



MT-3 RADIO SYSTEMS

PAGING MODULATOR INSTRUCTION MANUAL CI-PM-3

Covers models: CI-PM-3-00

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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 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.

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1 GENERAL

1.1 Introduction

The CI-PM-3 Paging Modulator module is an optional plug-in component of the MT-3 Radio Repeater System. This module provides digital and/or analog paging capability for Daniels MT-3 transmitters in all supported frequency bands.

The CI-PM-3 is designed for low power consumption, typically drawing less than 250 mA in steady state. In its standard configuration, the CI-PM-3 uses an on-board frequency reference source consisting of a 10 MHz OCXO with a standard stability of 0.03 PPM. 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. To ensure that paging signals are the same relative to each transmitter, the CI-PM-3 also incorporates a limited delay compensation for the different link propagation paths between transmitters.

The CI-PM-3 Paging Modulator supports both analog and digital paging formats, and can transmit POCSAG and other 2-level modulation schemes at data 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 in non-repeater mode (i.e. in a base station paging transmitter application only) at data transfer rates up to 1600 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.

Setup conditions are established via front panel switch settings, while internal jumper settings and setup adjustments are easily accessible using the EC-96, 96 Pin Extender Card.

The CI-PM-3 Paging Modulator includes the following standard features:

- low power analog and CMOS control circuitry.
- extended operating temperature range;
- jumper selectable Repeater/paging transmitter configuration;
- on-board +/-0.03 PPM 10 MHz OCXO;
- front panel selection of PLL OCXO using external high stability frequency reference;
- jumper and line selectable analog / digital paging configuration;
- connection for optional CTCSS encoder / decoder;
- balanced 600 Ω / single-ended microphone input;
- selectable digital delay for Simulcast operation

1.2 Construction

The CI-PM-3 Paging Modulator is packaged in a compact Eurostandard shell module housing of nickel/steel with an anodized aluminum front panel. Corrosion resistant fasteners are used throughout the assembly.

1.3 Printed Circuit Board Numbering Convention

To ease troubleshooting and maintenance procedures, Daniels Electronics Limited has adopted a printed circuit board (PCB) numbering convention in which the last two digits of the Circuit Board number represent the Circuit Board version. For example:

- PCB number 50002-02 indicates Circuit Board version 2.0.
- PCB number 43-912010 indicates Circuit Board version 1.0;

All PCB's manufactured by Daniels Electronics are identified by one of the above conventions.

1.4 Specifications

1.4.1 General Specifications

Model Number:	CI-PM-3
Type:	MT-3 Series Paging Modulator
Compatibility:	MT-3 Series Radio Systems
Modulation:	16K0F3E (FM Analog), and 14K7F1D (FM Data Transmission)
Audio Input:	Balanced 600 Ω (tone or voice)
Digital Input:	Bipolar: RS-232 compatible
Reference Input:	10 MHz, 0.5 to 2.5 V rms, 50 Ω Front Panel SMA
Reference Output:	10 MHz (Modulated), 2.5 V rms, 50 Ω Front Panel SMA

Frequency Stability:	Standard: $\pm 0.03\text{ppm}$ from -40°C to $+60^{\circ}\text{C}$ Optional: External High Stability $\pm 0.002\text{ppm}$ from -40°C to $+60^{\circ}\text{C}$ (requires WWV or GPS reference source).
Duty Cycle:	Continuous, 100% from -40°C to $+60^{\circ}\text{C}$
Audio Response:	0 Hz to 3.4 kHz
Maximum Deviation:	± 50 PPM
Analog / Digital PTT Activation:	Front panel connector and rear motherboard connection
Current Consumption:	+13.8 VDC supply: 600 mA power 200 mA steady state +9.5 VDC supply: 200mA (all options enabled) 80mA (all options disabled) 70mA (LED indicators off).
Operating Temperature Range:	-40°C to $+60^{\circ}\text{C}$
Paging Formats:	4-Level Base Station paging only (Flex) 2-Level Multiple Transmitter paging (POCSAG)
Simulcast Operation:	Supported with the addition of WWV/GPS receiver.
IC Type Approval:	Approved for use with MT-3 VHF Tx additional frequency band approvals to be sought.
FCC Type Acceptance:	Approved for use with MT-3 VHF Tx additional frequency band approvals to be sought.

1.4.2 CTCSS Decoder/Encoder (Option)

Manufacturer:	Communications Specialists Inc.
Model Number:	TS-64
Number of Tones:	64
Frequency Range of Tones:	33.0 to 254.1 Hz
Signal to Noise:	Better than 4 dB SINAD
Decode Time:	150 ms nominal
Fade Time:	350 ms nominal
Squelch Tail Elimination::	160 ms reverse phase burst
Current Consumption:	9 mA

1.4.3 Physical Specifications

Physical Dimensions:	<u>Width:</u> 3.5 cm (1.38")	<u>Height:</u> 12.8 cm (5.05")	<u>Depth:</u> 19 cm (7.5")
Module Weight:	0.4 kg (1 lb.)		
Corrosion Prevention:	Anodized aluminum construction with stainless steel hardware. Selectively applied Conformal coated glass epoxy 4 layer printed circuit boards. Gold plated module connectors.		
Module Design:	Compact Eurostandard modular design. Plug-in module mates with Daniels standard 19" M3 repeater subrack. Interchangeable for test and repair.		
External Connections:	REF Input and Output SMA connectors located on the module's front panel. Motherboard Connections (Audio, Modulation, Power, and Control) are made through a 96 pin, gold plated type C connector on the rear of the module. User connections (Audio, Modulation, and Control) are made through a front panel DB-15 connector as well as through the 96 pin connector on the rear of the module.		

2 THEORY OF OPERATION

3 ALIGNMENT PROCEDURE AND INSTALLATION

3.1 General

The CI-PM-3 Paging Modulator is by default configured for stand-alone base station paging, using 2-Level paging data with a binary polarity of 1, and using the on-board +/-0.03 PPM 10 MHz OCXO. Table 4-4 contains a complete list of CI-PM-3 default jumper settings. The CI-PM-3 can also be configured for 4-level signal (base transmitter only) paging, remote paging, link repeater or higher stability operation. Each of these configurations is covered separately in the following sections.

3.2 Repair Notes

Removal and replacement of surface mount components should be performed only in specifically designed surface mount rework and repair stations complete with electrostatic discharge (ESD) protection.

To help prevent damage to the circuit board pads when removing Surface Mount Solder Jumpers, it is recommended that solder braid be used in place of manual vacuum de-soldering tools.

3.3 Recommended Equipment List

Alignment of the CI-PM-3 requires the following test and radio equipment, or its equivalent:

- | | |
|----------------------------------|--|
| • Power Supply: | Regulated +13.8 VDC at 2 A |
| • Oscilloscope / Multi-meter: | Fluke 97 Scopemeter |
| • Current Meter: | Fluke 75 Multi-meter |
| • Radio Communications Test Set: | Marconi Instruments 2955R (W/External Reference) |
| • Sub-rack: | Daniels SR-3 Series 19" Sub-rack |
| • System Monitor: | Daniels SM-3 Series System Monitor |
| • Transmitter Module: | Daniels Enhanced Performance VT-3 / UT-3 Series |
| • Extender Card and Cable: | Daniels EC-96K, 96 Pin Extender Card and Cable |
| • Alignment Tool: | Johanson 8766 |

Note: It is highly recommended that the Radio Communications Test Set be frequency locked to an external 10 MHz reference (WWV or GPS), **especially** if the factory-adjusted frequency settings are to be altered in any way.

3.4 Installation

1. Install the Daniels EC-96 Extender Card in either the far left-hand or the far right-hand slot of the subrack (as viewed from the front). Remove the side covers of the CI-PM-3 Paging Modulator and attach the 96-Pin Extender Cable between it and the Extender Card.
2. Apply +13.8 VDC power to the Subrack. Allow approximately 15 minutes for warm-up.

3.5 Alignment

Refer to Figure 5-1 for the location of the CI-PM-3 module front panel controls.

1. Ensure the CI-PM-3 circuit board jumpers are initialized to their default settings (refer to Table 4-4). Note any differences so that the jumpers can be returned to their former positions.
2. For alignment procedures in this section, set the front panel switches to the following settings, unless otherwise noted:

a)	SW1 (FREQ REF)	set to	INT
b)	SW2 (MODE)	set to	SETUP
c)	SW3 (SET MOD)	set to	2 LEVEL
d)	SW4 (SET DEV)	set to	Data "1" (Top Position)
3. Ensure the Transmitter Audio Processor circuit board jumpers are initialized to their default settings (refer to Tables 4-7 or 4-8).
4. Connect the CI-PM-3 REF OUT connector to the transmitter REFERENCE INPUT connector via a SMA to SMA RF cable.
5. Remove external connections to the DB-15 connector on the CI-PM-3 or the Alarm lines on the back of the subrack.

Do not connect any other input signal/control lines to the CI-PM-3 at this time.

3.6 Frequency (Digital Paging) Adjustment

CI-PM-3 frequency adjustments are factory set. It is strongly recommended that they not be altered. The following procedure applies **only** if field adjustment is required:

1. Set front panel SW1 (FREQ REF) INT and remove shunt jumper JU6-A.
2. Set shunt jumpers JU23-A and JU41-B.
3. Set the transmitter front panel NORM/KEY TX switch to KEY TX.

4. Monitor the Communications Test Set and adjust FREQ ADJ potentiometer R82 for the transmitter operating frequency ± 1 Hz.
5. Set the transmitter front panel NORM/KEY TX switch to NORM and replace JU6-A.

3.7 Reference (Analog Paging) Adjustment

CI-PM-3 Reference frequency adjustment is factory set. It is strongly recommended that they not be altered. The following procedure applies **only** if field adjustment is required.

1. Ensure shunt jumper JU6-A is installed.
2. Set shunt jumpers JU23-A and JU41-A (or not installed).
3. Set the transmitter front panel NORM/KEY TX switch to KEY TX.
4. Monitor the Communications Test Set and adjust REF ADJ potentiometer R24 for the transmitter operating frequency ± 1 Hz.
5. Set the transmitter front panel NORM/KEY TX switch to NORM.

3.8 Test Data Symmetry Adjustment

1. Set the oscilloscope for 1.0 V/Div (vertical) and 0.5 ms/Div (horizontal). Monitor TP10.
2. Set shunt jumpers JU23-A and JU41-B, and set JU36 to bypass.
3. Set SW3 (SET MOD) to 2 LEVEL and SW4 (SET DEV) to the center or “Continuous Bit Stream” position.
4. Adjust R70 (Test Data Symmetry Adjust) for symmetrical positive and negative pulses (i.e. of equal width) as measured at TP10.

3.9 2 And 4 Level Deviation Adjustment

1. Set shunt jumpers JU23-A and JU41-A (or not installed).
2. Monitor TP11 with a voltmeter and adjust R110 for approximately 4 volts at TP11.
3. Monitor the transmitter frequency and deviation on the Communications Test Set and set the transmitter front panel NORM/KEY TX switch to KEY TX.
4. Set shunt jumpers JU23-A and JU41-B.

5. Set SW3 (SET MOD) to 2 LEVEL, and SW4 (SET DEV) to the Data “1” (top) position. For a VHF system adjust R5 (2-LVL +Dev) for +4.8 kHz deviation (4.8 kHz above center frequency). For a UHF system adjust R5 for +4.2 kHz deviation.
6. Change SW4 (SET DEV) to the Data “0” (bottom) position. For a VHF system adjust R6 (2-LVL -Dev) for -4.8 kHz deviation (4.8 kHz below center frequency). For a UHF system adjust R6 for -4.2 kHz deviation.
7. Set shunt jumper JU23-B.
8. Change SW3 (SET MOD) to 4 LEVEL. Adjust R4 (4-LVL -Dev) for -1.6 kHz deviation.
9. Change SW4 (SET DEV) to the Data “1” (top) position. Adjust R3 (4-LVL +Dev) for +1.6 kHz deviation.
10. Set SW3 (SET MOD) to 2 LEVEL. Set SW4 (SET DEV) to the center position. Adjust R23 (BP DEV ADJ) for maximum deviation of +/-4.8 kHz.

3.10 PLL Setup

CI-PM-3 PLL adjustments are factory set. It is **strongly** recommended that they not be altered. The following procedure applies **only** if field adjustment is required:

1. Install Power Enable surface mount jumpers JU37, JU39, JU56 and JU59.
2. Ensure front panel SW1 (FREQ REF) is set to EXT, and shunt jumper JU6-A is removed.
3. Set shunt jumpers JU23-A and JU41-A (or not installed).
4. Connect the 50 Ohm output of a high stability, 10 MHz reference to front panel REF IN SMA connector J3. Ensure the output level of the external reference is between 0.5 to 2.5 V rms.

Steps 5 through 7 apply to Daniels VR-3/150 transmitters.

5. Measure and record the voltage at TP13 with the DMM.
6. Measure the voltage at TP12 with the DMM.
7. Adjust PLL CAL potentiometer R101 until the voltage measured at TP12 matches the voltage measured in step (5) above within ± 0.2 Vdc. Note that when the PLL locks in, the voltage at TP12 will also lock in to within ± 0.2 Vdc of the voltage at TP13. At this point further adjustment of R101 will not change the value unless it is brought out of lock.

Steps 8 and 9 apply to Daniels UHF transmitters.

8. Monitor TP12 with an oscilloscope.
9. Adjust the PLL CAL potentiometer R101 until the voltage measured at TP12 is over 2.7 volts. You should observe a clean DC voltage when the PLL locks in. Any voltage below 2.7 volts results in a badly distorted 10 MHz square wave.
10. Replace shunt jumper JU6-A.

3.11 Data Delay Setup

1. Enable the DATA DELAY option by installing Power Enable surface-mount jumpers JU38 And moving the two DATA DELAY shunt jumpers of JU36 to the DELAY (vertical) position.
2. Set front panel switches SW2 (MODE) to SETUP, SW3 (SET MOD) to 2 LEVEL, and SW4 (SET DEV) to “Continuous Bit Stream” (refer to SW4 DETAIL in Figure 6-1).

To calibrate the positive and negative edge delay:

3. Set the oscilloscope for 1.0 V/Div (vertical) and 0.5 μ s/Div (horizontal). Select channel 1 as trigger input and set Trigger Slope to positive.
4. Monitor the data signal at TP9 on channel 1 of the oscilloscope.
5. Monitor and record the period of the data delay pulse at TP7 on channel 2 of the oscilloscope.
6. Set Trigger Slope to negative.
7. Continue monitoring the data signal at TP9 on channel 1 of the oscilloscope while monitoring the period of the data delay pulse at TP7 on channel 2.
8. Adjust R95, DELAY SYNC, until the period of the data delay pulse measured at TP7 is identical to that measured in step (5) above.

To set the delay resolution (output frequency of Programmable Counter U22):

9. With surface mount jumpers JU31A, JU32A and JU33A installed, monitor the frequency of the signal at TP8.
10. Adjust tuning capacitor C55 for a frequency of 1.0 MHz (+/- 10 Hz) at TP8.

3.12 Simulcast Delay Setup

A typical Simulcast system is depicted in Figure 5-2. To correctly determine the differing propagation path delays to each transmitter in a Simulcast system and compensate for them, signal delays in both the transmission medium and the equipment must be known. For the purposes of this manual, it is assumed that only Daniels MT-3 radio equipment will be utilized at each paging site, and that each radio subrack will be identically configured with CI-PM-3 Paging Modulator modules.

Signal delays from the base transmitter to any paging transmitter are calculated as follows:

$$\text{Delay} = t_{(\text{Link})} + t_{(\text{Eqpt})}$$

Where:

$$\begin{aligned} t_{(\text{Link})} &= \text{Propagation delay from Base TX to Paging TX} \\ t_{(\text{Eqpt})} &= t_{(\text{RX})} + t_{(\text{PM})} + t_{(\text{TX})} \\ t_{(\text{RX})} &= \text{Delay through Receiver} \\ t_{(\text{PM})} &= \text{Delay through Paging Modulator} \\ t_{(\text{TX})} &= \text{Delay through Transmitter} \\ d &= \text{Distance} \end{aligned}$$

The delay through the equipment at each paging transmitter site, $t_{(\text{Eqpt})}$, will be identical for each link, and can therefore be eliminated from our calculations. As such, the only delay variable(s) of interest will be the distance from the base transmitter to each paging transmitter. Since radio waves propagate at or near the speed of light (3×10^8 m/sec), the delay calculation becomes:

$$\begin{aligned} \text{Delay} &= t_{(\text{Link})} \\ &= d \text{ (km)} \times 3.33 \mu\text{sec} \\ &\quad \text{or} \\ &= d \text{ (mi)} \times 5.37 \mu\text{sec} \end{aligned}$$

For the Simulcast system depicted in Figure 5-2, the signal transmitted by PAGING TX #1 will not be delayed, as this is the furthest site from the BASE TX. However, to ensure identical signal processing characteristics at each site, the DATA DELAY circuitry of the CI-PM-3 at PAGING TX #1 will be enabled, but with zero delay selected. PAGING TX #2 will have its paging signal delayed by a value proportional to the difference in distance between PAGING TX #1 and PAGING TX #2 to the BASE TX. The delay for PAGING TX #2 is therefore calculated as:

$$\begin{aligned} \text{Delay}_{(\text{Link B})} &= (d_{(\text{Link A})} \text{ (km)} - d_{(\text{Link B})} \text{ (km)}) \times 3.33 \mu\text{sec} \\ &\quad \text{or} \\ &= (d_{(\text{Link A})} \text{ (mi)} - d_{(\text{Link B})} \text{ (mi)}) \times 5.37 \mu\text{sec} \end{aligned}$$

The delay calculations for any paging transmitter site in a multiple-transmitter system, with distances measured from the site of interest back to the BASE TX, becomes:

$$\begin{aligned} \text{Delay}_{(\text{Site of Interest})} &= (d_{(\text{Furthest Site})} (\text{km}) - d_{(\text{Site of Interest})} (\text{km})) \times 3.33\mu\text{sec} \\ &\text{or} \\ &= (d_{(\text{Furthest Site})} (\text{mi}) - d_{(\text{Site of Interest})} (\text{mi})) \times 5.37\mu\text{sec} \end{aligned}$$

To set the delay value: Once the required delay has been calculated for a particular paging site, refer to Table 4-3 delay settings:

- a) Locate the DELAY (µsec) value which is closest to the calculated value.
- b) Set surface mount jumpers JU31, JU32, JU33, and JU35 according Table 4-3 in section 4.3.

Data Delay Adjust: To set delay values other than those listed in Table 4-3:

1. Set the oscilloscope for 1.0 V/Div (vertical) and 0.5 µs/Div (horizontal). Select channel 1 as trigger input and set Trigger Slope to positive.
2. Monitor the test data signal at TP9 on channel 1 of the oscilloscope and the output signal at TP5 on channel 2.
3. Adjust the oscilloscope for maximum horizontal display of the distance between the signals' leading edges. Adjust tuning capacitor C55 until the output signal's leading edge on channel 2 is delayed from the input signal's leading edge on channel 1 by the desired delay amount.

Example: To set a delay of 44 µsec:

- i) Set oscilloscope horizontal resolution to 5 µsec/div.
- ii) Install surface mount jumpers JU31B, JU32A, JU33A and JU35E (refer to Table 4-3).
- iii) Monitor TP9 on channel 1 of the oscilloscope. Monitor TP5 on channel 2 of the oscilloscope. Adjust C55 for 8.8 horizontal divisions between the signals' leading edges (8.8 × 5 µsec = 44 µsec delay).

3.13 Repeater Configuration

The CI-PM-3 modules at both the base transmitter and paging/repeater must be configured individually. Individual setup procedures must also be followed for analog/digital paging and for digital-only paging.

Note: The CI-PM-3 modules must be set for 2-level signal operation only when configured for use in a paging repeater system.

3.13.1 Base Transmitter Site CI-PM-3 Configuration

The setup instructions of sections 3.13.1 through 3.13.3 must be completed prior to commencing setup of the remote paging/repeater site CI-PM-3. Jumper designators separated by a '/' indicates an 'and/or' selection (eg JU19/JU45 means JU19 and/or JU45).

3.13.1.1 Digital-Only Paging

1. Install shunt jumpers JU7-A, JU8-A, JU10-A, JU41-C and JU23-A, JU23-B or JU23-C.
2. Install surface mount jumpers JU22, JU55, and JU20/JU21.
3. Remove surface mount jumpers JU19, JU28, JU29, JU30, JU34, JU43, JU44, JU45, JU52, JU53 and JU54.

3.13.1.2 Analog/Digital Paging

Ensure the TS-64 CTCSS Module, MOD1, is installed. Refer to section 3.13.3 for TS-64 CTCSS Module Configuration and settings for jumpers JU52, JU53 and JU54.

1. Install shunt jumpers JU7-A, JU8-A, JU10-B, JU41-A and JU23-A, JU23-B or JU23-C.
2. Install surface mount jumper JU20/JU21, JU22 and JU55.
3. Remove surface mount jumpers JU19, JU28, JU29, JU30, JU34, JU43, JU44, JU45 and JU51.

3.13.2 Repeater Site CI-PM-3 Configuration

At the remote paging/repeater site, the digital paging signal is received and discriminated by the receiver, regenerated (reshaped) by the CI-PM-3, and re-transmitted through the normal CI-PM-3 data signal path. Analog paging signals are routed from the receiver, through the CI-PM-3, then directly to the transmitter.

3.13.2.1 Digital-Only Repeater

1. Install shunt jumpers JU41-C and JU23-A, JU23-B or JU23-C.
2. Install surface mount jumpers JU7-B, JU8-B, JU10-A, JU19/JU45, JU20/JU21, JU22, JU29/JU43, and JU55.
3. Remove surface mount jumpers JU34, JU51, JU52, JU53 and JU54.

3.13.2.2 Analog/Digital Repeater

Ensure the TS-64 CTCSS Module, MOD1, is installed. Refer to section 3.13.3 for TS-64 CTCSS Module Configuration and settings for jumpers JU52, JU53 and JU54.

1. Install shunt jumpers JU7-B, JU8-B, JU10-B, JU41-A and JU23-A, JU23-B or JU23-C.
2. Install surface mount jumpers JU19/JU45, JU20/JU21, JU22, JU28, JU29/JU43, JU30/JU44 and JU55.
3. Remove surface mount jumpers JU34 and JU51.

3.13.3 TS-64 Configuration

1. Ensure POLARITY jumper JP7 is installed.
2. For normal operation (i.e. receiver audio is muted until a CTCSS coded transmission is received):
 - a) Ensure TS-64 jumper JP11 is removed.
 - b) Ground the TS-64 Hang-up Input:
 - i) Install jumper JU52, or
 - ii) Remove jumper JU52, install jumper JU53 and ground CTCSS HU/BUSY input J1 Pin 11.

3. To place the TS-64 in monitor mode (i.e. over-ride the decoder and unmute the receiver audio for channel monitoring):
 - a) Ensure TS-64 jumper JP11 is removed.
 - b) Ensure the TS-64 Hang-up Input is floating or above ground potential:
 - i) Remove jumpers JU52 and JU53, or
 - ii) Remove jumper JU52, install jumper JU53, and leave CTCSS HU/BUSY input J1 Pin 11 floating.
4. To disable paging transmission while the channel is busy:
 - a) Install TS-64 jumper JP11.
 - b) Remove jumper JU52, install jumpers JU53 and JU54.

4 CONNECTOR PIN FUNCTIONS AND JUMPER FUNCTIONS

4.1 Data / Control Port (Connector J1) Pin Functions

Table 4-1 Data / Control Port (Connector J1) Pin Functions

PIN	NAME	FUNCTION
1	2-Lvl Data	2 Level RS-232 Data input.
2	4-Lvl Data	4 Level RS-232 Data input.
3	Ext Clock	External Clock for 4 Level signal synchronization.
4	2-Lvl/4-Lvl Select	2 Level / 4 Level select. Low = 2 Level, High = 4 Level.
5	A/D Mode Select	Analog / Digital Mode select. Low = Digital, High = Analog.
6	Discr O/P	Discriminator Output from Receiver.
7	PTT	Push To Talk.
8	Ground	Ground.
9	Balanced Audio I/P 1	Balanced Audio Input 1. Routed directly to Transmitter.
10	Balanced Audio I/P 2	Balanced Audio Input 2. Routed directly to Transmitter.
11	Data Out	Regenerated digital data from receiver.
12	HU/Busy	CTCSS Hang Up / Busy signal from optional CTCSS module.
13	No Connection	-
14	No Connection	-
15	No Connection	-

4.2 Motherboard Interface (Connector P1) Pin Functions

Table 4-2 Motherboard Interface Connector P1 Pin Functions

Note: **Bolded** entries are utilized by CI-PM-3

PIN	NAME	FUNCTION
C1	IMC1	Inter-module Communications Line No. 1
B1	5W RX AUDIO	5W RX A/RX B Audio From System Monitor
A1	5W RX AUDIO	5W RX A/RX B Audio From System Monitor
C 2	TX A AUDIO CNTL	TX A Audio Control
B2	13.8V	13.8V from M3 Motherboard J8 (Unregulated)
A2	13.8V	13.8V from M3 Motherboard J8 (Unregulated)
C3	IMC2	Inter-module Communications Line No. 2
B3	RX A AMPD AUDIO	RX A Amplified Audio Output
A3	RX B AMPD AUDIO	RX B Amplified Audio Output
C 4	TX B AUDIO CNTL	TX B Audio Control
B4	9.5V	Regulated +9.5V from System Monitor
A4	9.5V	Regulated +9.5V from System Monitor
C5	IMC3	Inter-module Communications Line No. 3
B5	RX A 9.5V	RX A Current Sense Output Line (Supply)
A5	RX B 9.5V	RX B Current Sense Output Line (Supply)
C 6	ALARM 1	Inter-module Alarm Line No. 1.
B6	TX A PTT	Transmitter A Press To Talk input.
A6	TX B PTT	Transmitter B Press To Talk input.
C 7	ALARM 2	Inter-module Alarm Line No. 2.
B7	RX A 9.5V MON	RX A Current Sense Output Line (Module)
A7	RX B 9.5V MON	RX B Current Sense Output Line (Module)
C 8	ALARM 3	Inter-module Alarm Line No. 3
B8	RX A COR	RX A Carrier Operated Relay Output
A8	RX B COR	RX B Carrier Operated Relay Output

PIN	NAME	FUNCTION
C 9	ALARM 4	Inter-module Alarm Line No. 4
B9	TX A STANDBY	TX A Audio Standby
A9	TX B STANDBY	TX B Audio Standby
C10	RX A SQL OVERRIDE	RX A Squelch Disable Input
B10	RX A DISC O/P	RX A Discriminator Output
A10	TX A PTT OUT	TX A Microphone Press To Talk Output
C11	ALARM 5	Inter-module Alarm Line No. 5
B11	SPARE 5	Inter-module Spare Line No. 5
A11	SPARE 6	Inter-module Spare Line No. 6
C12	RX A SQL FLAT	RX A Squelched, Flat Audio Output
B12	RX A ISO COR A	RX A Isolated Carrier Operated Relay, Side A O/P
A12	RX A ISO COR K	RX A Isolated Carrier Operated Relay, Side K O/P
C13	ALARM 6	Inter-module Alarm Line No. 6
B13	RX A DISC L/P O/P	RX A Discriminator Low-Pass Audio Output
A13	RX B DISC L/P O/P	RX B Discriminator Low-Pass Audio Output
C14	RX B SQL DE-EMP	RX B Squelched, De-Emphasized Audio Output
B14	SPARE 3	Inter-module Spare Line No. 3
A14	SPARE 4	Inter-module Spare Line No. 4
C15	ALARM 7	Inter-module Alarm Line No. 7
B15	RX A SIG STREN	RX A Signal Strength Indicator Output
A15	RX B SIG STREN	RX B Signal Strength Indicator Output
C16	TX B BAL I/P 1	TX B Balanced Audio Input, Side 1
B16	TX B SUBT I/P 1	TX B Subtone Audio Input No. 1
A16	TX B PTT OUT	TX B Microphone Press To Talk Output
C17	ALARM 8	Inter-module Alarm Line No. 8
B17	TX A VSWR FWD	TX A VSWR Forward Level Indicator Output
A17	TX B VSWR FWD	TX B VSWR Forward Level Indicator Output
C18	TX A BAL I/P 1	TX B Balanced Audio Input, Side 1
B18	TX A BAL I/P 2	TX B Balanced Audio Input, Side 2
A18	TX B BAL I/P 2	TX B Balanced Audio Input, Side 2
C19	SPARE 1	Inter-module Spare Line No. 1
B19	TX A VSWR REV	TX A VSWR Reverse Level Indicator Output
A19	TX B VSWR REV	TX B VSWR Reverse Level Indicator Output
C20	SPARE 2	Inter-module Spare Line No. 2
B20	TX A DIR MOD	TX A Direct Modulation Input
A20	TX B DIR MOD	TX B Direct Modulation Input
C21	TX A CSEL D0	TX A Channel Select Line No. D0
B21	TX A CSEL D1	TX A Channel Select Line No. D1
A21	TX A CSEL D2	TX A Channel Select Line No. D2
C22	TX A SUBT I/P 1	TX A Subtone Audio Input No. 1
B22	RX A MUTE	RX A Mute Input
A22	RX A SQL DE-EMP	RX A Squelched, De-Emphasized Audio Output
C23	TX A CSEL D3	TX A Channel Select Line No. D3
B23	RX A CSEL D0	RX A Channel Select Line No. D0
A23	RX A CSEL D1	RX A Channel Select Line No. D1
C24	TX A SUBT I/P 2	TX A Subtone Audio Input No. 2
B24	RX A BAL O/P 1	RX A Balanced Audio Output, Side 1
A24	RX A BAL O/P 2	RX A Balanced Audio Output, Side 2
C25	RX A CSEL D2	RX A Channel Select Line No. D2
B25	RX A CSEL D3	RX A Channel Select Line No. D3
A25	TX B CSEL D0	TX B Channel Select Line No. D0
C26	TX B SUBT I/P 2	TX B Subtone Audio Input No. 2
B26	RX B SQL OVERRIDE	RX B Squelch Disable Input
A26	RX B MUTE	RX B Mute Input

PIN	NAME	FUNCTION
C27	TX B CSEL D1	TX B Channel Select Line No. D1
B27	TX B CSEL D2	TX B Channel Select Line No. D2
A27	TX B CSEL D3	TX B Channel Select Line No. D3
C28	RX B DISC O/P	RX B Discriminator Audio Output
B28	RX B ISO COR K	RX B Isolated Carrier Operated Relay, Side K O/P
A28	RX B ISO COR A	RX B Isolated Carrier Operated Relay, Side A O/P
C29	RX B CSEL D0	RX B Channel Select Line No. D0
B29	RX B CSEL D1	RX B Channel Select Line No. D1
A29	RX B CSEL D2	RX B Channel Select Line No. D2
C30	RX B BAL O/P 1	RX B Balanced Audio Output, Side 1
B30	RX B BAL O/P 2	RX B Balanced Audio Output, Side 2
A30	RX B SQL FLAT	RX B Squelched, Flat Audio Output
C31	RX B CSEL D3	RX B Channel Select Line No. D3
B31	RX A PRIORITY COR	RX A Priority COR (not affected by Mute)

4.3 CI-PM-3 Data Delay Jumper Settings

Table 4-3 Delay Settings

JUMPER SETTINGS				DELAY	DISTANCE	DISTANCE
JU33	JU32	JU31	JU35	(μ Sec)	(km)	(mi)
A	A	A	A	4	1.20	0.75
A	A	B	A	8	2.40	1.49
A	A	A	C	12	3.60	2.24
A	B	A	A	16	4.80	2.98
A	A	A	E	20	6.00	3.73
A	B	B	C	24	7.20	4.47
A	B	B	A	32	9.60	5.97
A	A	B	E	40	12.00	7.46
A	B	A	C	48	14.40	8.95
B	A	A	A	64	19.20	11.93
A	B	A	E	80	24.00	14.91
A	B	B	C	96	28.80	17.90
B	A	B	A	128	38.40	23.86
A	B	B	E	160	48.00	29.83
B	A	A	C	192	57.60	35.79
B	B	A	A	256	76.80	47.72
B	A	A	E	320	96.00	59.65
B	A	B	C	384	115.20	71.59
B	B	A	B	512	153.60	95.45
B	A	B	E	640	192.00	119.31
B	B	A	C	768	230.40	143.17
B	B	A	D	1024	307.20	190.89
B	B	A	E	1280	384.00	238.62
B	B	A	F	1536	460.80	286.34

4.4 CI-PM-3 Circuit Board Jumpers

Table 4-4 CI-PM-3 Default Jumper Settings

REF. DESIG.	DESCRIPTION	JUMPER TYPE	DEFAULT POSITION
JU1	2-LVL Polarity Select (A = Inverted ; B = Normal)	Shunt	B
JU2	4-LVL Polarity Select (A = Normal; B = Inverted)	Shunt	A
JU3	RX A Balanced O/P 1 Enable	SM Solder	Not Installed
JU4	RX A Balanced O/P 2 Enable	SM Solder	Not Installed
JU5	XO Polarity Select (A = Normal; B = Inverted)	Shunt	B
JU6	XO Select (A=OCXO; B=VCXO)	Shunt	A
JU7	Data Regeneration (A = Disable; B = Enable)	SM Solder	A
JU8	Data Input (A = Data/Ctrl Port; B=RX A Regenerated Data)	SM Solder	A
JU9	Discriminator O/P To Front Panel J1 Enable	SM Solder	Not Installed
JU10	Repeater CTCSS Enable (A = Disable; B = Enable)	SM Solder	A
JU11	TX A Direct Modulation Enable	SM Solder	Installed
JU12	TX B Direct Modulation Enable	SM Solder	Not Installed
JU13	TX A Subtone I/P 2 Enable	SM Solder	Not Installed
JU14	TX B Subtone I/P 2 Enable	SM Solder	Not Installed
JU15	TX A Balanced I/P 1 Enable	SM Solder	Installed
JU16	TX B Balanced I/P 1 Enable	SM Solder	Not Installed
JU17	TX A Audio Control Enable	SM Solder	Installed
JU18	TX B Audio Control Enable	SM Solder	Not Installed
JU19	RX A COR Enable	SM Solder	Not Installed
JU20	TX A PTT Enable	SM Solder	Installed
JU21	TX B PTT Enable	SM Solder	Not Installed
JU22	Repeater PTT Enable	SM Solder	Not Installed
JU23	Level Select (A=2/4-LVL; B=4-LVL)	Shunt	A
JU24	TX A Balanced I/P 2 Enable	SM Solder	Installed
JU25	TX B Balanced I/P 2 Enable	SM Solder	Not Installed
JU26	Alarm 7 To TX A and B Balanced O/P 1 Enable	SM Solder	Installed
JU27	Alarm 5 To TX A and B Balanced O/P 2 Enable	SM Solder	Installed
JU28	CTCSS RX A Mute Bypass	SM Solder	Not Installed
JU29	RX A Discriminator Output Enable	SM Solder	Not Installed
JU30	RX A Mute Enable	SM Solder	Not Installed
JU31	Data Delay Selection (Refer to Table 4-3)	SM Solder	A
JU32	Data Delay Selection (Refer to Table 4-3)	SM Solder	A
JU33	Data Delay Selection (Refer to Table 4-3)	SM Solder	A
JU34	CTCSS PTT Bypass	SM Solder	Installed
JU35	Data Delay Selection (A - F, Refer to Table 4-3)	SM Solder	A
JU36	Data Delay/By-Pass	Shunt	Bypass
JU37	Switched 8.0 Volts For PLL I/O Circuitry	SM Solder	Not Installed
JU38	Switched 8.0 Volts For Data Delay Circuitry	SM Solder	Not Installed
JU39	Switched 5.0 Volts For PLL I/O Circuitry	SM Solder	Not Installed
JU40	Switched 5.0 Volts For Regenerated PTT and Data Delay Circuitry	SM Solder	Not Installed
JU41	Analog/Digital Mode Over-ride	Shunt	A
JU42	Low Frequency Deviation Enable	SM Solder	Not Installed
JU43	RX B Discriminator O/P Enable	SM Solder	Not Installed
JU44	RX B Mute Enable	SM Solder	Not Installed
JU45	RX B COR Enable	SM Solder	Not Installed
JU46	RX B Balanced O/P 1 Enable	SM Solder	Not Installed
JU47	RX B Balanced O/P 2 Enable	SM Solder	Not Installed
JU48	External Clock Enable (A = Disable; B = Enable)	Shunt	A
JU49	Switched 5.0 Volts For 2-LVL / 4-LVL Switching Circuitry	SM Solder	Installed
JU50	RS-232 Data Out Enable	SM Solder	Not Installed

REF. DESIG.	DESCRIPTION	JUMPER TYPE	DEFAULT POSITION
JU51	Repeater Digital-Only PTT Enable	SM Solder	Installed
JU52	TS-64 Hang-up RX Mute	SM Solder	Not Installed
JU53	TS-64 Busy Input Enable	SM Solder	Not Installed
JU54	TS-64 Busy Input Connect to COR	SM Solder	Not Installed
JU55	TS-64 Repeater PTT Enable (Analog/Digital only)	SM Solder	Not Installed
JU56	Switched 9.5 Volts For Reference Input Circuitry	SM Solder	Not Installed
JU57	U18 (14174 IC) enable	SM Solder	Not Installed
JU58	Data regeneration	SM Solder	Not Installed
JU59	PLL calibration reference	SM Solder	Not Installed
JU60	U4 or U4A select	SM Solder	Not Installed

4.5 TS-64 MOD1 Jumper Settings - (If installed)

Table 4-5 CTCSS Jumper Settings

REF. DESIG.	DESCRIPTION	DEFAULT POSITION
JP1-JP6	CTCSS Tone Frequency Select	*
JP7	RX Audio Mute Polarity (Installed: Mute = Open, Not Installed: Mute = Ground)	Installed
JP8-JP10	TX Time-Out-Timer Interval Select	*
JP11	Hang-Up/Busy-Input Configure (Installed = Busy-Input, Not Installed = Hang-Up Input)	Not Installed

Note: Refer to TS-64 Instruction Sheet for configuration details.

4.6 4-Level Modulation Bit Pattern

Table 4-6 4-Level Modulation Bit Pattern

J1-PIN1 (BIT 0)	J1-PIN2 (BIT 1)	DEVIATION SETTING
0	0	- 4800 Hz
0	1	- 1600 Hz
1	1	+ 1600 Hz
1	0	+ 4800 Hz

4.7 Receiver IF / Audio PCB Jumper Settings

Table 4-9 Receiver IF / Audio PCB Jumper Settings

JUMPER	POSITION
JU5	Short
JU25	Short
JU37	Open

Note: All other jumper settings as per the factory defaults.

4.8 Transmitter Audio Processor Jumper Settings

Figure 4-1 Transmitter Audio Processor V1.6 Jumper Settings

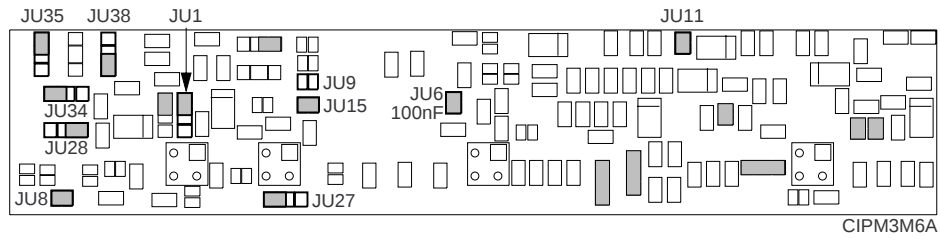


Table 4-7 Transmitter Audio Processor V1.6 Jumper Settings

JUMPER	POSITION	JUMPER	POSITION
JU1	Y	JU15	Open
JU6 (VHF)	Replaced with 100nF	JU27	Y
JU6 (UHF)	Short	JU28	Y
JU8	Short	JU34	Y
JU9	Open	JU35	Y
JU11	Open	JU38	Y
JU10	Short		

Note: All other jumper settings as per the factory defaults.

Figure 4-2 Transmitter Audio Processor V1.8 Jumper Settings

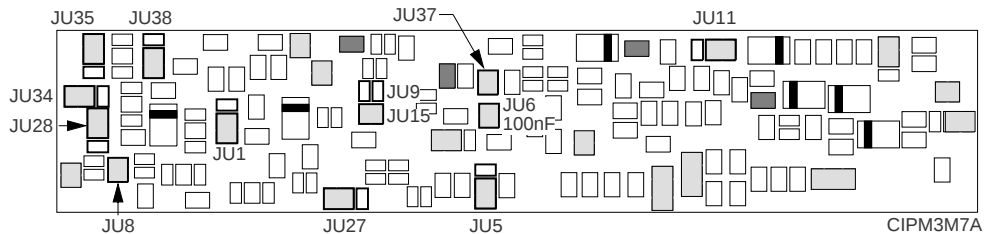


Table 4-8 Transmitter Audio Processor V1.8 Jumper Settings

Jumper	Balanced I/P	Subtone I/P 1 / 2	Description
JU1	OUT	OUT	Direct Modulation Circuits Power Source Select
JU2	OUT	OUT	MT-2 Deviation Enable (MT-2 Transmitters)
JU3	OUT	OUT	Microphone Preamplifier Flat Response
JU4	OUT	IN	Subtone Input 2 Audio Path Select
JU5	OUT	OUT / Y	Auxiliary Input Enable (DC Or AC Coupled)
JU6	IN(UHF)	IN(UHF)	Processed Audio Path Enable (Limited And Filtered). Replace with a 100nF capacitor for VHF
JU7	OUT	OUT	Unprocessed Auxiliary Audio Path Enable (Unfiltered)
JU8	IN	IN	Audio Output DC Coupled
JU9	OUT	OUT	Balanced Input Pre-emphasis Response Enable
JU10	IN	OUT	Balanced Input Flat Audio Response Enable

JU11	Y	OUT	Balanced Input To Auxiliary Audio Circuit Enable
JU12	OUT	OUT	Tone/Digital Input To Auxiliary Audio Circuit Enable
JU13	OUT	OUT / IN	Direct Modulation Input To Auxiliary Audio Circuit Enable
JU14	OUT	OUT	Auxiliary Input Pre-emphasis Response Enable
JU15	OUT	OUT / IN	Auxiliary Input Flat Audio Response Enable
JU16	OUT	IN / OUT	Subtone Input 1 Audio Path Select
JU17	OUT	OUT	MT-2 Temperature Compensation Bypass
JU18	OUT	OUT	Continuous Data Mode Selection
JU19	X	X	Audio Switches Power Source Select (X=Continuous, Y=Switched)
JU20	Y	Y	Q2 Power Source Select (Y=Continuous, X=Switched)
JU21	Y	Y	Bilateral Switch Power Source Select (Y=Continuous, X=Switched)
JU22	X	X	Audio Output To Splatter Filter
JU23	OUT	OUT / IN	Direct Modulation Input To Subtone 2 Enable
JU24	OUT	OUT	Splatter Filter Response Select
JU25	OUT	OUT	Splatter Filter Response Select
JU26	OUT	OUT	Splatter Filter Response Select
JU27	Y	Y	Direct Modulation Input Audio Path Select
JU28	Y	Y	Amplified Direct Modulation Bypass
JU29	OUT	OUT	Amplified Direct Modulation Input DC Coupled Enable
JU30	OUT	OUT	Amplified Direct Modulation Audio Path Select
JU31	OUT	OUT	Audio Output AC-Coupled (MT-3 Synthesized Transmitters)
JU32	OUT	OUT	Audio Output AC-Coupled (MT-3 Crystal Transmitters)
JU33	OUT	OUT	Audio Output AC-Coupled
JU34	Y	Y	Audio Output From Direct Modulation Circuits Select
JU35	OUT	OUT	Direct Modulation Output Source Select
JU36	Y	OUT	AGC Preamplifier Power Source Select (Y=Continuous, X=Switched)
JU37	OUT	OUT	Direct Modulation Output Enable
JU38	OUT	OUT / X	Subtone 2, DC Coupled, To Direct Modulation Output Select
JU39	OUT	OUT	Direct Modulation Low Input Impedance Enable
JU40	OUT	OUT	Microphone Preamplifier Power Enable
JU41			<i>Not Used</i>
JU42	OUT	OUT	Processed Audio Path To Direct Modulation Output
JU43	OUT	OUT	Bilateral Switch U9 Bypass Enable

Figure 4-3

Transmitter Audio Processor V2.3 Jumper Settings

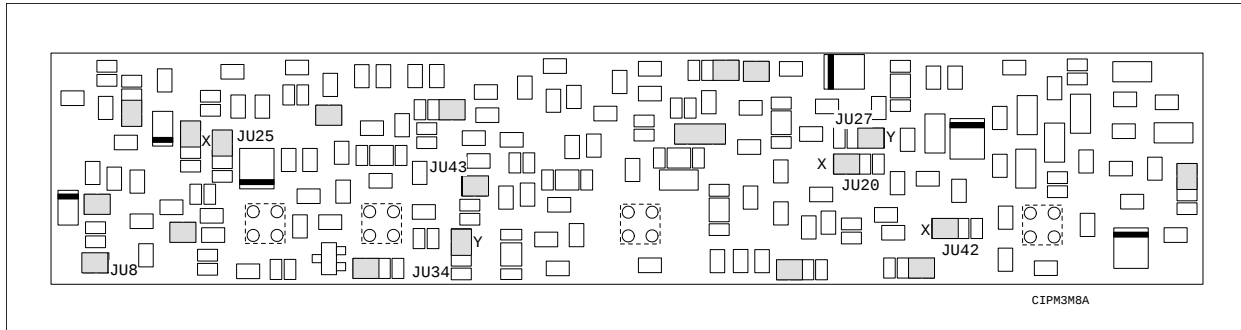
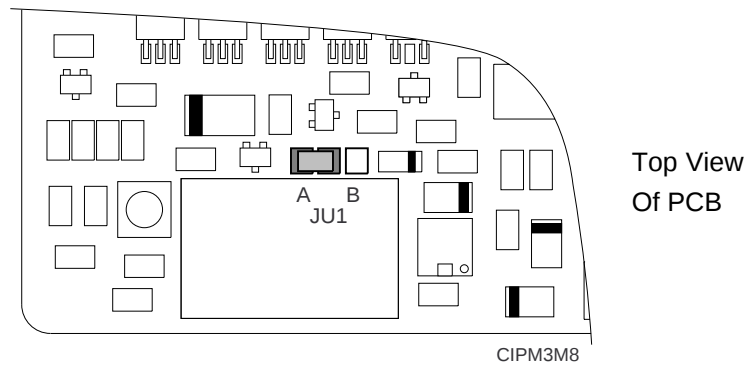


Table 4-9 Transmitter Audio Processor V2.3 Jumper Settings

JUMPER	POSITION	DESCRIPTION
JU8	Short	Audio Output DC couple
JU20	X	Direct modulation input buffer (X enabled, Y bypass)
JU21	Y	Transmit audio control
JU25	X	Wide/Narrow Band Switched Select (X wide)
JU27	Y	Direct Modulation Input Offset Output (Y enabled, X Bypass)
JU34	Y	Audio Routing (Y enabled , X dual port)
JU42	X	Modulation input bias select (X no offset, Y offset adjust)
JU43	Short	Modulation input Direct (Short) / Cap Couple (Open)

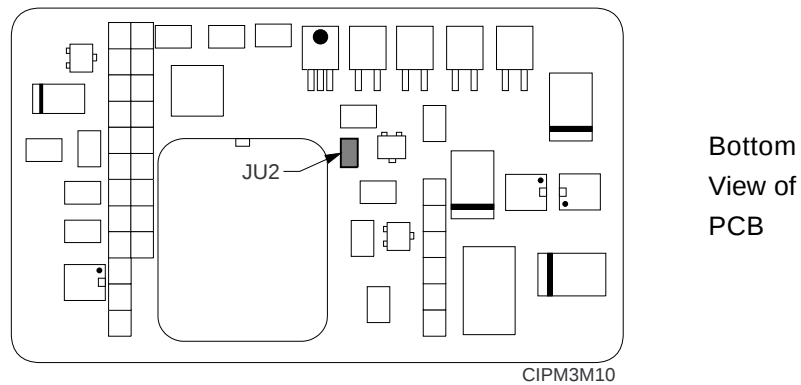
4.9 Transmitter Synthesizer Jumper Settings

Figure 4-3 VHF and (400 MHz) UHF Synthesizer Analog PCB Jumper Settings



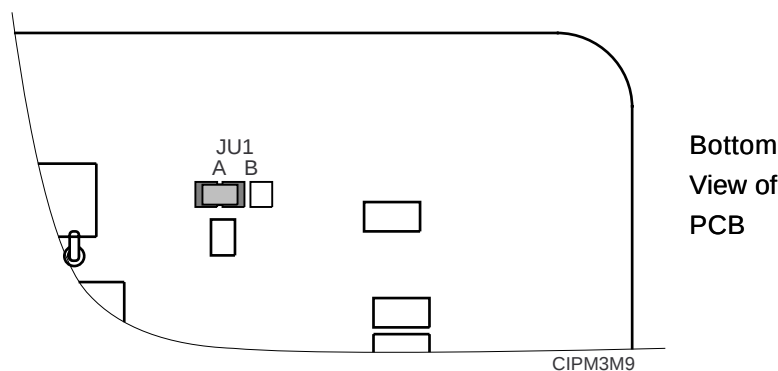
Jumper JU1 must be installed in the 'A' position to enable the external reference option.

Figure 4-4 VHF and (400 MHz) UHF Synthesizer Digital PCB Jumper Settings



Jumper JU2 must be installed to enable the 10MHz reference option.

Figure 4-5 800MHz and 900MHz Transmitter Synthesizer Jumper Settings



Jumper JU1 must be installed in the 'A' position to enable the external reference option.

4.10 CI-PM-3 Test Points

Table 4-10 CI-PM-3 Test Points

TEST POINT	DESCRIPTION
TP1	+8 Vdc Supply
TP2	+4 Vdc Supply
TP3	+5 Vdc Supply
TP4	Analog / Digital Mode (High = Digital, Low = Analog)
TP5	2 Level Data (TTL)
TP6	OCXO 9.5 Vdc Supply
TP7	Positive and Negative Edge Integrator Output
TP8	Data Delay Programmable Counter Output.
TP9	Input to Data Delay Circuitry
TP10	2 Level Data
TP11	Level Adjusted Paging Signal
TP12	OCXO Reference Adjust (nominally 2.5 Vdc)
TP13	PLL Correction Voltage
TP14	Tx A/B Direct Modulation Output
TP15	13.8 Vdc Supply Input (from Subrack)
TP16	9.5 VDC Supply Input (from Subrack)
TP17	Low Pass Filter Output

5 ILLUSTRATIONS AND SCHEMATIC DIAGRAMS

5.1 CI-PM-3 Front Panel Controls

6 PARTS LISTS

6.1 CI-PM-3 Electrical Parts List

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7 REVISION HISTORY

Issue	Issued	Revised	Details
3	Nov 99	N/A	All prototype updates incorporated in this issue. All previous revision history in preliminary issue 3 (Pre3).
		Jan 02	New CI-PM-3 version to accommodate multiple footprints for U4 (AD9901) , and incorporate changes to the reference input circuit (MMIC removed).
4	Jan 02		New Issue, incorporates all changes since release of Issue 3.
4 A		Dec 02	Correct component layout (bottom CIPM3M4E) - TP14 & TP15 locations corrected - JU56 designation removed



MT-3 RADIO SYSTEMS

UHF TRANSMITTER INSTRUCTION MANUAL UT-3 896 - 960 MHz

Covers models:

UT-3/900-SWB3, UT-3/935-SWB3, UT-3/950-SWB3,
UT-3/900-SNB3, UT-3/935-SNB3, UT-3/950-SNB3.

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Reviewed By:

Quality Assurance:

Larry Freeman

Name

Signature

Date

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 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.

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MODULE MANUALS

Transmitter Main Board Instruction Manual	IM20-MT3TXMN
UHF Amplifier Instruction Manual UT-3 806 - 960 MHz	IM25-UT38900AMP
Low Current Synthesizer Instruction Manual OS(R/T)-3 132-960 MHz	IM11-OS3
UHF Transmitter Channel Designation Table UT-3 896 - 960 MHz...	IM16-URT3900CT

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1 GENERAL

1.1 Introduction

The UT-3 896 - 960 MHz transmitter is a low power, synthesized, FM transmitter, capable of operation in 6.25 KHz channels. The transmitter operates in three frequency bands: 896 - 902 MHz, 928 - 935 MHz, and 935 - 960 MHz and power output is adjustable from 0.5W to 3.0W. A modular design allows each of the transmitter's modules: OS-3 896 - 960 MHz synthesizer, UT-3 800/900 amplifier, MT-3 audio processor, and MT-3 transmitter main board to be individually assembled and tested. This facilitates construction, maintenance, as well as troubleshooting procedures. The synthesizer module can be programmed to have up to 16 channels exclusive to one frequency band (896 - 902 MHz, 928 - 935 MHz, or 935 - 960 MHz) making the UT-3 an extremely versatile transmitter. In addition, the UT-3 896 - 960 MHz transmitter is capable of standard modulation or low frequency modulation.

The UT-3 896 - 960 MHz transmitter is designed to interface with Daniels Electronics' MT-3 Repeater System while maintaining MT-2 System compatibility. Both repeater systems are characterized by dependable, low maintenance performance under the most severe environmental conditions.

1.2 Manual Organization

The organization of this manual reflects the modular makeup of the UT-3 product line. Each module is fully described within its respective submanual, all of which are contained within this document. In general, each submanual contains:

1. A functional description and specification summary,
2. A detailed technical description (Theory of Operation) and
3. Assembly, setup and alignment procedures relevant to that particular module.

The module manuals are as follows.

Note: material presented in a given "sub-manual" may include information related to other module versions not directly applicable to the 896 - 960 MHz Transmitter family (eg, the Low Current Synthesizer Instruction Manual OS(R/T)-3 covers models from 132 MHz to 960 MHz).

UHF Transmitter Instruction Manual UT-3 896 - 960 MHz: This manual provides an overview of the complete transmitter, manual organization and assembly in terms of the other modules.

MT-3 Transmitter Main Board Instruction Manual: This manual pertains to the audio processor module, transmitter Main Board and Front Panel Board. Most of the user selectable options are accessed within the Transmitter Main Board module, including channel selection. Since all external connections (including power and signal lines) are made to the Transmitter Main Board, most of the material pertaining to transmitter operation and installation is found here.

UHF Amplifier Instruction Manual UT-3 806 - 960 MHz : The amplifier module provides the final stages of RF power amplification and harmonic filtering for the transmitter. This manual is intended primarily as a reference since the amplifier module is adjusted at the factory.

Low Current Synthesizer Instruction Manual OS(R/T)-3 132 - 960 MHz: This manual pertains to the enhanced synthesizer module.

UHF Rx/Tx Channel Designation Table UT-3 896 - 960 MHz: This document relates operating frequency to the transmitter channel number (see section 2.2).

1.3 UT-3 896 - 960 MHz Transmitter Family Models

The UT-3 896 - 960 MHz line of transmitters has a single RF power output rating of 3.0 Watt, with wide or narrow band FM (12.5 kHz or 25 kHz channels) and employs synthesizer based frequency generation. The six basic (i.e. no options added) band specific models of the transmitter are as follows:

- UT-3/900-SNB3 - synthesized, 896 - 902 MHz band, 12.5 kHz channels, 0.5 - 3.0 Watt
- UT-3/935-SNB3 - synthesized, 928 - 935 MHz band, 12.5 kHz channels, 0.5 - 3.0 Watt
- UT-3/950-SNB3 - synthesized, 935 - 960 MHz band, 12.5 kHz channels, 0.5 - 3.0 Watt
- UT-3/900-SWB3 - synthesized, 896 - 902 MHz band, 25 kHz channels, 0.5 - 3.0 Watt
- UT-3/935-SWB3 - synthesized, 928 - 935 MHz band, 25 kHz channels, 0.5 - 3.0 Watt
- UT-3/950-SWB3 - synthesized, 935 - 960 MHz band, 25 kHz channels, 0.5 - 3.0 Watt

The transmitter models are very similar and the transmitters' band of operation is determined by select components in the synthesizer and amplifier.

1.4 Performance Specifications

1.4.1 General

Type:	MT-3 Series Transmitter.
Compatibility:	MT-2 Series and MT-3 Series Radio Systems.
Frequency Range:	896 - 960 MHz
R.F. Power Output:	Adjustable: 0.5W to 3.0W.
Modulation:	11/16K0F3EJN (Frequency Modulation).
Channel Spacing:	12.5 kHz or 25 kHz.

Frequency Generation:	Synthesized (internal plug-in module: 2 bands).
Reference Frequency:	9.600000 MHz.
Channel Selection:	In 6.25 kHz increments selected through four internal BCD rotary switches. Preset capability for 16 channel memory selectable through external control.
Frequency Stability:	Standard: $\pm 1\text{ppm}$ -30°C to $+60^{\circ}\text{C}$. Optional: $\pm 1\text{ppm}$ -40°C to $+60^{\circ}\text{C}$. Optional: High stability external reference.
System Impedance:	50 Ω ; Type N (Standard).
Duty Cycle:	100%; Continuous operation $+60^{\circ}\text{C}$
Spurious Emissions:	More than -80dB below carrier.
Hum and Noise Level:	45 dB (300 Hz to 3.4 kHz).
Front Panel Control:	NORM (repeat mode), OFF, and KEY TX (Tx on).
PTT Activation:	• Active to ground with or without time-out timer; • Microphone activated with or without time-out timer; • Front Panel switch: - KEY TX - without time-out timer - NORM - with or without time-out timer. • Isolated (optional relay) with or without time-out timer.
PTT Time-Out-Timer:	Selectable 1 second to 8 hours (factory set 5 minutes).
Transmitter Mismatch Protection:	20:1 VSWR at all phase angles. Protected by internal ferrite Isolator
Transmitter Alarm:	Forward power sense and reverse VSWR; • open collector output (separate or 'OR'ed configuration); • linear output (separate lines only).
Transmit Current:	1.8 Amps at 3 Watts RF Power Output.
Standby Current and Rise time:	95% RF power, 95% system deviation within; 50 ms: typically 7 mA (Mode 1), 25 ms: typically 50 mA (Mode 2), 10 ms: typically 75 mA (Mode 3).
Operating Temperature Range:	-30°C to $+60^{\circ}\text{C}$ (Optional: -40°C to $+60^{\circ}\text{C}$).
Operating Humidity:	95% R.H. (Non-condensing) at $+25^{\circ}\text{C}$.

DOC Type Approval:	RSS119	142 194 305
	RSS122	142 221 131
FCC Type Acceptance:	H4JUT-3-900-SN03	(896-902 MHz, narrow band)
	H4JUT-3-900-SW03	(896-902 MHz, wide band)
	H4JUT-3-930-SN03	(928-935 MHz, narrow band)
	H4JUT-3-930-SW03	(928-935 MHz, wide band)
	H4JUT-3-950-SN03	(935-960 MHz, narrow band)
	H4JUT-3-950-SW03	(935-960 MHz, wide band)

1.4.2 Audio Specifications

Audio Input:	Balanced 600 ohm or unbalanced (optional). Input level sensitivity, -25 dBm to 0 dBm.
Audio Response:	Pre-emphasis (6 dB per octave); +0.5 to -2.0 dB from 300 Hz to 3 kHz;
Flat Audio Response:	+1 to -2 dB from 100 Hz to 3 kHz.
Audio Deviation:	Preset to ± 1.5 kHz or ± 3.0 kHz with a 1 kHz tone; (capable ± 2.5 kHz or ± 5.0 kHz).
Subtone Audio Input 1:	0.5 Vpp at 200 Hz for ± 500 Hz deviation (internally adjustable).
Subtone Audio Input 1 Freq range:	60 Hz to 300 Hz.
Subtone Audio Input 2:	0.5 Vpp at 100 Hz for ± 500 Hz deviation (internally adjustable).
Subtone Audio Input 2 Freq range:	DC to 150 Hz.
Direct Modulation Input:	0.5 Vrms at 1 kHz or ± 3 kHz deviation.
Direct Modulation Freq range:	DC to 5 kHz.
Audio Distortion:	Less than 2.5% THD; 1 kHz tone at 1.5 kHz or 3 kHz deviation (-40°C to +60°C).
Hum and Noise:	Better than 40 dB (test receiver band limited: 400 Hz to 30 kHz).

1.4.3 Physical Specifications

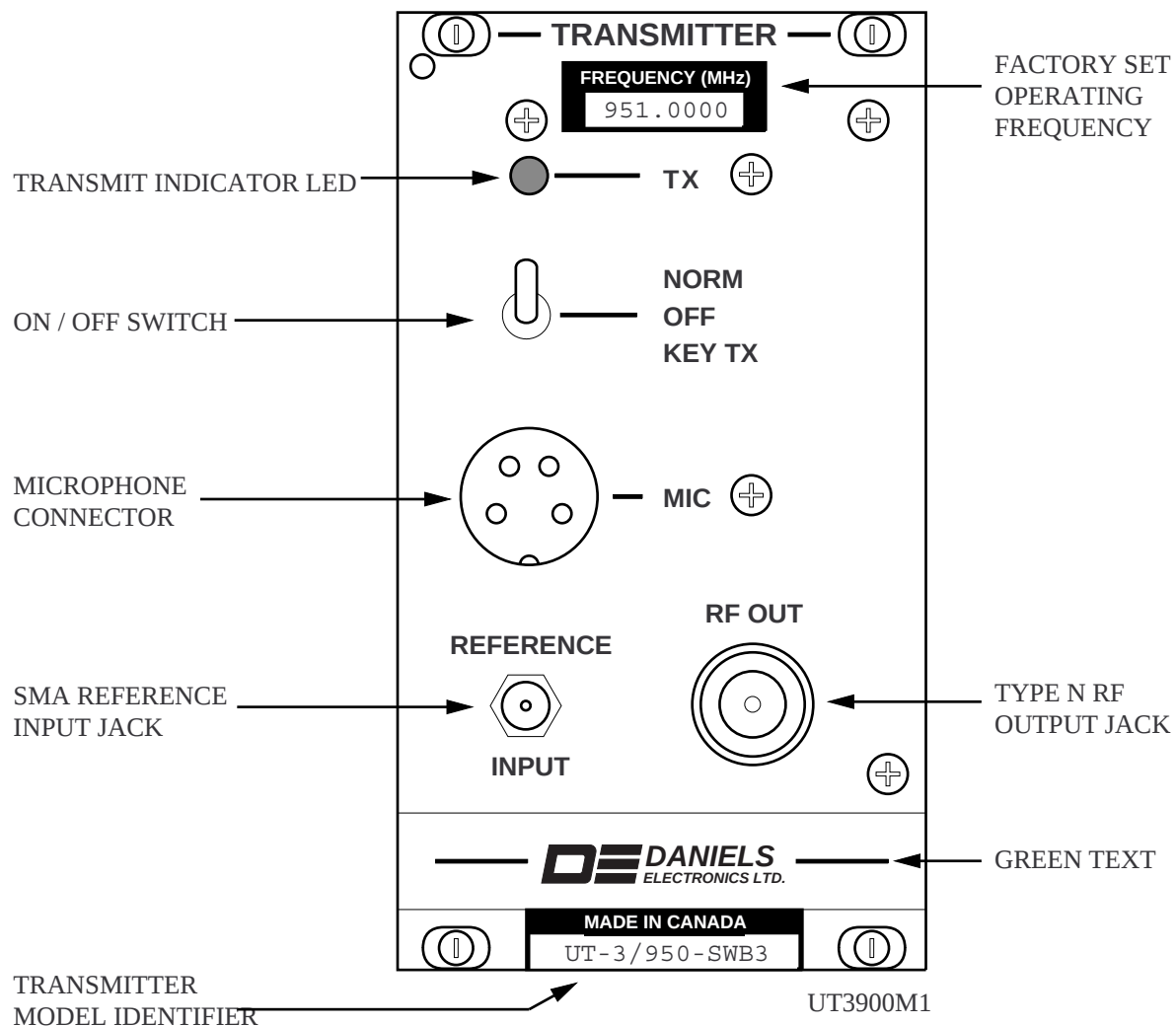
Physical Dimensions:	Width:	Height:	Depth:
	7.1 cm (2.8 in)	12.8 cm (5.05 in)	19 cm (7.5 in)
Module Weight:	1.5 kg (3.3 lbs)		
Corrosion Prevention:	Anodized aluminum construction. Stainless steel hardware. Selectively conformal coated glass epoxy 2 and 4 layer printed circuitboards. Gold plated module connectors.		
Module Design:	Compact Eurostandard modular design. Plug-in modules mate with Daniels standard M3 repeater 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 transmitter module front panel. Motherboard Connections (Audio, Power, and Control) are made through a 48 pin, gold plated, type F connector on the rear of the transmitter module. User connection made through mated "mother board" assembly of the repeater 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:	Green.		

2 SYSTEM OVERVIEW

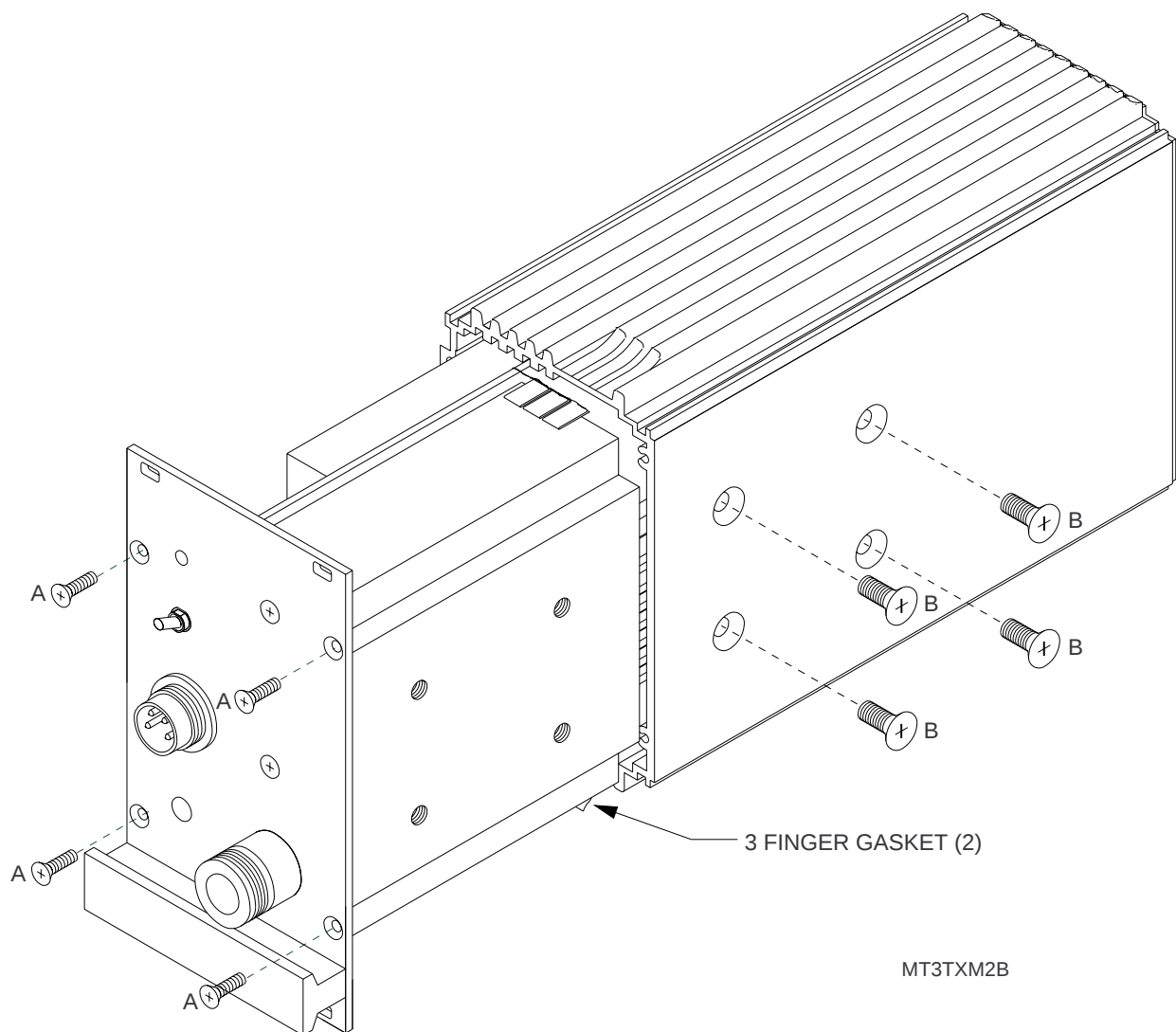
2.1 Transmitter Operation

3 ILLUSTRATIONS

3.1 MT-3 Transmitter Front Panel



3.2 MT-3 Transmitter Case - Exploded View



Transmitter Case Removal:

1. Remove screws A (four M3x8mm).
2. Remove screws B (four M5x8mm).
3. Hold front panel and pull case.

4 PARTS LIST

5 REVISION HISTORY

ISSUE	DATE	DESCRIPTION AND (REASON)
5	May 98	• Manual formatted to modular style. All previous revision history in issue 4.

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MT-3 RADIO SYSTEMS

TRANSMITTER MAIN BOARD INSTRUCTION MANUAL

Covers: Version 1.7 of the Transmitter Main Board
Version 1.6 & 1.8 of the FM Audio Processor Board

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Victoria, B.C.

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Reviewed By:

Quality Assurance:

Larry Freeman

Name

Signature

Date

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 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.

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1 GENERAL

1.1 Introduction

The MT-3 Transmitter Main Board integrates the MT-3 Front Panel Board, MT-3 Audio Processor, Synthesizer or Crystal Controlled Oscillator module, and Amplifier module together to comprise a MT-3 series transmitter (see section 5.1: MT-3 Transmitter Block Diagram). The Front Panel Board and the Audio Processor are soldered directly to the Transmitter Main Board while the Amplifier and the Synthesizer or Crystal Controlled Oscillator module are frequency band sensitive, plug-in modules. Circuitry and jumpers on the Transmitter Main Board control the operation of the modules as well as the overall operation of the MT-3 transmitter. Power and signal connections are made through the 48 pin type 'F' connector on the rear of the Transmitter Main Board where they are then routed to the other MT-3 modules. The front and rear panels are attached to the Transmitter Main Board and together with the extruded aluminum shell, form the transmitter enclosure.

1.2 Performance Specifications

1.2.1 General

Type: MT-3 Series Transmitter

Compatibility: MT-3 Series Amplifier, OC-3 Crystal Controlled Oscillator module, OS-3 and OS-3H Frequency Synthesizer modules.

Modulation: 11K0F3E or 16K0F3E (Frequency Modulation).

Operating Temperature Range: -30°C to +60°C, optional -40°C to +60°C temperature test.

Operating Humidity: 95% RH (non-condensing) at +25°C.

Operating Voltage: +9.5 Vdc Regulated. +13.8 Vdc Nominal (11 - 16 Vdc).

Front Panel Controls: NORM (repeat mode), OFF, and KEY TX (Tx on).

PTT Activation:

- Active to ground with or without time-out-timer;
- Microphone activated with or without time-out-timer;
- Front Panel switch: KEY TX - without time-out-timer;
- NORM - with or without time-out-timer.
- Isolated (optional relay) with or without time-out-timer.

PTT Time-Out-Timer: Selectable from 1 sec. to 8 hrs. (Factory Default: 5 min.).

1.2.2 Audio Specifications

Audio Input:	Balanced 600 ohm or unbalanced (optional). Input level sensitivity, -25 dBm to 0 dBm.
Audio Response:	Pre-emphasis (6 dB per octave); +0.5 to -2.0 dB from 300 Hz to 3 kHz;
Flat Audio Response:	+1 to -1 dB from 100 Hz to 3 kHz.
Audio Deviation:	Preset to ± 1.5 kHz (Narrow Band) or ± 3.0 kHz (Wide Band) with a 1 kHz tone (capable ± 2.5 kHz or ± 5.0 kHz).
Subtone Audio Input 1:	0.5 Vpp at 200 Hz for ± 500 Hz deviation (internally adjustable).
Subtone Audio Input 1 Frequency range:	60 Hz to 300 Hz.
Subtone Audio Input 2:	0.5 Vpp at 100 Hz for ± 500 Hz deviation (internally adjustable).
Subtone Audio Input 2 Frequency range:	DC to 150 Hz.
Direct Modulation Input:	0.5 Vrms at 1 kHz or ± 3 kHz deviation.
Direct Modulation Frequency range:	DC to 5 kHz.

2 THEORY OF OPERATION

2.1 Transmitter Main Board

2.1.1 General

3 TRANSMITTER ALIGNMENT

3.1 General

Transmitter alignment is simplified by using an M-3 Subrack, SM-3 System Monitor, and RF extender cable to provide transmitter power and signal interconnection. Alternatively, +9.5 Vdc and +13.8 Vdc may be applied directly to a transmitter module through positive connection for the +9.5 Vdc to pins B6 and Z6, for the +13.8 Vdc to pins B2 and Z2, and negative connection to pins B30, Z30, B32, and Z32. Transmitter balanced audio (600 Ω) is available at pins B18 and Z18.

3.2 Repair Note

MT-3 Transmitter modules are mainly made up of surface mount devices 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 Dissipative (ESD) protection.

When removing Surface Mount Solder Jumpers, it is recommended to use solder braid in place of manual vacuum type desoldering tools when removing jumpers. This will help prevent damage to the circuitboards.

3.3 Printed Circuitboard Numbering Convention

To ease troubleshooting and maintenance procedures, Daniels Electronics Limited has adopted a printed circuitboard (PCB) numbering convention in which the last two digits of the circuitboard number represent the circuitboard version. For example:

- PCB number 43-912010 indicates circuitboard version 1.0;
- PCB number 50002-02 indicates circuitboard version 2.0.

All PCB's manufactured by Daniels Electronics are identified by one of the above conventions.

3.4 Recommended Test Equipment List

Alignment of the complete transmitter requires the following test equipment or its equivalent. It is assumed that any adjustment of the Transmitter Main Board will also involve the other modules.

Dual Power Supply:	Regulated +9.5 Vdc at 2 A. Regulated +13.8 Vdc at 2 A - Topward TPS-4000
Oscilloscope / Multimeter:	Fluke 97 Scopemeter
Current Meter:	Fluke 75 multimeter

Radio communications test set :	Marconi Instruments 2955R
VSWR 3:1 mismatch load:	JFW 50T-035-3.0:1
Alignment Tool:	Johanson 4192

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 oscillator may be accurately set to within its ± 1 ppm frequency tolerance.

3.5 Standard Factory Settings and Jumper Configuration

Standard factory settings and the associated jumper configuration for each module of the MT-3 series transmitter are given below.

3.5.1 MT-3 Transmitter Board Factory Configuration

The MT-3 Transmitter Main Board is factory configured as follows:

- Transmitter standby mode 1 (lowest standby current consumption).
- Receiver squelched, de-emphasized audio amplifier disabled.
- Optional relay not installed.
- Separate amplifier power sense outputs.

The corresponding jumper settings are:

Jumper J2:	'x' position	Optional relay configuration
Jumper J3:	no connection	Optional relay configuration
Jumper J4:	'y' position	Optional relay configuration
Jumper J6:	not installed	Transmitter standby mode select - Mode 1
Jumper J7:	'y' position	Audio processor standby mode select
Jumper J9:	not installed	Receiver audio ac/dc input coupling
Jumper J12:	not installed	Amplifier power sense output configuration
Jumper J13:	'x' position	Amplifier power sense output configuration
Jumper J14:	'x' position	Amplifier power sense output configuration
Jumper J15:	'x' position	Amplifier power sense output configuration
Jumper J16:	'x' position	Microphone configuration
Jumper J17:	installed	Microphone output line
Jumper J18:	'y' position	Synthesizer or crystal module standby mode select
Jumper J19:	'x' position	600 Ω audio transformer enable. 'y' position disables
Jumper J20:	'x' position	600 Ω audio transformer enable. 'y' position disables
Jumper J21:	not installed	+8 Vdc audio processor supply bypass
Jumper J22:	'x' position	600 Ω audio transformer enable. 'y' position disables
Jumper J23:	'x' position	600 Ω audio transformer enable. 'y' position disables
Jumper J24:	installed	Subtone #2 output enable
Jumper J25:	'x' position	Audio output enable

• Jumper J26:	installed	Time-Out-Timer Timing resistor select.
• Jumper J27:	not installed	Time-Out-Timer Timing resistor select.
• Jumper J28:	not installed	Time-Out-Timer Timing period output select.
• Jumper J29:	installed	Time-Out-Timer Timing period output select.
• Jumper J31:	installed	Time-Out-Timer Timing period output select.
• Jumper J32:	not installed	Time-Out-Timer Timing period output select.
• Jumper J33:	installed	Time-Out-Timer input enable
• Jumper J34:	installed	Time-Out-Timer power enable
• Jumper J35:	installed	Time-Out-Timer output enable

Note: Jumpers J1, J5, J8, J10, J11 designations not used

3.5.2 MT-3 Audio Processor Factory Configuration (Version 1.6)

The MT-3 Audio Processor is factory configured as follows:

- Maximum Deviation: ± 2.5 kHz (12.5 kHz or 15 kHz channel),
 ± 5.0 kHz (25 kHz or 30 kHz channel).
- Microphone Input: 1 kHz signal at -10 dBm gives $\pm 50\%$ maximum deviation,
1 kHz signal compression set at $\pm 60\%$ maximum deviation.
- Audio Balanced Input: Enabled - pre-emphasis response,
1 kHz tone at -8 dBm gives $\pm 60\%$ maximum deviation.
1 kHz signal compression set at $\pm 60\%$ maximum deviation.
- Subtone Input 1: 100 Hz tone at -18 dBm gives ± 500 Hz deviation.
- All other audio inputs: Disabled.
- Time-Out-Timer: 5 minutes $\pm$ 30 seconds.

The corresponding Audio Processor jumper settings are:

- Jumper JU1: not installed Power source select for Direct Modulation circuits.
- Jumper JU2: not installed MT-2 deviation enable (MT-2 transmitters).
- Jumper JU3: installed Microphone preamplifier power enable.
- Jumper JU4: installed Balanced audio preamplifier power enable.
- Jumper JU5: not installed Balanced audio ground enable.
- Jumper JU6: installed Processed audio path enable (limited and filtered).
- Jumper JU7: not installed Unprocessed auxiliary audio path enable (unfiltered).
- Jumper JU8: not installed Audio output DC coupled (MT-2 transmitters).
- Jumper JU9: installed Balanced input preemphasis response enable.
- Jumper JU10: not installed Balanced input flat audio response enable.

• Jumper JU11: not installed	Balanced input to auxiliary audio circuit enable.
• Jumper JU12: not installed	Tone/Digital input to auxiliary audio circuit enable.
• Jumper JU13: not installed	Direct modulation input to auxiliary audio circuit enable.
• Jumper JU14: not installed	Auxiliary input preemphasis response enable.
• Jumper JU15: not installed	Auxiliary input flat audio response enable.
• Jumper JU16: not installed	Subtone input 2 audio path select.
• Jumper JU17: installed	MT-2 Temperature compensation bypass.
• Jumper JU18: not installed	Continuous data mode selection.
• Jumper JU19: 'y' position	Power source for audio switches.
• Jumper JU20 to JU22:	not used
• Jumper JU23: not installed	Direct modulation input to subtone 2 enable.
• Jumper JU24: installed	Lowpass filter response select.
• Jumper JU25: installed	Lowpass filter response select.
• Jumper JU26: installed	Lowpass filter response select.
• Jumper JU27: not installed	Direct Modulation input audio path select.
• Jumper JU28: not installed	Amplified direct modulation bypass.
• Jumper JU29: not installed	Amplified direct modulation input DC couple enable.
• Jumper JU30: not installed	Amplified direct modulation audio path select.
• Jumper JU31: not installed	Subtone 2, AC coupled, to direct modulation output enable.
• Jumper JU32: not installed	Audio output AC coupled (MT-3 crystal transmitters).
• Jumper JU33: not installed	Audio output AC coupled (MT-3 synthesized transmitters).
• Jumper JU34: not installed	Audio output from Direct Modulation circuits select.
• Jumper JU35: not installed	Direct Modulation output source select.
• Jumper JU36: 'x' position	Subtone input 1 audio path select.
• Jumper JU37: not installed	Summed Subtone audio to direct modulation output enable
• Jumper JU38: not installed	Subtone 2, DC coupled, to direct modulation output select.
• Jumper JU39: not installed	Direct Modulation low input impedance enable.

3.6 MT-3 Transmitter Board Alignment

3.6.1 General

Before proceeding with the transmitter alignment, check that the appropriate jumpers are installed. The standard jumper configuration for the Transmitter Main Board, given in section 3.5.1, is normally employed for transmitter alignment. In a standard configuration, the only alignment required on the MT-3 Transmitter Main Board for a synthesized transmitter is to set the frequency switches (FSW1, FSW2, FSW3, and FSW4) for the desired channel frequency. FSW1 is the most significant digit of the frequency switches. The switch settings for the desired channel frequency can be found in the channel designation tables. If the transmitter is using a crystal control oscillator module, the switch settings are irrelevant.

3.6.2 MT-3 Transmitter Board Test Points

- TP1: squelched, de-emphasized audio / +13.8 Vdc
- TP2: microphone audio
- TP3: microphone PTT WTO; inactive +9.5 Vdc, active 0 Vdc
- TP4: microphone PTT NTO; inactive +9.5 Vdc, active 0 Vdc
- TP5: +9.5 Vdc from backplane connector
- TP6: +9.5 Vdc from front panel board
- TP7: +9.5 Vdc Switched
- TP8: Qualified PTT; inactive +9.5 Vdc, active 0 Vdc: activated by synthesizer
- TP9: synthesizer enable; selected by J18
- TP10: synthesizer bootstrap line; +5 Vdc
- TP11: synthesizer PTT input; inactive +9.5 Vdc, active 0 Vdc
- TP12: audio processor TOT input; inactive +9.5 Vdc, active 0 Vdc
- TP13: audio processor TOT output; inactive +9.5 Vdc, active 0 Vdc
- TP14: audio processor audio output
- TP15: audio processor audio control line
- TP16: audio processor subtone #2 output
- TP17: audio processor direct modulation input
- TP18: audio processor subtone #2 input
- TP19: audio processor continuous +9.5 Vdc
- TP20: audio processor subtone #1 input
- TP21: audio processor supply +8 Vdc, selected by J7
- TP22: audio processor tone/digital input
- TP23: synthesizer receive data line; 0 Vdc
- TP24: synthesizer transmit data line; +5 Vdc
- TP25: Q1 collector; inactive 0 Vdc, active +9.5 Vdc
- TP26: U2d output; inactive +9.5 Vdc, active 0 Vdc
- TP27: U1a output (PTT WTO); inactive +9.5 Vdc, active 0 Vdc
- TP28: U1b output (PTT NTO); inactive +9.5 Vdc, active 0 Vdc
- TP29: Q6 collector / Q7 gate; inactive +9.5 Vdc, active 0 Vdc
- TP30: +9.5 Vdc PTT Switched
- TP31: U8 pin 1, Time-Out-Timer circuitry set input
- TP32: U8 pin 2, Time-Out-Timer circuitry reset input
- TP33: Audio processor balanced audio input
- TP34: Audio processor balanced audio input

3.7 Module Installation and Removal

Installation of the Enhanced Synthesizer or Crystal Controlled Oscillator module is facilitated by alignment pins on each corner of the module. When the four pins are aligned with their corresponding hole in the Transmitter Main Board, push the module down, taking care to ensure the connector pins on the bottom of the Synthesizer or Crystal Controlled Oscillator module are not bent.

To remove the Enhanced Synthesizer or Crystal Controlled Oscillator module, simply remove the center screw from the module lid and pull the module out. The module should be pulled straight out so that the four alignment pins do not bend or damage the circuitboard.

The Low Power Synthesizer uses two tabs soldered to the Transmitter Main Board for mounting. No alignment pins are used. As a result care must be taken to ensure the connector pins on the bottom of the Synthesizer are not bent. To install the low Power Synthesizer module, remove the two of the synthesizer side screws that correspond to the tabs on the Transmitter Main board and install the synthesizer module taking care not to bend the pins. Replace the two side screws; installing them through the tabs to hold the synthesizer module in place.

When removing the Low Power Synthesizer module, it is important to gently lift the synthesizer module "straight out" in order to prevent damage to the connector pins. Remove the two side screws holding the synthesizer module to the tabs. Using a plastic coated lifting tool, such as a small screwdriver with the tip covered in heat shrink material, gently lift the synthesizer module from the Transmitter Main Board by applying pressure in a rotating fashion about four corners of the synthesizer module. Replace the two side screws.

3.8 MT-3 Audio Processor Alignment (Version 1.6)

3.8.1 General

Verify the standard factory settings for the MT-3 Audio Processor as given in section 3.5.2 before beginning the standard deviation adjustment procedure. If the transmitter's channel frequency changes, the audio processor should be realigned to optimize the transmitter's performance. The schematic diagram for the audio processor is shown in section 5.4.2 and the component layout is shown in section 5.4.1.

3.8.2 MT-3 Audio Processor Standard Deviation Adjustment

Note: clockwise rotation of controls increases signal levels.

- 1 Connect the transmitter to the radio communications test set and monitor FM deviation, distortion, and audio frequency. Before adjusting the audio deviation, confirm that the transmitter RF output frequency is correct.
- 2 Connect the 600 ohm input to the incoming audio (pins B18, Z18). Set the audio frequency to 1 kHz at the desired level of -8 dBm.
- 3 Increase the balance level control (R31) for maximum gain.

- 4 Turn the transmitter on.
- 5 Adjust the balance compression level (R38) for compression at $\pm 60\%$ maximum deviation.
- 6 Set the audio frequency to 2.4 kHz, then adjust the deviation control (R29) for maximum deviation.
- 7 Reset the modulating frequency to 1 kHz and re-adjust R38 for $\pm 60\%$ maximum deviation.
- 8 Repeat steps 6 and 7 until both conditions are met.
- 9 Vary the audio signal from 1 kHz to 3 kHz and measure the positive deviation and then the negative deviation. Adjust the symmetry control (R14) until the $\pm$ deviation is symmetrical. The variation between $\pm$ deviation levels should not exceed 300 Hz over the 1 kHz to 3 kHz range.
- 10 Repeat steps 6 and 7 and re-adjust if necessary.
- 11 Adjust the balanced input level control (R31) until the deviation produced by a 1 kHz tone at -8 dBm falls below $\pm 60\%$ maximum deviation, then adjust R31 so that the deviation increases until compression is observed. The deviation should be ± 1.5 kHz or ± 3 kHz for narrowband and wideband channels respectively.
- 12 A 1 kHz tone at -8 dBm input level should produce $\pm 60\%$ maximum deviation. If not, go back to step 4 and make sure the pot is set for maximum gain and repeat the procedure. If so, increasing the input level by +20 dBm should not increase the deviation. This confirms that the AGC action of preamplifier U2 is working.
- 13 A 2.4 kHz tone at the desired audio input level should produce the maximum deviation. Increasing the input level by +20 dBm should not increase the deviation. This confirms that the limiting action of U4a and U5a is working.
- 14 Set the audio frequency back to 1 kHz at -8 dBm output. Confirm and record audio distortion with the appropriate filter on the communications test set.
- 15 Confirm the audio frequency response by referencing all output deviation measurements to a 1 kHz input tone at $\pm 20\%$ maximum deviation (± 500 Hz for narrowband or ± 1 kHz for wideband).
- 16 Remove the signal to the balanced input (pins B18, Z18).

- 17 Apply a 1 kHz tone at -8 dBm to the microphone audio input. Set the microphone compression control (R8) to produce $\pm 60\%$ maximum deviation. Reduce the signal to -10 dBm and adjust the microphone input level control (R2) for $\pm 50\%$ maximum deviation. Remove the signal.
18. Apply a 100 Hz tone at -18 dBm to the subtone 1 input and adjust the subtone 1 level control (R42) to produce ± 500 Hz deviation. Remove the signal.

3.9 Standard Factory Settings and Jumper Configuration

Standard factory settings and the associated jumper configuration for the MT-3 Audio Processor (Version 1.8) are given below.

3.9.1 MT-3 Audio Processor Factory Configuration (Version 1.8)

The MT-3 Audio Processor is factory configured as follows:

- Maximum Deviation: ± 2.5 kHz (12.5 kHz or 15 kHz channel),
 ± 5.0 kHz (25 kHz or 30 kHz channel).
- Microphone Input: 1 kHz signal at -10 dBm gives $\pm 50\%$ maximum deviation,
1 kHz signal compression set at $\pm 60\%$ maximum deviation.
- Audio Balanced Input: Enabled - pre-emphasis response,
1 kHz tone at -8 dBm gives $\pm 60\%$ maximum deviation.
1 kHz signal compression set at $\pm 60\%$ maximum deviation.
- Subtone Input 1: 100 Hz tone at -18 dBm gives ± 500 Hz deviation.
- All other audio inputs: Disabled.
- Time-Out-Timer: 5 minutes $\pm$ 30 seconds.

The corresponding Audio Processor jumper settings are:

- Jumper JU1: not installed Power source select for Direct Modulation circuits.
- Jumper JU2: not installed MT-2 deviation enable (MT-2 transmitters).
- Jumper JU3: 'y' position Microphone preamplifier flat response.
- Jumper JU4: not installed Subtone input 2 audio path select.
- Jumper JU5: not installed Auxiliary input enable (DC or AC coupled).
- Jumper JU6: installed Processed audio path enable (limited and filtered).
- Jumper JU7: not installed Unprocessed auxiliary audio path enable (unfiltered).
- Jumper JU8: not installed Audio output DC coupled (MT-2 transmitters).
- Jumper JU9: installed Balanced input preemphasis response enable.

• Jumper JU10: not installed	Balanced input flat audio response enable.
• Jumper JU11: 'y' position	Balanced input to auxiliary audio circuit enable.
• Jumper JU12: not installed	Tone/Digital input to auxiliary audio circuit enable.
• Jumper JU13: not installed	Direct modulation input to auxiliary audio circuit enable.
• Jumper JU14: not installed	Auxiliary input preemphasis response enable.
• Jumper JU15: not installed	Auxiliary input flat audio response enable.
• Jumper JU16: installed	Subtone input 1 audio path select.
• Jumper JU17: not installed	MT-2 Temperature compensation bypass.
• Jumper JU18: not installed	Continuous data mode selection.
• Jumper JU19: not installed	Power source for audio switches.
• Jumper JU20: not installed	Power source for Q2.
• Jumper JU21: not installed	Power source for bilateral switch U9.
• Jumper JU22: 'x' position	Audio output to lowpass filter
• Jumper JU23: not installed	Direct modulation input to subtone 2 enable.
• Jumper JU24: installed	Lowpass filter response select.
• Jumper JU25: installed	Lowpass filter response select.
• Jumper JU26: installed	Lowpass filter response select.
• Jumper JU27: not installed	Direct modulation input audio path select.
• Jumper JU28: not installed	Amplified direct modulation bypass.
• Jumper JU29: not installed	Amplified direct modulation input DC coupled enable.
• Jumper JU30: not installed	Amplified direct modulation audio path select.
• Jumper JU31: not installed	Audio output AC coupled (MT-3 synthesized transmitters)
• Jumper JU32: not installed	Audio output AC coupled (MT-3 crystal transmitters).
• Jumper JU33: installed	Audio output AC coupled.
• Jumper JU34: not installed	Audio output from direct modulation circuits select.
• Jumper JU35: not installed	Direct Modulation output source select.
• Jumper JU36: 'y' position	Power source select for AGC Preamplifier.
• Jumper JU37: not installed	Direct modulation output enable.
• Jumper JU38: not installed	Subtone 2, DC coupled, to direct modulation output select.
• Jumper JU39: not installed	Direct modulation low input impedance enable.
• Jumper JU40: installed	Power for Microphone preamplifier enable.
• Jumper JU41:	not used.
• Jumper JU42: not installed	Processed audio path to direct modulation output.
• Jumper JU43: installed	Bilateral switch U9 bypass enable.

3.10 MT-3 Audio Processor Alignment (Version 1.8)

3.10.1 General

Verify the standard factory settings for the MT-3 Audio Processor as given in section 3.9.1 before beginning the standard deviation adjustment procedure. If the transmitter's channel frequency changes, the audio processor should be realigned to optimize the transmitter's performance. The schematic diagram for the audio processor is shown in section 5.5.2 and the component layout is shown in section 5.5.1.

3.10.2 MT-3 Audio Processor Standard Deviation Adjustment

Note: clockwise rotation of controls increases signal levels.

- 1 Connect the transmitter to the radio communications test set and monitor FM deviation, distortion, and audio frequency. Before adjusting the audio deviation, confirm that the transmitter RF output frequency is correct.
- 2 Connect the 600 ohm input to the incoming audio (pins B18, Z18). Set the audio frequency to 1 kHz at the desired level of -8 dBm.
- 3 Increase the balance level control (R31) so that the deviation increases until compression is observed.
- 4 Adjust the compression control pot (R38) for compression at $\pm 60\%$ maximum deviation.
- 5 Set the audio frequency to 2.4 kHz, then adjust the deviation control (R29) for maximum deviation.
- 6 Reset the modulating frequency to 1 kHz and re-adjust R38 for $\pm 60\%$ maximum deviation.
- 7 Repeat steps 4 and 6 until both conditions are met.
- 8 Vary the audio signal from 1 kHz to 3 kHz and measure the positive deviation and then the negative deviation. Adjust the symmetry control (R14) until the $\pm$ deviation is symmetrical. The variation between $\pm$ deviation levels should not exceed 300 Hz over the 1 kHz to 3 kHz range.
- 9 Repeat steps 4 and 6 and re-adjust if necessary.

- 10 Adjust the balanced input level control (R31) so that the deviation increases until compression is observed. The deviation should be ± 1.5 kHz or ± 3 kHz for narrowband and wideband channels respectively.
- 11 Increase the input level (R31) by +20 dBm, it should not increase the deviation more than maximum. This confirms that the AGC action of preamplifier U1 is working.
- 12 A 2.4 kHz tone at the desired audio input level should produce the maximum deviation. Increasing the input level by +20 dBm should not increase the deviation. This confirms that the limiting action of U4a and U5a is working.
- 13 Set the audio frequency back to 1 kHz at -8 dBm output. Confirm and record audio distortion with the appropriate filter on the communications test set.
- 14 Confirm the audio frequency response by referencing all output deviation measurements to a 1 kHz input tone at $\pm 20\%$ maximum deviation (± 500 Hz for narrowband or ± 1 kHz for wideband). Remove the signal to the balanced input (pins B18, Z18).
- 15 Apply a 1 kHz tone at -8 dBm to the microphone audio input. Set the microphone compression control (R2) to produce $\pm 50\%$ maximum deviation. Reduce the signal to -10 dBm and adjust the microphone input level control (R2) for $\pm 50\%$ maximum deviation. Remove the signal.
16. Apply a 100 Hz tone at -18 dBm to the subtone 1 input and adjust the subtone 1 level control (R42) to produce ± 500 Hz deviation. Remove the signal.

3.11 Low Frequency Modulation Configuration

Note: the following information originates from Daniels Electronics document number A0361-06.

3.11.1 MT-3 Transmitters

For transmitters, the LTR™ or DCS signal should be applied to the DIRECT MODULATION input (pin Z28), which is also available on the M-3 and SR-3 motherboards at the control connectors J1, P1, or J7 on pins B20 (TX A DIR MOD) and A20 (TX B DIR MOD). **The signal from an LTR™ or DCS encoder should be applied through a 47k resistor to reduce the loading effect of the DIRECT MODULATION input.** The signal should be capacitively coupled to avoid pulling the transmitter frequency off centre. Most LTR™ and DCS encoder modules already have a capacitive output. Note that the controller generating the low frequency signal will need to key the transmitter's PTT input. Note that the synthesizer and the audio processor may require modifications as described later in this document.

MT-3 Transmitter (board version 43-920910 through 43-920911)

- J6 installed (synthesizer always powered up by +9.5V SWITCHED line).
- J7 installed in 'X' position (audio processor always powered up by +9.5V SWITCHED line).
- solder a wire from JA4-2 of main board to J51-18 of synthesizer. This connects the subtone output 2 to the synthesizer's phase modulation input.

MT-3 Transmitter (board version 43-920912 through 43-920913)

- J6 installed (synthesizer always powered up by +9.5V SWITCHED line).
- J7 installed in 'X' position (audio processor always powered up by +9.5V SWITCHED line).

MT-3 Transmitter (board version 43-920914 or higher)

- J6 installed (+9.5V SWITCHED line always powered).
- J7 installed in 'X' position. (audio processor always powered up by +9.5V SWITCHED line).
- J18 installed in the 'X' position (synthesizer always powered up by +9.5V SWITCHED line).

LTR™ is a Trademark of E.F. Johnson Company.

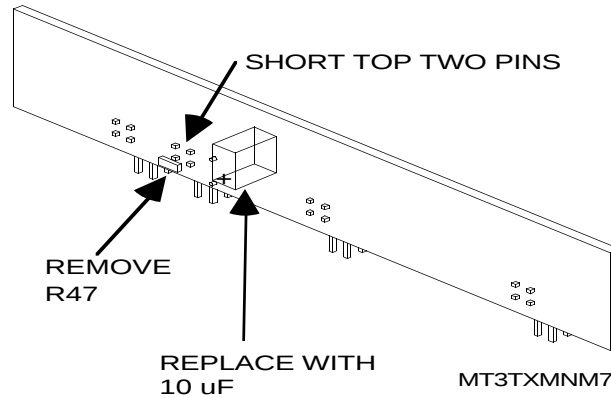
3.11.2 MT-3 Transmitter Audio Processors

MT-3 Transmitter Audio Processor (board version 43-911910 through 43-911913)

- Remove R47 to avoid having too low an input impedance.
- Change C40 to a 10 uF tantalum capacitor (stock code 1054-6E106M25) with the "+" polarity mark nearest to the edge of the PCB (see figure 3-1). This allows low frequencies to pass.
- Short pins P4-1 and P4-3 (or install J23) together with a short piece of 22 or 24 gauge solid wire and solder (see diagram below). This allows the DIRECT MODULATION

- input to the transmitter to be used to gain access to the SUBTONE INPUT 2 which connects to the PHASE MOD IN input of a modified synthesizer.
- Make sure J13 and J16 are not installed.

Figure 3-1 Transmitter Audio Processor Low Frequency Modulation.



MT-3 Transmitter Audio Processor (board version 43-911914 through 43-911916)

- Install jumpers: JU38Y, JU35Y
- Remove jumpers: JU27X, JU27Y, JU31, JU35X, JU37, JU38X
- Short pins P4-1 and P4-3 (or install J23) together with a short piece of 22 or 24 gauge solid wire and solder (see figure 3-1). This allows the DIRECT MODULATION input to the transmitter to be used to gain access to the SUBTONE INPUT 2 which connects to the PHASE MOD IN input of a modified synthesizer.

Note that the SUBTONE 2 input should not be used while this modification is in effect. Note also that adjusting R44 has no effect on the deviation of the low frequency signal.

MT-3 Transmitter Audio Processor (board version 43-911918)

- Contact factory for configuration.

3.11.3 Synthesizer and Crystal Controlled Oscillator

Refer to the manual for the Oscillator used in your Transmitter for the required Low Frequency Modulation modifications.

3.11.4 Tuning the Transmitter

For all MT-3 transmitters, apply a low impedance source of 20-300 Hz to the Direct Modulation input of the transmitter (Pin Z28 of the 48 pin connector) through a 22 uF capacitor, positive terminal connected to pin Z28. A Marconi 2955 works well for this test. Adjust R44 on the audio processor to the fully clockwise position.

- Apply a 100 Hz tone at -8 dBm to the Direct Modulation input of the transmitter (Pin Z28 of the 48 pin connector, and key the transmitter. Adjust the level of the tone until a deviation of 1.5 kHz is achieved. Note that the level required may be anywhere from -10 dBm to 0 dBm depending on the type of transmitter.
- Confirm that the frequency response rolls off by checking that the following deviations are observed: (note that the deviation will NOT roll off at 300 Hz if an OC-3 crystal oscillator is used instead of a synthesizer).
 - 20 Hz tone gives about 700 Hz deviation
 - 100 Hz tone gives 1.5 kHz deviation
 - 300 Hz tone gives about 500 Hz deviation
- Finally, confirm subtone 1 modulation: set-up for 100 Hz Mod with 500 Hz Dev.
 - Check 200 Hz Mod, Dev = $\frac{1.5 \text{ (VHF)}}{2.0 \text{ kHz (UHF)}}$
 - Check 300 Hz Mod, Dev = $\frac{1.5 \text{ (VHF)}}{4.0 \text{ kHz (UHF)}}$

4 TRANSMITTER INTERCONNECT PIN DEFINITIONS

The MT-3 series Transmitter employs a 48 pin Eurostandard connector for interfacing to all transmitter power, audio, and control functions. The following are the MT-3 series Transmitter backplane connections to the M-3 Motherboard.

Pin	Name	Pin	Name	Pin	Name
D2	No Connect	B2	+13.8 Vdc	Z2	+13.8 Vdc
D4	No Connect	B4	MIC Out	Z4	MIC In
D6	No Connect	B6	+9.5 Vdc	Z6	+9.5 Vdc
D8	No Connect	B8	Relay Positive	Z8	Relay Negative
D10	No Connect	B10	PTT WTO	Z10	PTT WTO
D12	No Connect	B12	Tx Standby	Z12	Tx Standby
D14	No Connect (IMC1)	B14	PTT NTO	Z14	PTT NTO
D16	No Connect (IMC2)	B16	No Connect (MT-2 +9.5V)	Z16	No Connect (MT-2 +9.5V)
D18	No Connect (IMC3)	B18	Balanced Input 2	Z18	Balanced Input 1
D20	Channel Select 0 (LSB)	B20	Squelched,De-emph Audio	Z20	Squelched, Flat Audio
D22	Channel Select 1	B22	Subtone Input 1	Z22	Tx Audio Control
D24	Channel Select 2	B24	PTT Output	Z24	Subtone Input 2
D26	Channel Select 3 (MSB)	B26	Forward Power Sense	Z26	Reverse Power Sense
D28	Synth Tx Data (Output)	B28	Monitor Out	Z28	Direct Mod Input
D30	Synth Rx Data (Input)	B30	Ground	Z30	Ground
D32	Synth Bootstrap (Input)	B32	Ground	Z32	Ground

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5 ILLUSTRATIONS AND SCHEMATIC DIAGRAMS

5.1 Transmitter Block Diagram

6 PARTS LISTS

6.1 Transmitter Main Board Parts List

6.1.1 Transmitter Main Board Electrical Parts List

7 REVISION HISTORY

ISSUE	DATE	REVISION
1	August 97	First Issue.
	Sept. 97	Included PCB version 1.4 Component Layout and Schematic diagrams.
2	Dec 97	Main PCB version now 1.7 (ECO 515). • BCD Switches changed from Surface Mount Part to Through Hole Part. • Audio Amplifier was removed because this option was never used. • Added Timer Out Timer circuitry to Main Tx Board. • TOT PCB no longer installed on Audio Processor. For A21-TX3-00 TX MAIN/FP, MT-3, STANDARD A21-TX3-30 TX MAIN/FP, MT-3, + REF. INPUT TUBING, TFE-260C,14AWG T/W,CLR 7610-260C14TW 18mm Long and Consummable Buss Wire 16 Awg 40mm Long NOW NOT INSTALLED
	Dec 97	For A21-TX3-01 TX MAIN/FP, MT-3, WITH FUSE A21-TX3-02 TX MAIN/FP, MT-3, + DC RELAY A21-TX3-03 TX MAIN/FP, MT-3, + FUSE,RELAY • Removed Jumpers J1, J5, J8, J10, J11. • Added Jumpers J22 - J29, J31 - J35. • Added Test Points TP28 - TP34
	Dec 97	Front Panel Board version now 1.2 (ECO 521). Modified MT-3 Tx Front Panel Board (FPB) to support all options on the New Transmitter Main Board . Also, the Front Panel Board is now easier to configure if new microphones (other than Daniels microphones) are used. The new FPB can be used on the old TX-3 main - all options will function. However, the old version of FPB will NOT work with the new version TX-3 Main PCB (unless you hard wire one of the microphone pins into the main PCB (13.8V line.) Added J2 SM Jumper. This jumper now selects Rx Audio or 13.8V to Pin 4 of the Microphone. This capability used to be selected by a jumper on the Main Tx Board. For Normal Opertion J2 'x' position must be installed Options - This is for future use (not used now). Added 2x4 header land pattern to Tx Front Panel Board. A 2x4 header can be installed to make other microphones compatible with Daniels Transmitters.
	Nov 98	MT-3 FM Audio Processor now version 1.8 The MT-3 FM Audio Processor was re-designed because the IC, XXXXX, XXXXX, SO-8 is no longer available from the supplier. Also, the new design improves the flat and 300Hz Pre-emphasis audio responses. Included PCB version 1.8 Component Layout, Schematic diagram, Parts List and Section 2.4, 3.9 and 3.10.

ISSUE	DATE	REVISION
3	Nov 98	Updated the DE logo and added the statutory trademark statement to the title page. Updated the Low Frequency Modulation section 3.11 to reflect the in house document A0361-06.



MT-3 RADIO SYSTEMS

ENHANCED AM/FM SYNTHESIZER INSTRUCTION MANUAL OS(R/T)-3(A/H) 29 - 935 MHz

Preliminary

Covers models:

OST-3H035, OST-3H045, OSR-3H061
OST-3A128, OSR-3A149
OST-3H141, OST-3H162, OSR-3H141, OSR-3H162
OST-3H440, OSR-3H440
OST-3H932

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Quality Assurance:

Claudia Boorman

Name

Signature

Date

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

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1 GENERAL

1.1 Introduction

The OS-3A/H Synthesizer is a compact, fully shielded and environmentally rugged frequency synthesis module that is the nucleus of every MT-3 synthesized Receiver and Transmitter radio module. The OS-3A/H generates a high stability, low distortion radio frequency signal in one of several frequency bands, including 29 - 50 MHz, 118 - 159.4 MHz, 118 - 174 MHz, 406 - 470 MHz and 928 – 935 MHz. The OS-3A/H utilizes an internal temperature compensated 9.6 MHz reference to produce a signal stable to ± 1 ppm within the temperature range of -40°C to $+60^{\circ}\text{C}$. Alternately, the OS-3A/H can be disciplined by an external 9.6 MHz or 10 MHz reference of higher stability. The OS-3A/H Synthesizer Module is manufactured in thirteen distinct models which cover five primary frequency bands (see section 1.2 below). All synthesizer modules are designed to be easily removed for programming, calibration and/or repair. The synthesizer circuitry is distributed between two printed circuit boards (PCBs) which are isolated yet interconnected via photo-logic optical transceivers that effectively eliminate residual electrical noise between digital and analog circuitry. Further shielding of the synthesizer's RF filter circuitry is provided by an internal shielded enclosure.

1.2 OS(R/T)-3(A/H) Enhanced Synthesizer Family Models

The OS-3A/H Synthesizer Module is utilized in both the MT-3 Receiver and Transmitter product lines. In MT-3 Transmitters, the OS-3A/H synthesizer provides a modulated, low-level RF signal to the Power Amplifier module. In MT-3 Receivers, the OS-3A/H synthesizer provides a low noise local oscillator (LO) signal that either directly drives the mixer circuitry or first drives a buffer amplifier which precedes the mixer circuitry (if a higher LO drive signal is required for enhanced intermodulation capability). There are thirteen distinct models within the OS-3A/H Enhanced Synthesizer Family. Note that this manual provides service and operating information for all thirteen synthesizer modules. It is extremely important to establish the correct synthesizer model number, as documentation is model-specific. The model number can be found on the synthesizer label, located on the synthesizer module top cover.

The thirteen synthesizer models that comprise the OS-3A/H Synthesizer family are follows:

Frequency Band: 29 - 50 MHz, Common OS-3H0xx Analog Board

- OST-3H035 - installed in FM transmitter, 29 - 38 MHz RF output.
- OST-3H045 - installed in FM transmitter, 38 - 50 MHz RF output.
- OSR-3H061 - installed in FM receiver, 50.4 - 71.4 MHz RF output.

Frequency Band: 118 - 159.4 MHz, AM Multichannel OS-3H1xx Analog Board

- OST-3A128 - installed in AM transmitter, 118 - 138 MHz RF output.
- OSR-3A149 - installed in AM receiver, 139.4 - 159.4 MHz RF output.

Frequency Band: 128 - 174 MHz, Common OS-3H1xx Analog Board

- OST-3H141 - installed in FM transmitter, 128 - 152.6 MHz RF output.
- OST-3H162 - installed in FM transmitter, 150 - 174 MHz RF output.
- OSR-3H141 - installed in FM receiver, 128 - 152.6 MHz RF output.
- OSR-3H162 - installed in FM receiver, 150 - 174 MHz RF output.

Frequency Band: 406 - 470 MHz, Common OS-3H4xx Analog Board

- OST-3H418 - installed in FM transmitter, 406 - 430 MHz RF output.
- OST-3H460 - installed in FM transmitter, 450 - 470 MHz RF output.
- OSR-3H440 - installed in FM receiver, 427.4 - 451.4 MHz RF output.

Frequency Band: 928 - 935 MHz, Common OS-3H932 Analog Board

- OST-3H932 - installed in FM transmitter, 928 - 935 MHz RF output.

All OS-3A/H Enhanced Synthesizer Modules, regardless of the frequency band, use the same digital PCB and mechanical construction. There are, however, significant differences between the various models when it comes to the analog PCB. There are five different analog PCBs, designed to cover the five frequency bands of 29 - 50 MHz, 118 - 159.4 MHz, 128 - 174 MHz, 406 - 470 MHz and 928 - 935 MHz. Each model's specific sub-band of operation within a given frequency band is determined through SELECT components on the corresponding analog board.

1.3 Performance Specifications

Type:	Narrow band FM, Single loop synthesizer module utilizing low noise VCO and PLL technology. Compatible with Daniels MT-3 series Transmitter and Receiver modules.
Frequency Range: (Tuning range with no adjustment is shown in [] brackets.)	29 MHz - 38 MHz [± 0.5 MHz] (OST-3H035) 38 MHz - 50 MHz [± 1.0 MHz] (OST-3H045) 50.4 MHz - 71.4 MHz [± 1.0 MHz] (OSR-3H061) 118 MHz - 138 MHz [Full band] (OST-3A128) 128 MHz - 152.6 MHz [± 2.0 MHz] (OST-3H141, OSR-3H141) 139.4 MHz - 159.4 MHz [Full band] (OSR-3A149) 150 MHz - 174 MHz [± 2.0 MHz] (OST-3H162, OSR-3H162) 406 MHz - 430 MHz [Full band] (OST-3H418) 427.4 MHz - 451.4 MHz [Full band] (OSR-3H440) 450 MHz - 470 MHz [Full band] (OST-3H460) 928 MHz - 935 MHz [Full band] (OST-3H932)
Output Power:	+5 dBm ± 2 dBm into 50 Ω
Harmonics:	<-30 dBc
Spurious:	<-90 dBc <-70 dBc above 400 MHz
Attack Time:	<10 ms (Normal Mode) <50 ms (Low Current Standby Mode)
Hum and Noise:	-55 dB
Modulation Sensitivity:	3.0 kHz peak deviation (400 mVrms input)
External Reference Input:	External reference input signal via SMB connector J1 Input level 0 dBm ± 3 dB Input impedance 50 Ω Input frequency 10.0 MHz or 9.6 MHz (selectable through digital board jumper JU1)
Power Requirements:	Normal Configuration: +9.5 Vdc @ 160 mA for FM and 65 mA for AM Low Current Standby Mode (TCXO enabled): +9.5 Vdc @ 14 mA for FM and 4 mA for AM

1.4 Printed Circuit Board Numbering Convention

To expedite troubleshooting and maintenance procedures, Daniels Electronics Ltd. has adopted a printed circuit board (PCB) numbering convention in which the last two digits of the circuit board number represent the circuit board version. All PCB's manufactured by Daniels Electronics Ltd. are identified by one of the following numbering conventions:

- PCB number 43-912010 indicates circuit board version 1.0; or
- PCB number 50002-02 indicates circuit board version 2.0

2 THEORY OF OPERATION

2.1 Internal Power and Control (Digital Board)

3 SYNTHESIZER ALIGNMENT

3.1 General

OS(R/T)-3(A/H) enhanced synthesizer alignment is simplified by using a Type 84 subrack and RF extender card/cable of providing receiver or transmitter power and signal interconnection. Alternately, +9.5 Vdc may be directly connected to a receiver or transmitter module with the positive connection on pins B6 / Z6 and the negative connection on pins B30 / Z30 / B32 / Z32. Receiver balanced audio (600 Ω) is available at pins B26 and Z26.

3.2 Repair Note

The OS(R/T)-3(A/H) synthesizer employs a large number of surface mount components. Removal and/or replacement of surface mount components should never be performed using an ordinary soldering iron but should only be performed at surface mount rework and repair stations equipped with Electro Static Dissipative (ESD) protection.

When removing Surface Mount Solder Jumpers, it is recommended that solder wick braid be used in lieu of vacuum type de-soldering tools to help prevent damage to the printed circuit boards.

3.3 Recommended Test Equipment

Alignment of the synthesizer requires the following test equipment, or its equivalent:

Power supply - Regulated +9.5 Vdc at 2 A. Phillips PM 2811

Oscilloscope / Multimeter - Fluke 97 Scopemeter

Radio communications test set - Marconi Instruments 2965A

It is recommended that the radio communications test set be referenced to an external high stability frequency source (WWVH, GPS, Loran C) so that the OS-3A/H internal high stability local oscillator may be accurately set to within its ± 1 ppm frequency tolerance.

3.4 OS(R/T)-3(A/H) Synthesizer Factory Configuration

The OS(R/T)-3(A/H) Synthesizer is factory configured as follows:

- Internal 9.6 MHz reference selected.
- VCO modulation (via audio processor) enabled (OST TX versions only)

The corresponding internal synthesizer jumper settings are:

Digital Board

- Jumper JU2 not installed 9.6 MHz internal frequency reference selected
- Jumper JU1 installed AM Multichannel mode selected

Analog Board

- Jumper JU1: 'B' position Internal frequency reference selected
- Jumper JU2 not installed Internal frequency reference selected

3.5 OS(R/T)-3(A/H) Synthesizer Alignment

3.5.1 General

Under normal circumstances (i.e. a change in operating frequency within the synthesizer's maximum tuning range), synthesizer alignment is accomplished with the synthesizer installed in the MT-3 Receiver IF/Audio Board or the MT-3 Transmitter Main Board. The alignment procedure involves setting the internal TCXO reference frequency (if one is installed and the internal reference option is enabled). This step is described in "[Reference Frequency Alignment](#)", [section 3.5.5.5](#). A change in operating frequency from the initial factory setting that exceeds the synthesizer's maximum tuning range ([Refer to Specifications section 1.3](#)) requires a more involved [alignment procedure as described in sections 3.5.2 to 3.5.5](#). Conversion of a synthesizer from internal reference to external reference or vice-versa is accomplished through selection of jumper JU1 A or B, as appropriate and JU2 ([Refer to section 3.5.6](#)).

3.5.2 Synthesizer Test Points

Analog Board Component Layout (Top)

Common to all synthesizer family members.

- TP1 +8.0 $\pm$ 0.3 Vdc. U6 positive regulator output.
- TP2 +5.0 $\pm$ 0.1 Vdc. U7 positive regulator output.
- TP3 +5.0 $\pm$ 0.1 Vdc. U8 positive regulator output (always on).
- TP4 PLL error voltage. Normal range is +0.5 to +4.5 Vdc (depending on frequency). Nominally adjusted for +2.3 Vdc (via C24) for center channel. UHF/VHF versions employing integrated VCO modules (OSR-3H440, OST-3H418, OST-3H460, OSR-3A149, OST-3A128, OST-3H932) require no adjustment.

Digital Board Component Layout (Bottom)

- TP1 +5.0 $\pm$ 0.1 Vdc. U2 positive regulator output (controlled via pin P2-4).
- TP2 Microcontroller E clock. 2 MHz logic level square wave.

3.5.3 Synthesizer Removal and Installation

The synthesizer module is secured to the main board (MT-3 Receiver IF/Audio Board or MT-3 Transmitter Main board) with a single counter sunk Phillips machine screw accessible from the top cover. Remove this screw to remove the synthesizer module. Using a plastic coated lifting tool, such as a small screwdriver with the tip covered in heat shrink material, gently lift the synthesizer module from the main circuit board by applying pressure in a rotating fashion about the four corners of the synthesizer module. It is important to gently remove the synthesizer module "straight out" in order to prevent damage to the connector pins. Installation of the synthesizer is performed in a reverse fashion. It is important to ensure complete connector pin alignment prior to any application of reinsertion force. Four corner locating pins on the synthesizer housing assist in connector pin alignment during installation and removal.

Note: Complete synthesizer alignment can be performed without removing the synthesizer.

The alignment procedure starting in section 3.5.5 may now be performed.

3.5.4 Circuit Board Removal

Note: Circuit board removal is not required for tuning purposes.

Using a vacuum de-soldering station, de-solder connections P1, P2 and P3. Remove SMB connectors J1 and J2 by de-soldering the center pins and removing four M2.0 machine screws. These connection points are shown in the "OS(R/T)-3(A/H) XXX - XXX MHz Analog Board Component Layout (Top)" diagrams. Remove seven M2.0 machine screws and carefully remove the analog circuit board. Removal of the analog circuit board will expose three inter-board wire connections. Carefully remove three ferrite beads and six Teflon washers from the inter-board connection wires. Attempt to maintain the position of the three inter-board wires in order to simplify re-assembly. The digital board may now be extracted by removing four M2.0 machine screws. Follow a reverse procedure to re-assemble.

3.5.5 Frequency Adjustment and Channel Selection

Connect a radio communications test set through a short section of low loss 50 Ω coaxial cable to the synthesizer module SMB RF output jack (J2). Select the desired channel number via the BCD frequency selection switches on the MT-3 Transmitter Main board or the MT-3 Receiver IF/Audio board (or through the Frequency Programming Module). Turn the power off and back on and wait a few minutes for the oscillator to completely stabilize. It should be noted that the internal synthesizer TCXO, if installed, operates continuously (regardless of the TX PTT state) when installed in a transmitter.

The measured RF output signal should be within ± 1.0 ppm of the specified oscillator frequency at an output level of +5 dBm. Note that unlocked synthesizer operation will be indicated by an unstable or spurious RF output signal. The "Unlocked" red LED will also be illuminated when the PLL is unlocked. Check that the requested channel number is within the frequency range of the particular synthesizer model. An unlocked condition may be rectified by adjusting the VCO tuning elements as described in the following procedures (no adjustment required for the Multichannel AM Synthesizers). Note that there are variations in alignment procedures between the three synthesizer family members as described in the following sections.

3.5.5.1 VHF OS(R/T)-3H 29 - 71.4 MHz VCO Alignment

Refer to the "OS(R/T)-3H 29 - 71.4 MHz Analog Board Component Layout" diagrams and the "OS(R/T)-3H 29 - 71.4 MHz Analog Board Schematic Diagram" on pages 4-1, 4-2 and 4-3 of this manual.

Using a high impedance (10 M Ω) DC Voltmeter, measure the PLL control voltage at TP4 located on the synthesizer module analog board (top). Access to TP4 is available through the synthesizer top cover. Using a small standard blade screwdriver, carefully adjust the VCO fine frequency "TUNE" trimmer capacitor C24 until a test point (TP4) voltage of approximately +2.3 Vdc is obtained. PLL loop control voltages below approximately +0.5 Vdc and above approximately +4.5 Vdc will indicate an "out of lock" synthesizer condition.

If a test point (TP4) reading of approximately +2.3 Vdc is unattainable through adjustment of C24, then the coarse frequency jumpers, JU2-JU4 require modification in order to pull the VCO tune range within the adjustment range of fine tuning capacitor C24. The top synthesizer cover must be removed in order to gain access to the coarse frequency jumpers. The coarse frequency jumpers (JU2-JU4) may be considered to be a selectable binary weighted capacitor element with JU2 being the most significant "bit" and JU4 being the least significant "bit". The tuning resolution size is ≈ 12 pF (JU4). If the tuning voltage remains higher than +2.3 Vdc, decrease the tuning jumper setting by 1 "bit" position and re-adjust C24 in an attempt to achieve +2.3 Vdc at TP4. For example, if coarse frequency jumpers JU2-JU4 are all installed and represented by 111 then a decrease by 1 "bit" position (12 pF) is represented by a binary jumper selection of 110; jumper JU4 is not installed and jumpers JU2, JU3 are installed. Continue to decrease the jumper position one "bit" at a time until the synthesizer regains lock with TP4 adjusted (C24) for +2.3 Vdc. If the tuning voltage remains lower than +2.3 Vdc, increase the jumper setting by 1 "bit" position and re-adjust C24 in an attempt to achieve +2.3 Vdc at TP4. Repeat this procedure until +2.3 Vdc is achieved at TP4.

It is important to check the loop control voltage at TP4 when multiple synthesizer channels have been programmed. All channel selections should result in a TP4 voltage within a +1.0 to +4.0 Vdc range. Adjust the fine-tuning capacitor C24 to center multiple channel voltages symmetrically about +2.3 Vdc. Channel selections beyond the tuning range capability of the

synthesizer will result in unlocked operation. The tuning range capability of all synthesizer models is listed in the Specifications section (1.3) of this manual.

3.5.5.2 VHF OS(R/T)-3A 118 - 159.4 MHz Alignment

Refer to the "OS(R/T)-3A 118 - 159.4 MHz Analog Board Component Layout" diagram and the "OS(R/T)-3A 118 - 159.4 MHz Analog Board Schematic Diagram" on pages 4-5, 4-6 and 4-7 of this manual.

Using a high impedance (10 MΩ) DC Voltmeter, measure the PLL control voltage at TP4 located on the synthesizer module analog board (top). Access to TP4 is available through the synthesizer top cover. VHF synthesizers operating in the 118 - 159.4 MHz frequency range require no frequency adjustment as tuning is microprocessor controlled. (The OST-3A128 and OSR-3A149, covering 118-138 MHz and 139.4 - 159.4 MHz respectively, provide full band coverage without tuning adjustment.)

All channel selections should result in a TP4 voltage between +3.1 and +3.5 Vdc. Channel selections beyond the tuning range capability of the synthesizer will result in unlocked operation over the temperature range -40C to +60C. The tuning range capability of all synthesizer models is listed in the Specifications section of this manual.

3.5.5.3 VHF OS(R/T)-3H 128 - 174 MHz VCO Alignment

Refer to the "OS(R/T)-3H 128 - 174 MHz Analog Board Component Layout" diagram and the "OS(R/T)-3H 128 - 174 MHz Analog Board Schematic Diagram" on pages 4-9, 4-10 and 4-11 of this manual.

Using a high impedance (10 MΩ) DC Voltmeter, measure the PLL control voltage at TP4 located on the synthesizer module analog board (top). Access to TP4 is available through the synthesizer top cover. Using a small standard blade screwdriver, carefully adjust the VCO fine frequency "TUNE" trimmer capacitor C24 until a test point (TP4) voltage of approximately +2.3 Vdc is obtained. Measured PLL loop control voltages below approximately +0.5 Vdc and above approximately +4.5 Vdc will indicate an "out of lock" synthesizer condition.

It is important to check the loop control voltage at TP4 when multiple synthesizer channels have been programmed. All channel selections should result in a TP4 voltage within the +1.0 to +4.0 Vdc range. Adjust the fine-tuning capacitor C24 to center multiple channel voltages symmetrically about +2.3 Vdc. Channel selections beyond the tuning range capability of the synthesizer will result in unlocked operation. The tuning range capability of all synthesizer models is listed in the Specifications section of this manual.

3.5.5.4 UHF OS(R/T)-3H 406 - 470 MHz VCO Alignment

Refer to the "OS(R/T)-3H 406 - 470 MHz Analog Board Component Layout" diagram and the "OS(R/T)-3H 406 - 470 MHz Analog Board Schematic Diagram" on pages 4-13, 4-14 and 4-15 of this manual.

Using a high impedance (10 M Ω) DC Voltmeter, measure the PLL control voltage at TP4 located on the synthesizer module analog board (top). Access to TP4 is available through the synthesizer top cover. The UHF synthesizers operating in the 406 - 470 MHz frequency range employ integrated VCO modules having no external frequency adjustment capability. The OST-3H418, OST-3H460 and OSR-3H440 models cover frequencies from 406 - 430 MHz, 450 - 470 MHz and 427.4 - 451.4 MHz respectively and provide full band coverage without tuning adjustment. For the OST-3H418, measured PLL control voltages below approximately +0.5 Vdc and above approximately +4.5 Vdc will indicate an "out of lock" condition. For the OSR-3H440 and the OST-3H460, measured PLL control voltages below approximately +1.0 Vdc and above approximately +7.0 Vdc will indicate an "out of lock" condition.

It is important to check the loop control voltage at TP4 when multiple synthesizer channels have been programmed. All channel selections should result in a TP4 voltage within the +0.5 to +4.5 Vdc range for the OST-3H418. The TP4 voltage for the OSR-3H440 and the OST-3H460 should be within the +1.0 to +7.0 Vdc range. Channel selections beyond the tuning range capability of the synthesizer will result in unlocked operation. The tuning range capability of all synthesizer models is listed in the Specifications section of this manual.

3.5.5.5 UHF OS(R/T)-3H 928 - 935 MHz VCO Alignment

Refer to the "OS(R/T)-3H 928 -935 MHz Analog Board Component Layout" diagram and the "OS(R/T)-3H 928 - 935 MHz Analog Board Schematic Diagram" on pages 4-17, 4-18 and 4-19 of this manual.

Using a high impedance (10 M Ω) DC Voltmeter, measure the PLL control voltage at TP4 located on the synthesizer module analog board (top). Access to TP4 is available through the synthesizer top cover. The UHF synthesizers operating in the 928 - 935 MHz frequency range employ integrated VCO modules having no external frequency adjustment capability. The OST-3H932 model covers frequencies from 928 - 935 MHz and provides full band coverage without tuning adjustment. For the OST-3H932, measured PLL control voltages below approximately +0.5 Vdc and above approximately +4.5 Vdc will indicate an "out of lock" condition.

It is important to check the loop control voltage at TP4 when multiple synthesizer channels have been programmed. All channel selections should result in a TP4 voltage within the +0.5 to +4.5 Vdc range for the OST-3H932. Channel selections beyond the tuning range capability of

the synthesizer will result in unlocked operation. The tuning range capability of all synthesizer models is listed in the Specifications section of this manual.

3.5.5.6 Reference Frequency Alignment

Adjust the synthesizer TCXO fine frequency potentiometer RV1 until the correct output frequency is achieved. Access to this potentiometer is through an opening in the synthesizer top cover. A RF power level of approximately +5 dBm should be measured at the synthesizer module output connector and the frequency should be within ± 1 ppm of the desired operating frequency. Reference frequency adjustments should be made at room temperature (+25°C) after a ten minute stabilization period.

3.5.6 Jumper Configuration

Solder jumpers are clearly marked on both synthesizer digital and analog circuit boards. Refer to the "OS(R/T)-3(A/H) Digital Board Component Layout (Bottom)" diagram on page 4-20 of this manual and the applicable "OS(R/T)-3(A/H) Analog Board Component Layout (Top)" diagram on page 4-21 for jumper locations. The following list details the required jumper configuration for the two synthesizer operating modes:

- 1) Internal reference. Install jumper JU1-B, on the Analog Board (Standard). The internal temperature compensated crystal oscillator (TCXO) provides the reference signal with a stability of ± 1 ppm from -30°C (Optional -40°C) to $+60^{\circ}\text{C}$.
- 2) External reference input. Install jumper JU1-A and JU2 on the Analog Board. This mode is used in applications requiring better than ± 1 ppm frequency stability. An external reference signal must be provided at synthesizer SMB connector J1.
- 3) Reference Frequency Select. Install jumper JU2 on the Digital Board to select a 10.0 MHz reference frequency. When not installed, the reference frequency is by default 9.6 MHz. JU2 must not be installed when using the internal 9.6 MHz TCXO reference. JU2 is used by the microcontroller to establish the correct reference frequency division ratio. (Located on the Digital Board; The Synthesizer module must be removed to change jumper JU2.)
- 4) AM Multichannel Synthesizer Select. Install jumper JU1 on the Digital Board to select and enable the AM Multichannel Synthesizer with Frequency Select Handle.

Caution: Care must be exercised when reinstalling the synthesizer module on the Transmitter Main board or the IF/Audio board. Pay careful attention to pin alignment before pressing the synthesizer module into its mating sockets.

4 ILLUSTRATIONS AND SCHEMATIC DIAGRAMS

4.1 OS(R/T)-3H 29 - 71.4 MHz Analog Board Diagrams

4.1.1 OS(R/T)-3H 29 - 71.4 MHz Analog Board Component Layout (Bottom)

5 PARTS LISTS

5.1 OS(R/T)-3H 29 - 71.4 MHz Analog Board Electrical Parts List

6 REVISION HISTORY

ISSUE	DATE	REVISION
1	May 97	• Issue 1
2	Mar 98	• Changes to the AM Analog board (OST-3A128) to improve performance. ECO #547. C37 was 220nF is now 100nF and C40 was 8.2pF is now not installed C45 was 33nF is now 22nF and C49 was 2.2nF is now 1.5nF R32 was 33kΩ is now 56kΩ and R36 was 3k3Ω is now 5k6Ω
3	Mar 00	• Changes to the AM Analog board to improve performance at -40°C. ECO #565. L4 was 1.5μH is now 3.9 μH • Changes to the FM Analog boards to improve manufacturing. ECO #572 C32 & C33 were 100μF through hole tantalums are now 100μF surface mount tantalums • Changes to the OS-3A/H Digital board for compatibility with the new AM wideband Synthesizers. ECO #579. Added C15 (10μF) and R41 (221kΩ). JU1 was added and is installed for AM modules only. PCB, DIGITAL, OS-3H/P SYNTH was version 2 now version 3. • Added the new component layouts, schematic diagram and parts lists for the new AM wideband synthesizer. Wideband referring to only having to be tune once and working over the whole AM band (118-138 MHz).
4	May 00	• Changes to the OS-3H 128-174 MHz Analog board. ECO #603. R29 was 18k2 is now 3k92, U10 was MC145191 is now MC145193. • Changes to the OSR-3H 128-174 MHz Analog board. ECO #609. R22 was 100R is now 0R0. • Changes to the OS-3A 118-159.4 Analog board. ECO #601. R42 & R53 were 137kΩ are now 100kΩ.
	Jul 00	• Corrected the SELECT table on the OS(R/T)-3H 128-174 MHz Schematic diagram (section 4.3.3).

ISSUE	DATE	REVISION
4	Aug 00	- Changes to the OS(R/T)-3(A/H) Digital board. ECO #599. R30, R31 & R32 were 332R are now 215R. - Changes to the OS-3H 406-470 MHz Analog board. ECO # 597. R48 was 27R4 is now 47R5, R49 was 33R2 is now 10R. R52 was 49R9 is now Not Installed.
	Oct 00	Added the TBA part numbers for U1- U4 & U18 on the OS-3A 118-159.4 MHz Analog Board.
	Dec 00	Changes to the OS-3H 29-71.4 MHz Analog Board. ECO #631 R22 was 475R is now 1k00.
	Jan 01	- Change to the OS-3A 118-159.4 MHz Analog Board. ECO #589. R31 was 100R is now 49R9 - Changes to the OST-3A128 Analog Board. C35 was 5.6pF is now 3.3pF and R40 was 330R is now 220R.
	Feb 01	- Corrected the confusion with D6 & D7 on the OS-3A 118-159.4 MHz Analog Board parts list. - Changes to the OS-3A 118-159.4 MHz Analog Board. ECO #634. C26 was 1nF is now 3.3pF. - Changes to the OS-3 128 – 174 MHz Analog Board. ECO #635. C56 was 330pF is now R42 (Select).
	Apr 01	Changes to the OST-3H4xx Analog Board. ECO #619. C37 – C39 were 1.0µF are now 1.5µF, C45 was 220nF is now 68nF. C49 was 22nF now 15nF, C60 was 100nF now a zero ohm wire jumper. R19 was 10k0 is now zero ohm jumper (Both OS(R/T)-3H4xx). R32 was 5k6 is now 6k2 and R36 was 2k2 is now 1k2.
	Jan 03	- Updated all sections to include an extra band from 928 - 935 MHz - Added Schematics, CLD and Parts lists for the OST-3H932 module



MT-3 RADIO SYSTEMS

UHF TX CHANNEL DESIGNATION TABLES UT-3/935 928 - 935MHz

Covers models: UT-3/935-SWB3, UT-3/935-SNB3

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Issue:	Preliminary	Previous Issue:	-	
Issue Date:	New	Previous Issue Date:	-	Daniels Electronics Ltd.
Printing Date:	Month Year			Victoria, BC.
Part No.:	New			PRINTED IN CANADA

Reviewed By:

Quality Assurance:

Larry Freeman

Name

Signature

Date

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 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.

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1. CHANNEL DESIGNATION TABLES

1.1 UT-3/932 Channel Designation Table: 928-935 MHz,6.25 kHz Increments

Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)
2400	928.00000	2475	928.46875	2550	928.93750	2625	929.40625	2700	929.87500	2775	930.34375	2850	930.81250
2401	0.00625	2476	0.47500	2551	0.94375	2626	0.41250	2701	0.88125	2776	0.35000	2851	0.81875
2402	0.01250	2477	0.48125	2552	0.95000	2627	0.41875	2702	0.88750	2777	0.35625	2852	0.82500
2403	0.01875	2478	0.48750	2553	0.95625	2628	0.42500	2703	0.89375	2778	0.36250	2853	0.83125
2404	0.02500	2479	0.49375	2554	0.96250	2629	0.43125	2704	0.90000	2779	0.36875	2854	0.83750
2405	0.03125	2480	928.50000	2555	0.96875	2630	0.43750	2705	0.90625	2780	0.37500	2855	0.84375
2406	0.03750	2481	0.50625	2556	0.97500	2631	0.44375	2706	0.91250	2781	0.38125	2856	0.85000
2407	0.04375	2482	0.51250	2557	0.98125	2632	0.45000	2707	0.91875	2782	0.38750	2857	0.85625
2408	0.05000	2483	0.51875	2558	0.98750	2633	0.45625	2708	0.92500	2783	0.39375	2858	0.86250
2409	0.05625	2484	0.52500	2559	0.99375	2634	0.46250	2709	0.93125	2784	0.40000	2859	0.86875
2410	0.06250	2485	0.53125	2560	929.00000	2635	0.46875	2710	0.93750	2785	0.40625	2860	0.87500
2411	0.06875	2486	0.53750	2561	0.00625	2636	0.47500	2711	0.94375	2786	0.41250	2861	0.88125
2412	0.07500	2487	0.54375	2562	0.01250	2637	0.48125	2712	0.95000	2787	0.41875	2862	0.88750
2413	0.08125	2488	0.55000	2563	0.01875	2638	0.48750	2713	0.95625	2788	0.42500	2863	0.89375
2414	0.08750	2489	0.55625	2564	0.02500	2639	0.49375	2714	0.96250	2789	0.43125	2864	0.90000
2415	0.09375	2490	0.56250	2565	0.03125	2640	929.50000	2715	0.96875	2790	0.43750	2865	0.90625
2416	0.10000	2491	0.56875	2566	0.03750	2641	0.50625	2716	0.97500	2791	0.44375	2866	0.91250
2417	0.10625	2492	0.57500	2567	0.04375	2642	0.51250	2717	0.98125	2792	0.45000	2867	0.91875
2418	0.11250	2493	0.58125	2568	0.05000	2643	0.51875	2718	0.98750	2793	0.45625	2868	0.92500
2419	0.11875	2494	0.58750	2569	0.05625	2644	0.52500	2719	0.99375	2794	0.46250	2869	0.93125
2420	0.12500	2495	0.59375	2570	0.06250	2645	0.53125	2720	930.00000	2795	0.46875	2870	0.93750
2421	0.13125	2496	0.60000	2571	0.06875	2646	0.53750	2721	0.00625	2796	0.47500	2871	0.94375
2422	0.13750	2497	0.60625	2572	0.07500	2647	0.54375	2722	0.01250	2797	0.48125	2872	0.95000
2423	0.14375	2498	0.61250	2573	0.08125	2648	0.55000	2723	0.01875	2798	0.48750	2873	0.95625
2424	0.15000	2499	0.61875	2574	0.08750	2649	0.55625	2724	0.02500	2799	0.49375	2874	0.96250
2425	0.15625	2500	0.62500	2575	0.09375	2650	0.56250	2725	0.03125	2800	930.50000	2875	0.96875
2426	0.16250	2501	0.63125	2576	0.10000	2651	0.56875	2726	0.03750	2801	0.50625	2876	0.97500
2427	0.16875	2502	0.63750	2577	0.10625	2652	0.57500	2727	0.04375	2802	0.51250	2877	0.98125
2428	0.17500	2503	0.64375	2578	0.11250	2653	0.58125	2728	0.05000	2803	0.51875	2878	0.98750
2429	0.18125	2504	0.65000	2579	0.11875	2654	0.58750	2729	0.05625	2804	0.52500	2879	0.99375
2430	0.18750	2505	0.65625	2580	0.12500	2655	0.59375	2730	0.06250	2805	0.53125	2880	931.00000
2431	0.19375	2506	0.66250	2581	0.13125	2656	0.60000	2731	0.06875	2806	0.53750	2881	0.00625
2432	0.20000	2507	0.66875	2582	0.13750	2657	0.60625	2732	0.07500	2807	0.54375	2882	0.01250
2433	0.20625	2508	0.67500	2583	0.14375	2658	0.61250	2733	0.08125	2808	0.55000	2883	0.01875
2434	0.21250	2509	0.68125	2584	0.15000	2659	0.61875	2734	0.08750	2809	0.55625	2884	0.02500
2435	0.21875	2510	0.68750	2585	0.15625	2660	0.62500	2735	0.09375	2810	0.56250	2885	0.03125
2436	0.22500	2511	0.69375	2586	0.16250	2661	0.63125	2736	0.10000	2811	0.56875	2886	0.03750
2437	0.23125	2512	0.70000	2587	0.16875	2662	0.63750	2737	0.10625	2812	0.57500	2887	0.04375
2438	0.23750	2513	0.70625	2588	0.17500	2663	0.64375	2738	0.11250	2813	0.58125	2888	0.05000
2439	0.24375	2514	0.71250	2589	0.18125	2664	0.65000	2739	0.11875	2814	0.58750	2889	0.05625
2440	928.25000	2515	0.71875	2590	0.18750	2665	0.65625	2740	0.12500	2815	0.59375	2890	0.06250
2441	0.25625	2516	0.72500	2591	0.19375	2666	0.66250	2741	0.13125	2816	0.60000	2891	0.06875
2442	0.26250	2517	0.73125	2592	0.20000	2667	0.66875	2742	0.13750	2817	0.60625	2892	0.07500
2443	0.26875	2518	0.73750	2593	0.20625	2668	0.67500	2743	0.14375	2818	0.61250	2893	0.08125
2444	0.27500	2519	0.74375	2594	0.21250	2669	0.68125	2744	0.15000	2819	0.61875	2894	0.08750
2445	0.28125	2520	928.75000	2595	0.21875	2670	0.68750	2745	0.15625	2820	0.62500	2895	0.09375
2446	0.28750	2521	0.75625	2596	0.22500	2671	0.69375	2746	0.16250	2821	0.63125	2896	0.10000
2447	0.29375	2522	0.76250	2597	0.23125	2672	0.70000	2747	0.16875	2822	0.63750	2897	0.10625
2448	0.30000	2523	0.76875	2598	0.23750	2673	0.70625	2748	0.17500	2823	0.64375	2898	0.11250
2449	0.30625	2524	0.77500	2599	0.24375	2674	0.71250	2749	0.18125	2824	0.65000	2899	0.11875
2450	0.31250	2525	0.78125	2600	929.25000	2675	0.71875	2750	0.18750	2825	0.65625	2900	0.12500
2451	0.31875	2526	0.78750	2601	0.25625	2676	0.72500	2751	0.19375	2826	0.66250	2901	0.13125
2452	0.32500	2527	0.79375	2602	0.26250	2677	0.73125	2752	0.20000	2827	0.66875	2902	0.13750
2453	0.33125	2528	0.80000	2603	0.26875	2678	0.73750	2753	0.20625	2828	0.67500	2903	0.14375
2454	0.33750	2529	0.80625	2604	0.27500	2679	0.74375	2754	0.21250	2829	0.68125	2904	0.1500
2455	0.34375	2530	0.81250	2605	0.28125	2680	929.75000	2755	0.21875	2830	0.68750	2905	0.15625
2456	0.35000	2531	0.81875	2606	0.28750	2681	0.75625	2756	0.22500	2831	0.69375	2906	0.16250
2457	0.35625	2532	0.82500	2607	0.29375	2682	0.76250	2757	0.23125	2832	0.70000	2907	0.16875
2458	0.36250	2533	0.83125	2608	0.30000	2683	0.76875	2758	0.23750	2833	0.70625	2908	0.17500
2459	0.36875	2534	0.83750	2609	0.30625	2684	0.77500	2759	0.24375	2834	0.71250	2909	0.18125
2460	0.37500	2535	0.84375	2610	0.31250	2685	0.78125	2760	930.25000	2835	0.71875	2910	0.18750
2461	0.38125	2536	0.85000	2611	0.31875	2686	0.78750	2761	0.25625	2836	0.72500	2911	0.19375
2462	0.38750	2537	0.85625	2612	0.32500	2687	0.79375	2762	0.26250	2837	0.73125	2912	0.20000
2463	0.39375	2538	0.86250	2613	0.33125	2688	0.80000	2763	0.26875	2838	0.73750	2913	0.20625
2464	0.40000	2539	0.86875	2614	0.33750	2689	0.80625	2764	0.27500	2839	0.74375	2914	0.21250
2465	0.40625	2540	0.87500	2615	0.34375	2690	0.81250	2765	0.28125	2840	930.75000	2915	0.21875
2466	0.41250	2541	0.88125	2616	0.35000	2691	0.81875	2766	0.28750	2841	0.75625	2916	0.22500
2467	0.41875	2542	0.88750	2617	0.35625	2692	0.82500	2767	0.29375	2842	0.76250	2917	0.23125
2468	0.42500	2543	0.89375	2618	0.36250	2693	0.83125	2768	0.30000	2843	0.76875	2918	0.23750
2469	0.43125	2544	0.90000	2619	0.36875	2694	0.83750	2769	0.30625	2844	0.77500	2919	0.24375
2470	0.43750	2545	0.90625	2620	0.37500	2695	0.84375	2770	0.31250	2845	0.78125	2920	931.25000
2471	0.44375	2546	0.91250	2621	0.38125	2696	0.85000	2771	0.31875	2846	0.78750	2921	0.25625
2472	0.45000	2547	0.91875	2622	0.38750	2697	0.85625	2772	0.32500	2847	0.79375	2922	0.26250
2473	0.45625	2548	0.92500	2623	0.39375	2698	0.86250	2773	0.33125	2848	0.80000	2923	0.26875
2474	0.46250	2549	0.93125	2624	0.40000	2699	0.86875	2774	0.33750	2849	0.80625	2924	0.27500

U(R/T)-3/900 Channel Designation Table: 896 to 902 MHz, 6.25 kHz Increments (continued)

Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)
2925	931.28125	3000	931.75000	3075	932.21875	3150	932.68750	3225	933.15625	3300	933.62500	3375	934.09375
2926	0.28750	3001	0.75625	3076	0.22500	3151	0.69375	3226	0.16250	3301	0.63125	3376	0.10000
2927	0.29375	3002	0.76250	3077	0.23125	3152	0.70000	3227	0.16875	3302	0.63750	3377	0.10625
2928	0.30000	3003	0.76875	3078	0.23750	3153	0.70625	3228	0.17500	3303	0.64375	3378	0.11250
2929	0.30625	3004	0.77500	3079	0.24375	3154	0.71250	3229	0.18125	3304	0.65000	3379	0.11875
2930	0.31250	3005	0.78125	3080	932.25000	3155	0.71875	3230	0.18750	3305	0.65625	3380	0.12500
2931	0.31875	3006	0.78750	3081	0.25625	3156	0.72500	3231	0.19375	3306	0.66250	3381	0.13125
2932	0.32500	3007	0.79375	3082	0.26250	3157	0.73125	3232	0.20000	3307	0.66875	3382	0.13750
2933	0.33125	3008	0.80000	3083	0.26875	3158	0.73750	3233	0.20625	3308	0.67500	3383	0.14375
2934	0.33750	3009	0.80625	3084	0.27500	3159	0.74375	3234	0.21250	3309	0.68125	3384	0.15000
2935	0.34375	3010	0.81250	3085	0.28125	3160	932.75000	3235	0.21875	3310	0.68750	3385	0.15625
2936	0.35000	3011	0.81875	3086	0.28750	3161	0.75625	3236	0.22500	3311	0.69375	3386	0.16250
2937	0.35625	3012	0.82500	3087	0.29375	3162	0.76250	3237	0.23125	3312	0.70000	3387	0.16875
2938	0.36250	3013	0.83125	3088	0.30000	3163	0.76875	3238	0.23750	3313	0.70625	3388	0.17500
2939	0.36875	3014	0.83750	3089	0.30625	3164	0.77500	3239	0.24375	3314	0.71250	3389	0.18125
2940	0.37500	3015	0.84375	3090	0.31250	3165	0.78125	3240	933.25000	3315	0.71875	3390	0.18750
2941	0.38125	3016	0.85000	3091	0.31875	3166	0.78750	3241	0.25625	3316	0.72500	3391	0.19375
2942	0.38750	3017	0.85625	3092	0.32500	3167	0.79375	3242	0.26250	3317	0.73125	3392	0.20000
2943	0.39375	3018	0.86250	3093	0.33125	3168	0.80000	3243	0.26875	3318	0.73750	3393	0.20625
2944	0.40000	3019	0.86875	3094	0.33750	3169	0.80625	3244	0.27500	3319	0.74375	3394	0.21250
2945	0.40625	3020	0.87500	3095	0.34375	3170	0.81250	3245	0.28125	3320	933.75000	3395	0.21875
2946	0.41250	3021	0.88125	3096	0.35000	3171	0.81875	3246	0.28750	3321	0.75625	3396	0.22500
2947	0.41875	3022	0.88750	3097	0.35625	3172	0.82500	3247	0.29375	3322	0.76250	3397	0.23125
2948	0.42500	3023	0.89375	3098	0.36250	3173	0.83125	3248	0.30000	3323	0.76875	3398	0.23750
2949	0.43125	3024	0.90000	3099	0.36875	3174	0.83750	3249	0.30625	3324	0.77500	3399	0.24375
2950	0.43750	3025	0.90625	3100	0.37500	3175	0.84375	3250	0.31250	3325	0.78125	3400	934.25000
2951	0.44375	3026	0.91250	3101	0.38125	3176	0.85000	3251	0.31875	3326	0.78750	3401	0.25625
2952	0.45000	3027	0.91875	3102	0.38750	3177	0.85625	3252	0.32500	3327	0.79375	3402	0.26250
2953	0.45625	3028	0.92500	3103	0.39375	3178	0.86250	3253	0.33125	3328	0.80000	3403	0.26875
2954	0.46250	3029	0.93125	3104	0.40000	3179	0.86875	3254	0.33750	3329	0.80625	3404	0.27500
2955	0.46875	3030	0.93750	3105	0.40625	3180	0.87500	3255	0.34375	3330	0.81250	3405	0.28125
2956	0.47500	3031	0.94375	3106	0.41250	3181	0.88125	3256	0.35000	3331	0.81875	3406	0.28750
2957	0.48125	3032	0.95000	3107	0.41875	3182	0.88750	3257	0.35625	3332	0.82500	3407	0.29375
2958	0.48750	3033	0.95625	3108	0.42500	3183	0.89375	3258	0.36250	3333	0.83125	3408	0.30000
2959	0.49375	3034	0.96250	3109	0.43125	3184	0.90000	3259	0.36875	3334	0.83750	3409	0.30625
2960	931.50000	3035	0.96875	3110	0.43750	3185	0.90625	3260	0.37500	3335	0.84375	3410	0.31250
2961	0.50625	3036	0.97500	3111	0.44375	3186	0.91250	3261	0.38125	3336	0.85000	3411	0.31875
2962	0.51250	3037	0.98125	3112	0.45000	3187	0.91875	3262	0.38750	3337	0.85625	3412	0.32500
2963	0.51875	3038	0.98750	3113	0.45625	3188	0.92500	3263	0.39375	3338	0.86250	3413	0.33125
2964	0.52500	3039	0.99375	3114	0.46250	3189	0.93125	3264	0.40000	3339	0.86875	3414	0.33750
2965	0.53125	3040	932.00000	3115	0.46875	3190	0.93750	3265	0.40625	3340	0.87500	3415	0.34375
2966	0.53750	3041	0.00625	3116	0.47500	3191	0.94375	3266	0.41250	3341	0.88125	3416	0.35000
2967	0.54375	3042	0.01250	3117	0.48125	3192	0.95000	3267	0.41875	3342	0.88750	3417	0.35625
2968	0.55000	3043	0.01875	3118	0.48750	3193	0.95625	3268	0.42500	3343	0.89375	3418	0.36250
2969	0.55625	3044	0.02500	3119	0.49375	3194	0.96250	3269	0.43125	3344	0.90000	3419	0.36875
2970	0.56250	3045	0.03125	3120	932.50000	3195	0.96875	3270	0.43750	3345	0.90625	3420	0.37500
2971	0.56875	3046	0.03750	3121	0.50625	3196	0.97500	3271	0.44375	3346	0.91250	3421	0.38125
2972	0.57500	3047	0.04375	3122	0.51250	3197	0.98125	3272	0.45000	3347	0.91875	3422	0.38750
2973	0.58125	3048	0.05000	3123	0.51875	3198	0.98750	3273	0.45625	3348	0.92500	3423	0.39375
2974	0.58750	3049	0.05625	3124	0.52500	3199	0.99375	3274	0.46250	3349	0.93125	3424	0.40000
2975	0.59375	3050	0.06250	3125	0.53125	3200	933.00000	3275	0.46875	3350	0.93750	3425	0.40625
2976	0.60000	3051	0.06875	3126	0.53750	3201	0.00625	3276	0.47500	3351	0.94375	3426	0.41250
2977	0.60625	3052	0.07500	3127	0.54375	3202	0.01250	3277	0.48125	3352	0.95000	3427	0.41875
2978	0.61250	3053	0.08125	3128	0.55000	3203	0.01875	3278	0.48750	3353	0.95625	3428	0.42500
2979	0.61875	3054	0.08750	3129	0.55625	3204	0.02500	3279	0.49375	3354	0.96250	3429	0.43125
2980	0.62500	3055	0.09375	3130	0.56250	3205	0.03125	3280	933.50000	3355	0.96875	3430	0.43750
2981	0.63125	3056	0.10000	3131	0.56875	3206	0.03750	3281	0.50625	3356	0.97500	3431	0.44375
2982	0.63750	3057	0.10625	3132	0.57500	3207	0.04375	3282	0.51250	3357	0.98125	3432	0.45000
2983	0.64375	3058	0.11250	3133	0.58125	3208	0.05000	3283	0.51875	3358	0.98750	3433	0.45625
2984	0.65000	3059	0.11875	3134	0.58750	3209	0.05625	3284	0.52500	3359	0.99375	3434	0.46250
2985	0.65625	3060	0.12500	3135	0.59375	3210	0.06250	3285	0.53125	3360	934.00000	3435	0.46875
2986	0.66250	3061	0.13125	3136	0.60000	3211	0.06875	3286	0.53750	3361	0.00625	3436	0.47500
2987	0.66875	3062	0.13750	3137	0.60625	3212	0.07500	3287	0.54375	3362	0.01250	3437	0.48125
2988	0.67500	3063	0.14375	3138	0.61250	3213	0.08125	3288	0.55000	3363	0.01875	3438	0.48750
2989	0.68125	3064	0.15000	3139	0.61875	3214	0.08750	3289	0.55625	3364	0.02500	3439	0.49375
2990	0.68750	3065	0.15625	3140	0.62500	3215	0.09375	3290	0.56250	3365	0.03125	3440	934.50000
2991	0.69375	3066	0.16250	3141	0.63125	3216	0.10000	3291	0.56875	3366	0.03750	3441	0.50625
2992	0.70000	3067	0.16875	3142	0.63750	3217	0.10625	3292	0.57500	3367	0.04375	3442	0.51250
2993	0.70625	3068	0.17500	3143	0.64375	3218	0.11250	3293	0.58125	3368	0.05000	3443	0.51875
2994	0.71250	3069	0.18125	3144	0.65000	3219	0.11875	3294	0.58750	3369	0.05625	3444	0.52500
2995	0.71875	3070	0.18750	3145	0.65625	3220	0.12500	3295	0.59375	3370	0.06250	3445	0.53125
2996	0.72500	3071	0.19375	3146	0.66250	3221	0.13125	3296	0.60000	3371	0.06875	3446	0.53750
2997	0.73125	3072	0.20000	3147	0.66875	3222	0.13750	3297	0.60625	3372	0.07500	3447	0.54375
2998	0.73750	3073	0.20625	3148	0.67500	3223	0.14375	3298	0.61250	3373	0.08125	3448	0.55000
2999	0.74375	3074	0.21250	3149	0.68125	3224	0.15000	3299	0.61875	3374	0.08750	3449	0.55625

Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)	Chan. Num.	Freq. (MHz)
3450	934.56250												
3451	0.56875												
3452	0.57500												
3453	0.58125												
3454	0.58750												
3455	0.59375												
3456	0.60000												
3457	0.60625												
3458	0.61250												
3459	0.61875												
3460	0.62500												
3461	0.63125												
3462	0.63750												
3463	0.64375												
3464	0.65000												
3465	0.65625												
3466	0.66250												
3467	0.66875												
3468	0.67500												
3469	0.68125												
3470	0.68750												
3471	0.69375												
3472	0.70000												
3473	0.70625												
3474	0.71250												
3475	0.71875												
3476	0.72500												
3477	0.73125												
3478	0.73750												
3479	0.74375												
3480	934.75000												
3481	0.75625												
3482	0.76250												
3483	0.76875												
3484	0.77500												
3485	0.78125												
3486	0.78750												
3487	0.79375												
3488	0.80000												
3489	0.80625												
3490	0.81250												
3491	0.81875												
3492	0.82500												
3493	0.83125												
3494	0.83750												
3495	0.84375												
3496	0.85000												
3497	0.85625												
3498	0.86250												
3499	0.86875												
3500	0.87500												
3501	0.88125												
3502	0.88750												
3503	0.89375												
3504	0.90000												
3505	0.90625												
3506	0.91250												
3507	0.91875												
3508	0.92500												
3509	0.93125												
3510	0.93750												
3511	0.94375												
3512	0.95000												
3513	0.95625												
3514	0.96250												
3515	0.96875												
3516	0.97500												
3517	0.98125												
3518	0.98750												
3519	0.99375												
3520	935.00000												

2 REVISION HISTORY

ISSUE	DATE	DESCRIPTION AND (REASON)
1	Jan 2003	• Preliminary.

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