCTION

The MT-4E Receiver and Transmitter are FM radio modules capable of analog operation in 12.5 kHz (narrow band) or 25 kHz (wide band) channels. A firmware upgrade may be purchased to allow P25 digital operation. The VHF modules operate over the band from 136 to 174 MHz and the UHF modules operate over the band from 406 to 470 MHz and 799 to 869 MHz (transmitter) or 406 to 430 MHz, 450 to 470 MHz, 470 to 520 MHz, 799 to 824 MHz and 851 to 869 MHz (receiver). Modular design allows each of the Receiver and Transmitter's internal modules to be individually assembled and tested, which facilitates construction, tuning, and general maintenance.

The MT-4E Receiver and Transmitter combine state of the art performance in a compact modular enclosure for applications ranging from remote mountain top repeaters to congested urban radio environments. Each module is characterized by dependable, low maintenance performance under the most severe environmental conditions.

NOTE: The transmitter is not to be operated as a repeater under an existing base station license.

The MT-4E Receiver and Transmitter are primarily software controlled radio modules, allowing tuning, programming and maintenance to be done via software service with few hardware adjustments required.

The MT-4E series is compatible with all Daniels' subrack and base station enclosures. It supports a basic analog interface, and may be used in a mixed system with MT-3 and MT-4 series Receivers and Transmitters.

P25 Digital Mode

When the P25 firmware upgrade is purchased, the MT-4E family of receivers and transmitters may be configured for P25 digital operation, or mixed mode operation. In a repeater configuration, the receiver passes the complete P25 digital voice packet directly to the transmitter so no P25 digital information is lost.

All P25 specifications, operational description and information contained in this Instruction Manual require the P25 firmware upgrade to function. If the MT-4E Receiver and Transmitter are purchased without the P25 firmware upgrade, the radio will program and operate in analog mode only.

Secure Communications

The Receiver and Transmitter are capable of decoding and encoding secure communications if a DES-OFB/AES encryption module is installed. To successfully decode or encode a transmission, the encryption module must be programmed with a valid encryption key using the Motorola KVL 3000+ or KVL 3000 Keyloader in conjunction with a Daniels Keyloader Cable. The Daniels Keyloader cable plugs into the front panel RJ45 jack on the front of the Receiver or Transmitter module. For correct keyloading, the KVL must be setup to operate using ASN mode. ASN Mode is the default mode of the KVL 3000 and an optional mode of the KVL 3000+. Consult the instructions for the Keyloader for details on loading a key. A loaded key may be cleared by pulling first the CLEAR KEYS 1 then the CLEAR KEYS 2 inputs to ground 500ms apart. Alternately, the CI-BC-4E Base Controller may be used to clear the keys for all modules in a system with a single key press of the switch marked ZEROIZE KEY. The CI-BC-4E Base Controller can also be used to control whether the transmitter outputs a secure or a clear signal.

Firmware Upgrades

Receiver and Transmitter firmware upgrading is performed with the PC-based Firmware Upgrade software. 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.

Firmware upgrades can be found on the Daniels Electronics Ltd. website at www.danelec.com.

MT-4E Receiver Family Models

There are eight models in the MT-4E Receiver family covering the 136 to 174 MHz, 406 to 430 MHz, 450 to 470 MHz and 470 to 520 MHz bands while operating in 12.5 kHz, 15 kHz, 25 kHz, or 30 kHz occupied channel bandwidths. The receivers are classified as Class A or Class B. The eight models are as follows:

VR-4E150-A0-000	synthesized, 136-174 MHz band, 12.5/15/25/30 kHz channels; Class A
UR-4E420-A0-000	synthesized, 406 - 430 MHz band, 12.5/15/25/30 kHz channels; Class A
UR-4E460-A0-000	synthesized, 450 - 470 MHz band, 12.5/15/25/30 kHz channels; Class A
UR-4E500-A0-000	synthesized, 470 - 520 MHz band, 12.5/15/25/30 kHz channels; Class A
VR-4E150-00-000	synthesized, 136-174 MHz band, 12.5/15/25/30 kHz channels; Class B
UR-4E420-00-000	synthesized, 406 - 430 MHz band, 12.5/15/25/30 kHz channels; Class B
UR-4E460-00-000	synthesized, 450 - 470 MHz band, 12.5/15/25/30 kHz channels; Class B
UR-4E500-00-000	synthesized, 470 - 520 MHz band, 12.5/15/25/30 kHz channels; Class B
UR-4E800-A0-000	synthesized, 799 - 824 MHz band, 12.5/25 kHz channels; Class A
UR-4E850-A0-000	synthesized, 851 - 869 MHz band, 12.5/25 kHz channels; Class A

RECEIVER PERFORMANCE SPECIFICATIONS

General

Frequency Range:	136 to 174 MHz / 406 to 430 MHz / 450 to 470 MHz / 470 to 520 MHz 799 to 824 MHz / 851 to 869 MHz
Channel Spacing:	12.5, 15, 25 & 30 kHz / 12.5 and 25 kHz for 799 to 869 MHz
Channel Selection:	In 2.5, 5.0 or 6.25 kHz increments selected with Radio Programming Software Package
Number of Channels:	Preset capability for 2 banks of 16 channels
Channel Switching Range:	± 2.0 MHz / unlimited for 799 to 869 MHz
Compatibility:	MT-3 and MT-4 Series Radio Systems; P25 interoperable*
System Impedance:	50 Ω (Type N connector)
Frequency Generation:	Internal Synthesizer
Reference Sensitivity:	-118 dBm (0.28uV) for 12 dB SINAD -118 dBm (0.28uV) for 5 % BER*
Local Oscillator Frequency Stability:	± 1.0 ppm (VHF) / ± 0.5 ppm (UHF) / ± 0.1 ppm 799 to 869 MHZ
Adjacent Channel Rejection (Selectivity):	Class A; < -45 dB; Narrowband Analog < -75 dB; Wideband Analog < -60 dB; Digital* Class B; < -40 dB; Narrowband Analog < -70 dB; Wideband Analog < -60 dB; Digital*
Intermodulation Rejection:	Class A; < -75 dB; Narrowband and Wideband Analog < -80 dB; Digital* Class B; < -70 dB; Narrowband and Wideband Analog < -70 dB; Digital*
Spurious Response Rejection:	Class A; < -75 dB; Narrowband Analog < -85 dB; Wideband Analog < -90 dB; Digital* Class B; < -70 dB; Narrowband and Wideband Analog < -70 dB; Digital*
Conducted Spurious Output Power:	< -95 dBm
Hum and Noise Ratio:	< -34 dB; Narrowband Analog < -40 dB; Wideband Analog
Audio Output:	600 Ω balanced line output (configurable for unbalanced line); De-emphasis or Flat output, +3 dBm maximum level
Audio Distortion:	Analog; ≤ 2.0 % (25 °C); ≤ 3.0 % (-30˚C to +60˚C) Digital as per TIA/EIA 102.CAAB*
Front Panel Controls:	Receiver Power On (Norm) / Off Squelch Disable (Push-button) Analog & Digital Receive LED indicators

** P25 Digital specifications are applicable only for modules with the P25 Digital firmware upgrade.*

COR Interface:	150 mA, 50 V open drain power MOSFET
Supply Voltage:	+13.8 VDC Nominal (range +10 to +17 VDC) +9.5 VDC Regulated
Supply Current:	Class A; < 250 mA; with no encryption module installed < 280 mA; with encryption module installed Class B; < 105 mA; with no encryption module installed < 135 mA; with encryption module installed
Operating Temperature Range:	-30°C to +60°C
Operating Humidity:	95 % RH (non-condensing) at +25°C
CTCSS Decode:	Programmable to any of 42 CTCSS tones
DCS Decode:	Programmable to any of 83 DCS sequences. Normal or inverted DCS can be selected
IC Certification No.:	n/a - Declaration of Conformity (DOC)
FCC ID:	n/a - Declaration of Conformity (DOC)

** P25 Digital specifications are applicable only for modules with the P25 Digital firmware upgrade.*

MT-4E Transmitter Family Models

There are three models in the MT-4E Transmitter family covering the 136 to 174 MHz, 406 to 470 MHz bands, 470 to 520 MHz and 799 to 869 MHz. The four models are as follows:

VT-4E150-00-800	136–174 MHz band, 0.5–8.0 W
UT-4E450-00-800	406–470 MHz band, 0.5–8.0 W
UT-4E500-00-800	470–520 MHz band, 0.5–8.0 W
UT-4E850-00-300	799–869 MHz band, 0.5–4.0 W

TRANSMITTER PERFORMANCE SPECIFICATIONS

General

Frequency Range:	136 to 174 MHz / 406 to 470 MHz / 470 to 520 MHz / 799–869 MHz
Carrier Frequency Stability:	± 1.0 ppm (VHF) / ± 0.5 ppm (UHF) / 1 to .1 ppm 799–869 MHz
Channel Spacing:	12.5, 15, 25 & 30 kHz / 12.5 & 25 kHz 799–869 MHz
Channel Selection:	In 2.5, 5.0 or 6.25 kHz increments selected with Radio Programming Software Package
Number of Channels:	Preset capability for 2 banks of 16 channels
Compatibility:	MT-3 and MT-4 Series Radio Systems; P25 interoperable*
RF Output Power:	0.5 to 8.0 W Continuous / 0.5 – 4.0 W 799–869 MHz
Emission Designators:	Analog: 11K0F3E (Narrowband); 16K0F3E (Wideband) Digital Paging: 9K2F1D P25 Digital: 8K10F1E (Digital Voice); 8K10F1D (Digital Data)*
System Impedance:	50 Ω; Type N connector
Duty Cycle:	100 %; Continuous operation
Undesired Emissions: (Adjacent Channel Power Ratio)	< -70 dBc; Analog < -70 dBc; Digital* -80 dBc; 799–869 MHz
Intermodulation Attenuation:	< -45 dB Analog < -45 dB Digital*
Undesired Emissions: (Conducted Spurious)	< -70 dBc @ 8 W < -80 dBc @4.0 W & 799–869 MHz
VSWR Protection:	< 20:1 VSWR at all phase angles
Operating Temperature Range:	-30˚C to +60˚C
Operating Humidity:	95 % RH (non-condensing) at +25°C
Operating Voltage:	+13.8 VDC Nominal (range +10 to +17 VDC) +9.5 VDC Regulated
Transmit Current:	< 1.7 A at 2 W RF Power Output < 2.8 A at 8 W RF Power Output < 1.8 A @ 4 W RF Output
Stand By Current:	< 75 mA (no encryption modules installed) < 105 mA (with encryption modules installed)
Front Panel Controls:	Transmitter power On (Norm) / Off / Key Tx Mic Mode: Analog / Digital Analog & Digital Transmit LED indicators
PTT Time-Out-Timer:	Programmable from 15 to 465 sec. (in increments of 1 sec.) or infinity (Default 300 sec.), using Radio Service Software package
Audio Input:	Balanced, 600 Ω or optional unbalanced input (600 Ω or 15k Ω selectable input impedance)
Audio Frequency Response:	Pre-emphasis; +1, -3 dB (300 to 3000 Hz)
Audio Deviation Limiting:	± 2.5 kHz Narrowband, ± 5.0 kHz Wideband
Audio Distortion:	< 3 % THD; 1 kHz tone at 1.5 kHz or 3 kHz deviation
FM Hum and Noise Ratio:	< -34 dB (0.3 to 3.4 kHz De-Emphasis Off)
CTCSS Decode / Encode:	Programmable to any of 42 CTCSS tones.
DCS Decode / Encode:	Programmable to any of 83 DCS sequences. Normal or inverted DCS can be selected. Turnoff code optional.
IC Certification No.:	142A-VT4E150 (VHF) / 142A-UT4E450 (UHF)

** P25 Digital specifications are applicable only for modules with the P25 Digital firmware upgrade.*

FCC ID:	H4JVT-4E150 (VHF) / H4JUT-4E450 (UHF)

** P25 Digital specifications are applicable only for modules with the P25 Digital firmware upgrade.*

PHYSICAL SPECIFICATIONS

Physical Dimensions:	Width: 7.1 cm (2.8 in)	Height: 12.8 cm (5.05 in)	Depth: 19 cm (7.5 in)
Module Weight:	Receiver: 1.2 kg (2.5 lbs.) Transmitter: 1.4 kg (3.0 lbs.)		
Corrosion Prevention:	Anodized aluminum construction Stainless steel hardware Gold plated module connectors		
Module Design:	• Compact Eurostandard modular design. • Plug-in modules mate with the Daniels standard MT-3 subrack. • Subracks / modules comply with IEEE 1101, DIN 41494 and IEC 297-3 (mechanical size / modular arrangement).		
External Connections:	RF Connection: type N connector located on the module front panel. Digital I/O interface is made via RJ45 modular jack located on the front panel. Programming interface is made via mini-type B USB 1.1 jack located on the front panel. Motherboard Connections (Audio, Power, and Control) are made through a 48 pin, gold plated, type F connector on the rear of the module. User connection made through mated “motherboard” assembly of the radio subrack. Type F standard connector complies with DIN 41612 Level 2 (200 mating cycles, 4 day 10 ppm SO_2 gas test with no functional impairment and no change in contact resistance).		
Handle Text Colour:	Red (VHF) / Black (UHF)		

CHANNEL AND BANK SELECTION

Four channel select lines CSEL0-3 are named on the Motherboard, and are brought into the receiver and transmitter modules by the 48 pin rear connector, allowing selection of 16 different channels. These signals are normally pulled low in the receiver and transmitter, but are typically set by jumpers on the Motherboard to select channel 1 by default. In addition, a bank select input is provided to switch between Bank A and B, each of which has 16 channels. The Bank select line normally floats high (+5 V), selecting Bank A, but may be pulled low or high externally.

Channel and Bank Select Line Mapping

The table below shows the relationship between the states of the bank and channel select lines. Note that the channel select lines follow a binary pattern, but that the binary “0” represents channel 1. The Bank A/B select line normally floats high (+5 V), selecting Bank A, but may be pulled low or high externally via the Bank A/B select line.

BANK A/B	CSEL3	CSEL2	CSEL1	CSEL0	Bank Selected	Channel Selected
HI	LO	LO	LO	LO	A	1
HI	LO	LO	LO	HI	A	2
HI	LO	LO	HI	LO	A	3
HI	LO	LO	HI	HI	A	4
HI	LO	HI	LO	LO	A	5
HI	LO	HI	LO	HI	A	6
HI	LO	HI	HI	LO	A	7
HI	LO	HI	HI	HI	A	8
HI	HI	LO	LO	LO	A	9
HI	HI	LO	LO	HI	A	10
HI	HI	LO	HI	LO	A	11
HI	HI	LO	HI	HI	A	12
HI	HI	HI	LO	LO	A	13
HI	HI	HI	LO	HI	A	14
HI	HI	HI	HI	LO	A	15
HI	HI	HI	HI	HI	A	16
LO	LO	LO	LO	LO	B	1
LO	LO	LO	LO	HI	B	2
LO	LO	LO	HI	LO	B	3
LO	LO	LO	HI	HI	B	4
LO	LO	HI	LO	LO	B	5
LO	LO	HI	LO	HI	B	6
LO	LO	HI	HI	LO	B	7
LO	LO	HI	HI	HI	B	8
LO	HI	LO	LO	LO	B	9
LO	HI	LO	LO	HI	B	10
LO	HI	LO	HI	LO	B	11
LO	HI	LO	HI	HI	B	12
LO	HI	HI	LO	LO	B	13
LO	HI	HI	LO	HI	B	14
LO	HI	HI	HI	LO	B	15
LO	HI	HI	HI	HI	B	16

RADIO SERVICE SOFTWARE PROGRAMMING

INTRODUCTION

Receiver and Transmitter programming is performed with the PC-based Radio Service Software (RSS). A type A to 5 pin mini-type B USB cable (included with the software) 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. The RSS allows the Receiver or Transmitter to be programmed for operating frequencies, CTCSS and DCS signaling, P25 Digital settings such as NAC and TGID, modulation type and many other parameters.

System Recommendations

- Microsoft Windows XP

Recommended Minimum Specification

- Pentium III Processor - 500 MHz
- 256 MB Memory (RAM)
- 1 GB Free Disk Space

Installation

The RSS should install automatically once the CD is inserted. If not, run SETUP.EXE, located on the CD.

Note: The Receiver and Transmitter must be programmed separately.

Once the connections are made, the Radio Service Software may be run on the computer and the radio switched on. The first time a Receiver or Transmitter is connected, the USB drivers will need to be installed from the CD using the Hardware Update Wizard. To test the connection, open the Receiver or Transmitter Configuration screen by clicking on the button in the Main screen. Click on the Receiver or Transmitter menu, then on the ID button. Click on the 'Read' button. The serial number, model number, firmware version and last programmed date should appear in the appropriate fields.

Programming settings are divided into two categories, Global options and Channel options. When the Receiver or Transmitter menu is selected from the main screen, both the Global and Channel options for the current channel are displayed. The RSS may be used to save a Receiver or Transmitter configuration to disk. This function allows the user to save a "standard" configuration, and use it as a starting configuration for all modules. An archive of configurations from each radio system in operation may also be kept so that replacement radios can be programmed easily.

If the MT-4E Receiver or Transmitter is purchased without the P25 Digital firmware upgrade, the P25 Digital options will not be available in the RSS software.

A service mode allows tuning, testing and setup of the Receiver and Transmitter modules. Analog and P25 Digital test modes may be selected by the Radio Service Software, such as Bit Error Rate testing andTest Pattern generation. Adjustments may also be performed in the Service mode, such as audio levels, RF power output and reference oscillator adjustments. The Service mode is covered in the Radio Service Software Tuning Chapter.

HARDWARE TUNING AND TROUBLESHOOTING

REPAIR NOTE

The MT-4E Receiver and Transmitter family employ 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.

RECOMMENDED TEST EQUIPMENT

Alignment of the Receiver and/or Transmitter requires the following test equipment or its equivalent.

Power supply - Regulated +9.5 VDC at 2 A	Phillips PM 2811
Power Supply - Regulated +13.8 VDC at 2 A	Topward TPS-4000
Oscilloscope / Multimeter	Fluke 97 Scopemeter
Current Meter:	Fluke 75 multimeter
Communications Service Monitor (Analog)	Marconi Instruments 2965A or equivalent
Communications Service Monitor (P25 Digital and Analog)	IFR 2975
Alignment Tools	Daniels A-TK-04

It is recommended that the radio communications test set 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.

Complete Receiver and Transmitter Alignment

A complete Receiver and Transmitter Alignment is performed at the factory and should not be required under normal circumstances. A large change in Receiver or Transmitter operating frequency, as discussed in the next section, or a replacement of major Receiver or Transmitter sub-assembly modules, may require a complete realignment operation.

RECEIVER JUMPERS

Receiver Main Board

Jumper	Default Position	Function / Description
JU1	OUT	When installed enables Clear Keys 1 Input
JU2	OUT	When installed enables Clear Keys 2 Input
JU3	IN	When installed enables power to Discriminator Output amplifier
JU5	OUT	When installed bypasses capacitance coupling on the Discriminator output
JU7	OUT	When installed enables power to Discriminator Output LPF amplifier
JU9	X	X: 600 Ω Audio Transformer Y: Bypass Transformer
JU10	X	X: 600 Ω Audio Transformer Y: Bypass Transformer
JU11	IN	When installed enables power to Balanced Audio Output amplifier
JU12	OUT	When installed increases the gain of Balanced Audio Output amplifier
JU13	OUT	When installed selects 600 Ω resistance to ground
JU14	X	X: 600 Ω Audio Transformer Y: Bypass Transformer

TRANSMITTER JUMPERS

Transmitter Main Board

Jumper	Default Position	Function / Description
JU1	X	X: A/D Front Panel Switch selects transmitter A/D mode Y: A/D External Input selects transmitter A/D mode
JU2	Y	X: MIC OUT connects to Microphone Audio Input Y: MIC IN connects to Microphone Audio input
JU3	X	X: 600 Ω Audio Transformer Y: Bypass Transformer
JU4	IN	When installed selects 600 Ω resistance to ground
JU5	IN	When installed enables Clear Keys 1 Input
JU6	IN	When installed enables Clear Keys 2 Input
JU7	X	X: 600 Ω Audio Transformer Y: Bypass Transformer
JU8	X	X: 600 Ω Audio Transformer Y: Bypass Transformer
JU9	OUT	When installed bypasses capacitance coupling on the Subtone / Direct Modulation Input

Jumpers are shown on the MT-4E Transmitter Jumper and Test Point Locator Illustrations.

FRONT PANEL RJ45 JACK PINOUTS

A single, 8 position RJ45 jack is mounted on the front panel of the receiver and transmitter. The following are the connections on the RJ45 jack.

Pin	Signal
1	CRYPTO MODULE KF
2	UNUSED SPARE
3	ANALOG COR / PTT
4	LVDS DATA A
5	LVDS DATA B
6	DIGITAL COR / PTT
7	NO CONNECTION
8	NO CONNECTION

48 PIN MOTHERBOARD INTERFACE CONNECTOR

A 48 pin connector is used for interfacing the MT-3 Motherboard to the receiver and transmitter.

Receiver

Pin	Name	Pin	Name	Pin	Name
D2	Relay Normally Open 1 [O/P]	B2	+13.8 VDC [I/P]	Z2	+13.8 VDC [I/P]
D4	Relay Common 1 [O/P]	B4	Receive Secure / Clear* [O/P]	Z4	No Connect
D6	Relay Normally Closed 1 [O/P]	B6	+9.5 VDC [I/P]	Z6	+9.5 VDC [I/P]
D8	Relay Normally Closed 2 [O/P]	B8	No Connect	Z8	No Connect
D10	Relay Common 2 [O/P]	B10	Discriminator LPF [O/P]	Z10	No Connect
D12	Relay Normally Open 2 [O/P]	B12	COR* [O/P]	Z12	COR* [O/P]
D14	Clear Keys 1* [I/P]	B14	Discriminator [O/P]	Z14	Squelch Override [I/P]
D16	Clear Keys 2* [I/P]	B16	No Connect	Z16	No Connect
D18	No Connect	B18	No Connect	Z18	Bank A/B* [I/P]
D20	Channel Select 0 (LSB) [I/P]	B20	SM-3 Speaker Audio [O/P]	Z20	No Connect
D22	Channel Select 1 [I/P]	B22	No Connect	Z22	No Connect
D24	Channel Select 2 [I/P]	B24	Signal Strength (RSSI) [O/P]	Z24	A/D Receive Mode [O/P]
D26	Channel Select 3 (MSB) [I/P]	B26	Balanced Audio 1 [O/P]	Z26	Balanced Audio 2 [O/P]
D28	No Connect	B28	Mute* [I/P]	Z28	No Connect
D30	No Connect	B30	Ground	Z30	Ground
D32	No Connect	B32	Ground	Z32	Ground

Transmitter

Pin	Name	Pin	Name	Pin	Name
D2	No Connect	B2	+13.8 VDC [I/P]	Z2	+13.8 VDC [I/P]
D4	No Connect	B4	Microphone Audio Output [O/P]	Z4	Microphone Audio Input [I/P]
D6	No Connect	B6	+9.5 VDC [I/P]	Z6	+9.5 VDC [I/P]
D8	No Connect	B8	Isolated Positive PTT [I/P]	Z8	Isolated Negative PTT [I/P]
D10	No Connect	B10	PTT* [I/P]	Z10	PTT* [I/P]
D12	No Connect	B12	Bank A/B* [I/P]	Z12	Bank A/B* [I/P]
D14	Clear Keys 1* [I/P]	B14	PTT* [I/P]	Z14	PTT* [I/P]
D16	Clear Keys 2* [I/P]	B16	No Connect	Z16	No Connect
D18	No Connect	B18	Balanced Audio 2 [I/P]	Z18	Balanced Audio 1 [I/P]
D20	Channel Select 0 (LSB) [I/P]	B20	SM-3 Speaker Audio [I/P]	Z20	No Connect
D22	Channel Select 1 [I/P]	B22	Subtone [I/P]	Z22	No Connect
D24	Channel Select 2 [I/P]	B24	PTT Output* [O/P]	Z24	Transmit Secure / Clear* [I/P]
D26	Channel Select 3 (MSB) [I/P]	B26	Forward Power Alarm* [O/P]	Z26	High VSWR Alarm* [O/P]
D28	No Connect	B28	No Connect	Z28	A/D Mode Control [I/P]
D30	No Connect	B30	Ground	Z30	Ground
D32	No Connect	B32	Ground	Z32	Ground

* Indicates an active low signal.

RECEIVER TROUBLESHOOTING

The receiver is composed of 4 main components; the Receiver Main Board, the Synthesizer Module, the RF Preselector, and the Universal Daughter Board (UDB). An optional Decryption Board can be installed in the Receiver.

These steps will help you determine the most likely sub-assembly that contains a fault, and may help you determine what that fault is. The sub-assembly or the entire receiver can be sent back to Daniels Service section for repair. Contact Daniels Service section before returning any product.

Before testing, the receiver should be in the subrack, or connected to the subrack by means of an Extender card or kit, and the main power to the system (+13.8 VDC) and the +9.5 VDC regulated supply should be checked via the front panel of the System Regulator.

Complete Receiver

Flip the receiver front panel ON/OFF switch from the OFF position to the NORM position and check that the two front panel LEDs both turn ON for less than 5 seconds and then turn OFF. If this is not the case, the most likely fault is on the UDB, on the Synthesizer, or on the Receiver Main Board. At this stage make sure that the UDB and the synthesizer module are properly seated on the Receiver Main Board.

Connect the Receiver to the PC with the USB cable and run the Radio Service Software (RSS). Select (P25 or Analog) Receiver, click on Configure, then click on Read to read the Receiver configuration. If the RSS returns “Device Not Responding”, physically inspect the USB cable and connection, check the Daniels USB driver, and check that the USB is recognized by the Device Manager. If the RSS still does not recognize the connection, the most likely fault is on the UDB.

Click on Rx ID, then click on Read to read the Receiver ID. Confirm that the Frequency Band in the Synthesizer ID Model Number matches the Frequency Band in the Receiver Global Settings. If the settings do not match, the synthesizer will require replacement, or the programming will need to be changed to match the synthesizer hardware.

If the receiver still is not functioning properly the module level check should be conducted in the following order:

Receiver Main Board

Check the following test points on the receiver Main Board:

Test Point	Signal Monitored	Typical Voltage
TP1	Voltage from motherboard +13.8 VDC line	+10 to +17 VDC
TP2	Regulated +9.5 VDC from motherboard	+9.5 VDC ± 5 %
TP9	Switched +13.8 VDC line from front panel switch	+10 to +17 VDC
TP37	+6.0 VDC supply	+6.0 VDC ± 5 %
TP38	-6.0 VDC supply	-6.0 VDC ± 5 %
TP54	+3.3 VDC supply	+3.3 VDC ± 5 %
TP55	+1.2 VDC supply	+1.2 VDC ± 5 %
TP56	+1.8 VDC supply	+1.8 VDC ± 5 %
TP57	+2.5 VDC supply	+2.5 VDC ± 5 %
TP58	+5.0 VDC supply	+5.0 VDC ± 5 %

Test Points are shown on the MT-4E Receiver Jumper and Test Point Locator Illustrations.

If the test point voltages are within the specified range the following tests further verify that the Receiver Main Board may not be the source of problem.

Apply an IF signal of frequency 21.4 MHz at a level of -30 dBm to the Receiver Main Board IF Input SMB connector as shown on the MT-4E Receiver Top Component View (2). If the signal is properly demodulated it proves that the Receiver Main Board and UDB are in working condition. Proceed to the following step:

Synthesizer and UDB Modules

The Synthesizer module and UDB are bound together through their communication link. At this level of fault diagnosis it is not feasible to isolate the problem between two units.

If the receiver front panel ON/OFF switch is set from the OFF position to the NORM position and the two front panel LEDs stay on, check that the Synthesizer and the UDB are properly seated on the Receiver Main Board and check the following test points on the UDB (to access the UDB, the shield lid covering the UDB will need to be removed as shown on the MT-4E Receiver Bottom Component View):

Test Point	Signal Monitored	Typical voltage
TP2	Logic power	+3.3 VDC ± 5 %
TP3	DSP core supply	+1.2 VDC ± 5 %
TP4	CPLD core supply	+1.8 VDC ± 5 %

Test Points are shown on the MT-4E Receiver Jumper and Test Point Locator Illustrations.

If the UDB voltages are not within the specified tolerances, it is most likely that the Receiver Main Board (that supplies these voltages to the UDB) is faulty or there is a short within the UDB.

If the UDB voltages are within the specified tolerances, inject a -70 dBm carrier on the Receiver frequency into the RF Input and check the RSSI Meter reading in the Service section of the RSS. If the RSSI Meter reading is low (< 30), perform the following test to verify that the synthesizer is locked on frequency:

Disconnect the LO output SMB connector from the Synthesizer to the RF Preselector, as shown on the MT-4E Receiver Top Component View (1), and connect the Synthesizer LO output to a radio communication test set. Confirm that the synthesizer LO frequency matches the Target Synthesizer RF OUT found in the Reference Oscillator area of the Service section on the RSS. The LO output should be approximately +7 dBm.

Check that the LO output (21.4 MHz above or below the receiver frequency / 73.35 MHz @ 800 MHz) of the synthesizer module is within the receiver frequency tolerances of ± 1.0 ppm (VHF) / ± 0.5 ppm (UHF) and ± 0.1 ppm @ 800 mHz, and that the RF frequency will change with programmed channel changes in the RSS. If this is not the case, it is most likely that the synthesizer or the UDB or both are faulty. The fault may be associated with the synthesizer code, the DSP Code or both.

Receiver RF Preselector

Check the +9.5 VDC Power Supply wire to the RF Preselector as shown on the MT-4E Receiver Top Component View (2). The supply voltage should be +9.5 VDC ± 5 %. inject a -30 dBm carrier on the Receiver frequency into the RF Input and check the IF Output of the RF Preselector is 21.4 MHz and 73.35 MHz @ 800 MHz, and it can be demodulated through the communication test set. If this is not the case the synthesizer, the RF Preselector or both are faulty.

To further isolate the fault, the LO output as shown on the MT-4E Receiver Top Component View (1) can be disconnected from the Synthesizer, and an LO input can be applied from an external source to the RF Preselector. The frequency of the external LO input should be the Target Synthesizer RF OUT found in the Reference Oscillator area of the Service section on the RSS. Check the 21.4 MHz and 73.35 MHz @ 800 MHz output of the module using a communication test set.

TRANSMITTER TROUBLESHOOTING

The Transmitter is composed of 4 main components, the Transmitter Main Board, the Synthesizer Module, RF Power Amplifier and Universal Daughter Board (UDB). An optional Encryption Board can also be installed in the Transmitter.

These steps will help you determine the most likely sub-assembly that contains a fault, and may help you determine what that fault is. The sub-assembly or the entire transmitter can be sent back to Daniels Service section for repair. Contact Daniels Service section before returning any product.

Before testing, the transmitter should be in the subrack, or connected to the subrack by means of an Extender card or kit, and the main power to the system (+13.8 VDC) and the +9.5 VDC regulated supply should be checked via the front panel of the System Regulator. The transmitter RF output should be terminated with a 50 Ω load, or communications test set.

Complete Transmitter

Flip the transmitter front panel NORMAL/OFF/ KEY TX switch from the OFF position to the NORMAL position and check that the two front panel LEDs both turn ON for less than 2 seconds and then turn OFF. If this is not the case, or the transmitter is not functioning properly, the following steps can be taken:

Connect the Transmitter to the PC with the USB cable and run the Radio Service Software (RSS). Select (P25 or Analog) Transmitter click on Configure, then click on Read to read the Transmitter configuration. If the RSS returns “Device Not Responding”, physically inspect the USB cable and connection, check the Daniels USB driver, and check the connection through the Device Manager. If the RSS still does not recognize the connection, the most likely fault is on the UDB.

Click on Tx ID, then click on Read to read the Transmitter ID. Confirm that the Frequency Band in the Synthesizer ID Model Number matches the Frequency Band in the Transmitter Global Settings. If the settings do not match, the synthesizer will require replacement, or the programming will need to be changed to match the synthesizer hardware.

If the transmitter still is not functioning properly the module level check should be conducted in the following order:

Transmitter Main Board

Check the following test points on the Transmitter Main Board:

Test Point	Signal Monitored	Typical voltage
TP1	Voltage from motherboard +13.8 VDC line	+10 to +17 VDC
TP2	Regulated +9.5 VDC from motherboard	+9.5 VDC ± 5 %
TP3	USB connector power	+3.0 VDC or +5.0 VDC
TP4	Switched +13.8 VDC line from front panel switch	+10 to +17 VDC

Test Points are shown on the MT-4E Transmitter Jumper and Test Point Locator Illustrations.

If the test point voltages are within the specified range, it is most likely that the Transmitter Main Board is not the source of problem. Proceed to the following step:

Synthesizer and UDB Modules

The Synthesizer module and UDB are bound together through their communication link. At this level of fault diagnosis it is not feasible to isolate the problem between two units.

If the transmitter front panel NORMAL/OFF/ KEY TX switch is set from the OFF position to the NORMAL position and the two front panel LEDs stay on, check that the Synthesizer and the UDB are properly seated on the Transmitter Main Board and check the following test points on the UDB (to access the UDB, the Amplifer sub-assembly and the shield lid covering the UDB will need to be removed as shown on the MT-4E Transmitter Amplifier Removed View):

Test Point	Signal Monitored	Typical Voltage
TP2	Logic power	+3.3 VDC ± 5 %
TP3	DSP core supply	+1.2 VDC ± 5 %
TP4	CPLD core supply	+1.8 VDC ± 5 %

Test Points are shown on the MT-4E Transmitter Jumper and Test Point Locator Illustrations.

If the UDB voltages are not within the specified tolerances, the Transmitter Main Board (that supplies these voltages to the UDB) is most likely faulty. If the UDB voltages are within the specified tolerances, it is most likely that the synthesizer or the UDB or both are faulty. The fault may be associated with the synthesizer code, the DSP Code or both.

If the transmitter front panel NORMAL/OFF/ KEY TX switch is set from the OFF position to the NORMAL position and the two front panel LEDs both turn ON for less than 2 seconds and then turn OFF and the RF output power control is set at its maximum in the Power Levels area of the Service section on the RSS, but the RF output power is considerably less than 8 W and 4 W @ 800 MHz:

check that the synthesizer Reference Oscillator is set to internal reference in the System Setup; Jumper Settings area of the Service section on the RSS.

check that the output of the synthesizer module on the RF cable as shown on the MT-4E Transmitter Bottom Component View is 0 dBm (± 2 dBm) and that the RF frequency will change with programmed channel changes in the RSS. If this is not the case, it is most likely that the synthesizer or the UDB or both are faulty. The fault may be associated with the synthesizer code, the DSP Code or both.

Transmitter Amplifier

Set the front panel switch on the transmitter to KEY TX and check that the Transmitter Output Power is set appropriately. The output power can be adjusted in the Power Levels area of the Service section on the RSS.

Check the following pins on connector J1 (while the transmitter is keyed):

Pin	Signal Monitored	Typical voltage
1	RF Enable / Power Control (+0.5 to +3.0 VDC corresponds to 0.5 to 8.0 W RF Power Output)	+0.5 to +3.0 VDC
2	Regulated +9.5 VDC from motherboard	+9.5 VDC ± 5 %
3	Voltage from motherboard +13.8 VDC line	+10 to +17 VDC

Pins are shown on the MT-4E Transmitter Bottom Component View.

If Pin 1 is not within tolerance, the most likely fault is in the UDB or Synthesizer module. If Pins 1, 2 and 3 are within the specified tolerances, and there is no RF output power, the most likely fault is in the Amplifier.

To test the RF power amplifier sub-assembly, set the output power to maximum, using the Power Level Adjustments in the Service mode of the RSS software and drive the input of the amplifier with a 0 dBm RF signal. Check that the RF power output is 8.0 W and 4.0 W @ 800 MHz when the front panel switch is set to KEY TX.

SYSTEM TROUBLESHOOTING

If the radio system is not receiving or transmitting on the right frequency, check the Channel and Bank select lines of the Receiver and Transmitter modules. The Motherboard has jumpers that allow one of 16 channels to be selected on a receiver or transmitter. The factory default is to have them all set to ground the channel select lines CSEL0-3, forcing the radio to operate on channel 1. On the receiver and transmitter there is also a Bank A/B line which usually floats high selecting Bank A. The receiver and transmitter have separate control of their channel select lines, so changing receiver channels does not affect the transmitter channel.

If the Radio Service Software is failing partway through a read or write of the receiver, check that the receiver is not squelching and unsquelching repeatedly during the read or write operation. Disconnect the RF signal source from the receiver during the read or write operation.

RADIO SYSTEM CONFIGURATIONS

REPEATER

The MT-4E series Receivers and Transmitters may be configured in a repeater configuration. The standard way of setting up a repeater system is to connect the receiver to the transmitter through a Radio Interconnect Cable plugged into the RJ45 CNTL BUS connectors on the front panels of each radio module. This cable routes Analog and Digital COR / PTT signals and LVDS Serial Data from the receiver to the transmitter in both Analog and P25 Digital mode. The Radio Interconnect Cable may be connected directly from the receiver to the transmitter, or may be routed through a Repeater Control Card.

A typical configuration is to set up the repeater to re-transmit an incoming signal in the same mode as it is received (i.e. normally, you would want a received analog signal to be repeated as analog and a received digital signal to be repeated as digital). This requires the Receiver and Transmitter modules to be programmed in Mixed Mode of operation through the RSS software. The repeater may also be programmed to operate in analog or P25 digital mode only.

Mixed Mode Repeat operation occurs as follows:

1. The receiver determines whether an incoming signal is analog or digital and asserts either the ANALOG COR or DIGITAL COR signal line on the front panel RJ45 CNTL BUS connector. LVDS Serial Data is sent to the RJ45 CNTL BUS connector as well.
2. The COR signal and LVDS Serial Data is transferred over the Radio Interconnect Cable directly to the Transmitter or is routed through a Repeater Control Card.
3. The transmitter senses the incoming ANALOG PTT or DIGITAL PTT signal from the front panel RJ45 CNTL BUS connector and keys up in analog mode or P25 digital mode. LVDS Serial Data is routed through the transmitter for transmission.

An alternate way of setting up a repeater system is to connect the receiver to the transmitter through an Audio Control Card or Base Controller. These control cards route analog audio and a single COR / PTT signal from the receiver to the transmitter. This configuration is recommended for analog repeater systems only.

The receiver and transmitter have no connection between them apart from the audio (Audio Control Card or Base Controller only), COR / PTT signals and LVDS Serial Data lines. The transmitter does not get any information from the receiver about which frequency or channel number to key up on. The receiver and transmitter channel is determined by the state of the channel select lines and bank select line.

NOTE: The transmitter is not to be operated as a repeater under an existing base station license.

ANALOG FIXED (BASE) STATION INTERFACE

The MT-4E series Receivers and Transmitters may be configured in a fixed (or base) station configuration with an analog interface. An Audio Control Card or Base Controller is added to the system for E & M control. For Tone Remote control of the system, a Tone Remote Adapter is added to the system along with the Controller. The Audio Control Card or Base Controller will also allow for repeat capability of the system using analog audio as the repeat path.

The Base Controller is used for system control of encryption and decryption of the P25 digital voice messages (the optional decryption / encryption boards are required in the receiver / transmitter modules).

DIGITAL FIXED (BASE) STATION INTERFACE

The MT-4E series Receivers and Transmitters may be configured in a fixed (or base) station configuration with a digital interface. A Universal Interface Card is added to the system for Ethernet control.

PARTS LISTS

MT-4E RECEIVER ELECTRICAL PARTS LIST

Part Number	Description	Product	Quantity
A11-FE4-150	RF PRESELECTOR CLASS B,136-174	VHF CLASS B	1
A11-FE4A-150	RF PRESELECTOR CLASS A,136-174	VHF CLASS A	1
A13-FE4-420	RF PRESELECTOR CLASS B,406-430	UHF (406-430) CLASS B	1
A13-FE4A-420	RF PRESELECTOR CLASS A,406-430	UHF (406-430) CLASS A	1
A13-FE4-460	RF PRESELECTOR CLASS B,450-470	UHF (450-470) CLASS B	1
A13-FE4A-460	RF PRESELECTOR CLASS A,450-470	UHF (450-470) CLASS A	1
A13-FE4-500	RF PRESELECTOR CLASS B,470-520	UHF (470-520) CLASS B	1
A13-FE4A-500	RF PRESELECTOR CLASS A,470-520	UHF (470-520) CLASS A	1
A11-RX4E-MAIN	RECEIVER MAIN BOARD ASSEMBLY	ALL	1
A11-UDB	UNIVERSAL DAUGHTER BOARD	ALL	1
A64-OR4-150	SYNTHESIZER, RX, VHF,136-174	VHF	1
A64-OR4-440	SYNTHESIZER, RX ,UHF,406-470	UHF	1
A64-OR4-500	SYNTHESIZER, RX ,UHF,470-520	UHF	1
A64-0R4-800	SYNTHESIZER, RX ,UHF,799-869	UHF	1
A14-RX4E-Main	RECEIVER MAIN BOARD ASSEMBLY	800 MHz	1
A15-FE4A-800	RF PRESELECTOR CLASS A 799–824	UHF 799–824 CLASS A	1
A15-FE4A-850	RF PRESELECTOR CLASS A 851–869	UHF 851–869 CLASS A	1

MT-4E RECEIVER MECHANICAL PARTS LIST

Part Number	Description	Product	Quantity
3536-10111405	LABEL/LEXAN, 14HP, VHF: RED	VHF	1
3536-10131410	LABEL/LEXAN, 14HP, UHF: BLACK	UHF	1
3702-10000120	FASTENER, QUICK RELEASE, GRAY	ALL	4
3702-10000614	HANDLE, FRONT PANEL, 14HP,GREY	ALL	1
3702-10001214	NAMEPLATE, BLANK, 14HP, ALUM.	ALL	1
3702-62501010	CASE, 14HP RF PLUG-IN, MT-3 RX	ALL	1
3702-63001101	PANEL, REAR,POS.1,14HP EXTRSN.	ALL	1
3802-61001082	PANEL/FRONT,W/IDENT: MT-4E RX	ALL	1
5630-12023250	GASKET, BeCu,3FINGER,.71”,CLIP	ALL	2
5671-250N062B	HOLE PLUG, .250” HOLE,NYL.,BLK	ALL	1
5812-2M5FP14S	SCREW, M2.5 x 14 FLAT/PHIL, A2	ALL	2
5812-2M5PP06S	SCREW, M2.5 x 6, PAN/PHIL, A2 (E)	ALL	3
5812-2M5PP12S	SCREW, M2.5 x 12 PAN/PHIL, A2	ALL	1
5812-2M5PP14S	SCREW, M2.5 x 14 PAN/PHIL, A2 (D)	ALL	1
5812-2M5VP08S	SCREW, M2.5x8,OVAL C/S/PHIL,A2	ALL	1
5812-3M0PP08T	SCREW, M3 x 8, PAN/PHIL, BLACK	ALL	4
5812-3M0VP06S	SCREW, M3 x 6,OVAL C/S/PHIL,A2 (C)	ALL	2
5812-3M0VP08S	SCREW, M3 x 8,OVAL C/S/PHIL,A2 (A & B)	ALL	6
5813-2M5SQ50Z	NUT, M2.5, SQUARE-5mm, ZINC	ALL	2
5814-3M0LK00S	LOCKWASHER, M3, SPLIT,A2 STEEL	ALL	4

MT-4E RECEIVER P25 DIGITAL FIRMWARE

Part Number	Description	Product	Quantity
APP-FIRM01-W-XX	DIGITAL UPGRADE FIRMWARE, MT-4E RX	ALL	1

MT-4E RECEIVER AND TRANSMITTER ENCRYPTION

Part Number	Description	Product	Quantity
ENCRYPT-MT4E-XX	ENCRYPTION MODULE, MT-4E RX/TX	ALL	1

MT-4E RECEIVER AND TRANSMITTER RSS

Part Number	Description	Product	Quantity
APP-RSS03-WC-XX	RADIO SERVICE SOFTWARE, MT-4E	ALL	1

MT-4E TRANSMITTER ELECTRICAL PARTS LIST

Part Number	Description	Product	Quantity
A11-UDB	UNIVERSAL DAUGHTER BOARD	ALL	1
A21-TX4E-MAIN	TRANSMITTER MAIN BOARD ASSEMBLY	ALL	1
A21-VPA155-08	TX POWER AMP, VHF130-180 MHz	VHF	1
A23-UPA450-08	TX POWER AMP, UHF 380-512 MHz	UHF	1
A64-OT4-150	SYNTHESIZER, TX, VHF,136-174 MHz	VHF	1
A64-OT4-440	SYNTHESIZER, TX, UHF,406-470 MHz	UHF	1
A64-OT4-500	SYNTHESIZER, TX, UHF,470-520 MHz	UHF	1
A64-0R4-800	SYNTHESIZER, TX, UHF,799-869 MHz	UHF	1
A25-UPA835-03	TX POWER AMP, UHF, 799-869 MHz	UHF	1

MT-4E TRANSMITTER MECHANICAL PARTS LIST

Part Number	Description	Product	Quantity
3536-10111405	LABEL/LEXAN, 14HP, VHF: RED	VHF	1
3536-10131410	LABEL/LEXAN, 14HP, UHF: BLACK	UHF	1
3702-10000120	FASTENER, QUICK RELEASE, GRAY	ALL	4
3702-10000614	HANDLE, FRONT PANEL, 14HP,GREY	ALL	1
3702-10001214	NAMEPLATE, BLANK, 14HP, ALUM.	ALL	1
3702-62502010	CASE, 14HP RF PLUG-IN, MT-3 TX	ALL	1
3702-63002101	PANEL, REAR,POS.4,14HP EXTRSN.	ALL	1
3802-61002121	PANEL/FRONT, W/IDENT: MT-4E TX	ALL	1
5630-12023250	GASKET, BeCu,3FINGER,.71”,CLIP	ALL	2
5671-250N062B	HOLE PLUG, .250” HOLE,NYL.,BLK	ALL	1
5812-2M5FP14S	SCREW, M2.5 x 14 FLAT/PHIL, A2	ALL	2
5812-2M5PP06S	SCREW, M2.5 x 6, PAN/PHIL, A2 (F)	ALL	4
5812-2M5PP12S	SCREW, M2.5 x 12 PAN/PHIL, A2 (E)	ALL	2
5812-3M0PP06S	SCREW, M3 X 6, PAN/PHILLIPS,A2 (D)	ALL	2
5812-3M0PP08T	SCREW, M3 x 8, PAN/PHIL, BLACK	ALL	4
5812-3M0VP08S	SCREW, M3 x 8,OVAL C/S/PHIL,A2 (A & C)	ALL	6
5812-5M0FP08S	SCREW, M5 x 8, FLAT/PHIL., A2 (B)	ALL	4
5813-2M5SQ50Z	NUT, M2.5, SQUARE-5mm, ZINC	ALL	2
5814-3M0LK00S	LOCKWASHER, M3, SPLIT,A2 STEEL	ALL	4
7910-WP0WP011	CABLE,SMB PLUG-PLUG,RG316,11cm	ALL	1
A89-MIC4-08	CABLE/CONN ASSY,MICROPHONE CON	ALL	1

MT-4E TRANSMITTER P25 DIGITAL FIRMWARE

Part Number	Description	Product	Quantity
APP-FIRM02-W-XX	DIGITAL UPGRADE FIRMWARE, MT-4E TX	ALL	1

GLOSSARY OF TERMS

AMBE+2™
: Abbreviation for “Advanced Multi Band Excitation”.

Bandwidth
: The difference between the limiting frequencies of a continuous frequency band. Typically measured in Kilohertz. May be considered the amount in kilohertz required for a single communications channel.

BER
: Abbreviation for “BIT Error Rate”

BPS
: Abbreviation for BITs Per Second, a data rate measure.

C4FM
: The acronym for a 4-ary FM transmitter which uses QPSK modulation to work with a CFDD compatible receiver.

Channel
: A single unidirectional or bidirectional path for transmitting or receiving, or both, of electrical or electromagnetic signals.

Channel Spacing
: Typically measured in kilohertz from the center of one channel to the center of the next-adjacent-channel. May, or may not, be identical to bandwidth.

Common Air Interface (CAI)
: A radio to radio signal path defined in terms of Access Method, Modulation Scheme, Vocoding Method, Channel Data Rate and Channel Data Format.

CTCSS
: Abbreviation for “Continuous Tone-Controlled Squelch System”.

DCS
: Abbreviation for “Digital Coded Squelch”.

DSP
: Abbreviation for “Digital Signal Processor” a specialized microcomputer.

DTMF
: Abbreviation for “Dual-Tone Multi-Frequency” - a signaling scheme used by the telephone system in which two voice band tones are generated for each keypad key press.

Encryption
: A coding of plain text (or clear voice) into unintelligible forms for secure transmission.

Error Correction
: Digital coding technique for detecting and correcting information transmission errors.

FCC
: Abbreviation for “Federal Communications Commission”

Firmware
: Software that is permanently stored in a hardware device which allows reading and executing the software, but not writing or modifying the software.

Modulation
: A controlled variation of any property of a carrier wave for the purpose of transferring information.

LSB
: Abbreviation for “Least Significant BIT.”

MSB
: Abbreviation for “Most Significant BIT.”

NAC
: Abbreviation for “Network Access Code.” A twelve bit field identifying the network of the radio message. Typically used to steer repeater functions.

PTT
: Abbreviation for “Push-to-Talk”, the switch on a subscriber unit which, when pressed, causes the subscriber unit to transmit.

QPSK
: Abbreviation for “Quadrature Phase Shift Keying” modulation technique. PSK using four phase states.

RF
: Abbreviation for “Radio Frequency.”

Signal
: The detectable transmitted energy which carries information from a transmitter to a receiver.

SINAD
: Abbreviation for “SIgnal plus Noise And Distortion” to “noise and distortion” ratio.

Squelch
: A radio circuit that eliminates noise from the speaker when no transmitted signal is present.

Subscriber Unit
: A mobile or portable radio unit used in a radio system.

TGID
: Abbreviation for “Talk-Group Identifier.” A sixteen bit field identifying talk-group of the radio message.

TIA
: Abbreviation for “Telecommunications Industry Association”

Time-Out-Timer
: A function that limits the transmission period to a pre-defined time. The user will automatically stop transmitting when the timer goes off after the pre-defined time.

VOCODER (Voice-Coder)
: A type of voice coder. Usually consisting of a speech analyzer and a speech synthesizer which convert analog speech into digital signals for transmission and digital signals back into artificial speech sounds for reception.