METEORCOMM LLC

ITCR Base Radio
User's Manual and Installation Instructions

Applicable Models: 63030-24, 63030-48

Note: The final version of this manual will include a French translation.

Revision History

Revision	Date	Summary of Changes	Contributor
0.1		Initial draft.	Neil Ross
0.2		Changes by Neil Ross.	
0.3	8/29/2011	Add notices to user and expanded RF exposure Information. General editing.	Fred Cleveland
0.4	9/8/2011	Fix errors and omissions	Fred Cleveland

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1. Overview

This document provides important radio frequency safety information and instructions for the basic operation and adjustment of the base station radio. This document pertains to Meteorcomm Interoperable Train Control Radio Network (ITCR) Base Radio models, numbers 63030-24 and 63030-48. Operation of these two models is identical except for input power requirements of 24 Vdc and 48 Vdc, respectively.

1.1 Applicable Radio Models and Identifiers

This document applies to two Base radio models listed below along with their regulatory identifiers. These two models differ only in their power supply input voltage and associated power supply circuits.

Model: 63030-24 FCC ID: BIB63030-24 IC: 1300A-6303024	Model: 63030-48 FCC ID: BIB63030-48 IC: 1300A-6303048

1.2 General Description

Meteorcomm base radios are designed to satisfy the industry standard Positive Train Control (PTC) requirements as part of an integrated 220 MHz radio network. The Base radio, Locomotive radio, and Wayside radio form the transportation backbone on which a messaging application provides communication capabilities between railroad assets and their back offices. The ITCR is designed to provide communication in an interoperable fashion enabling messaging to occur across railroad boundaries.

1.3 Chassis

Base radios are housed in electrically sealed metal cases. The Base radio fits within a standard 19” rack mount and has a maximum depth of 24 inches and a height rack of 4 RUs, weighing less than 25 lbs.

It contains a fan with a temperature sensor that can be set to turn on at a configurable temperature.

All input/output ports are grounded and/or shielded. In addition, best engineering practices have been employed with respect to internal shielding, unit assembly and PCB design in an effort to minimize potential sources of unwanted radiated emissions.

1.4 Ports and Ethernet Connectors

The Base radio supports two RJ45 Ethernet I/O ports, each on its own network.

1.5 Power Connectors

The Base radio has two studs (marked ‘+’ and ‘-‘) to support the connection of power cables. See input power requirements further below.

1.6 Antenna Connectors

The Base radio supports N-type connectors for narrowband RF antenna(s). The connector marked TX/RX should be routed to the transmit antenna. The connectors marked RX1 and RX2 are provided for optional use of separate receiving antennas.

2. Important Information for the User

2.1 Transmitter Warm-up Period.

The base transmitter uses a precision oven-controlled crystal oscillator (OCXO). The OCXO warm-up period is one minute minimum after application of input power before any transmission should commence.

2.2 RF Safety

This radio is intended for use in occupational/controlled conditions, where users have full knowledge of their exposure and can exercise control over their exposure to meet FCC and IC limits. This radio device is NOT authorized for general population, consumer, or any other use.

This two-way radio uses electromagnetic energy in the radio frequency (RF) spectrum to provide communications between two or more users over a distance. It uses RF energy or radio waves to send and receive calls. RF energy is one form of electromagnetic energy. Other forms include, but are not limited to, sunlight and x-rays. RF energy, however, should not be confused with these other forms of electromagnetic energy, which when used improperly, can cause biological damage. Very high levels of x-rays, for example, can damage tissues and genetic material.

Experts in science, engineering, medicine, health, and industry work with organizations to develop standards for safe exposure to RF energy. These standards provide recommended levels of RF exposure for both workers and the general public. These recommended RF exposure levels include substantial margins of protection.

All 2-way radios marketed in North America are designed, manufactured, and tested to ensure they meet government-established RF exposure levels. In addition, manufacturers also recommend specific operating instructions to users of 2-way radios. These instructions are important because they inform users about RF energy exposure and provide simple procedures on how to control it. Please refer to the following Web sites for more information on what RF energy exposure is and how to control your exposure to assure compliance with established RF exposure limits.

http://www.fcc.gov/oet/rfsafety/rf-faqs.html

http://www.osha.gov/SLTC/radiofrequencyradiation/index.html

2.3 Limiting RF Exposure

This transmitter is intended to be operated with a fixed antenna in an Occupational/Controlled Exposure environment per FCC OET 65 or Controlled Use Environment per IC RSS-102 and is not subject to specific absorption rate (SAR) measurements. The Maximum Permitted Exposure (MPE) limit for this type device in the 100-300 MHz range is $1mW/cm^2 = 10W/m^2$.

The table below lists the calculated lateral distances to be maintained between personnel and an operational base station transmitter antenna for two typical antenna gains, 2.1 dBi for a vertical dipole or a vertical monopole over ground plane and 8 dBi for a 2-element collinear vertical dipole antenna.

Table 1. Required Distance Between Personnel and Transmitting Antenna

Rated Power, W PEP	Maximum Duty Cycle, %	Antenna Gain, dBi	Minimum Lateral Spacing, cm
75	50	2.1	70
75	50	8	137

Note: RF exposure compliance at multiple transmitter sites must be addressed on a site-by-site basis. It is the responsibility of the licensee to ensure compliance with maximum exposure limits.

2.4 Fixed Antenna Guidelines

This section contains antenna information and additional notes regarding methods to limit RF exposure.

- The licensee is required to comply with limits on power and effective antenna height per 47CFR 90.729.
- Install base station antennas on permanent outdoor structures that are not intended for human occupation.
- Acceptable antennas are vertical monopole over ground plane, vertical dipole, multiple collinear vertical dipole, or similar designs.

- Unauthorized antennas, equipment modifications or attachments could invalidate any equipment warranty or authority to transmit. Modification could damage the radio and may violate FCC or IC regulations.
- Install all antennas in accordance with the manufacturer's instructions.
- Maintain a safe distance from energized transmitting antennas. See above.
- Disable the transmitter when installing or servicing its antenna or transmission line.

2.5 RF Interference to Residential Receivers

NOTICE TO USER: This device complies with part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

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

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

2.6 Equipment Modifications

Caution: Any changes or modifications to this equipment not expressly approved by the party responsible for compliance (in the respective country of use) could void the user's authority to operate the equipment.

3. Setup and Configuration for the Base Radio

Set up physical connections with the following:

- DC Power
- Ethernet
- RF output termination

The sections below identify each of the physical connections.

3.1 Input Power

A label on the radio chassis indicates the rated voltage of the base radio: 24 or 48V. The table below describes the power supply requirements for each type.

Caution: Applying an incorrect voltage outside the rated voltage range of a Base radio can damage it. Confirm the voltage ratings of the radio and the power supply before applying power.

Table 2. Base Radio Input Power Parameters

Parameter	Base Radio	
Nominal DC Power Input Voltage	24VDC radio version	48VDC radio version
Operational Range	21-27 Vdc (+/-12.5%)	42-54 Vdc (+/-12.5%)
Damage limit	30VDC	60VDC
Current Drain (while transmitting rated power)	11A peak max while transmitting into 50 ohm load 7.5A for max average operating current	6A peak max while transmitting into 50 ohm load 4A for max average operating current

3.2 Ethernet Connection

Base radios use a standard CAT5 Ethernet cable connected between a PC and the maintenance port of the radio. Configure the PC network card with a fixed IP address of 10.10.1.254.

You will use XtermW, a Meteorcomm terminal emulation program, to connect with and control the radio via commands issued at command prompts.

3.3 RF Output Termination

The Base radio is rated for 75W PEP max into a 50 ohm resistive load. Base radios have a single TX/RX port with two additional ports for receiving only. For transmitter testing, connect the test equipment to the port labeled “TX/RX.” A suitable RF power attenuator should be used to protect test equipment.

4. Tuning the Base Radio

There are three parameters to test and potentially tune before/during RF testing:

- Master reference crystal oscillator frequency

- RF output power
- RF output channel

Factory technicians tune the master reference crystal oscillator and set the RF gain for maximum rated output power. You may have to adjust the three parameters before or during RF testing by entering commands using XtermW or any other terminal emulation program.

4.1 Equipment Required

1. 10A DC power supply at rated voltage of base radio.
2. Personal computer with ethernet network adapter and Meteorcomm XtermW or equivalent terminal program installed.
3. 30 dB 100W RF power attenuator.
4. Vector spectrum analyzer for power and frequency measurements.
5. Optional 8+ digit frequency counter for frequency measurements.
6. External high stability time base (e.g., rubidium) accurate to 0.01 ppm. Can be internal to items 4 and 5.

4.2 Set up the Radio for Testing

1. Find the input voltage rating marking on the radio chassis. It is either 24VDC or 48VDC. Adjust a 10A DC power supply to the proper voltage; then disable its output. Observing polarity markings connect the power supply between the radio power terminals and the power supply.
2. Connect a CAT5 ethernet cable between the RJ-45 port labeled MAINT. Connect the other end to a computer network card. The default radio IP address is 10.10.1.254. Set the IP address of the computer network card to a compatible fixed address such as 10.10.1.1. The computer should have Meteorcomm XtermW or a similar terminal emulation program installed.
3. Apply power to the radio. Wait 30 seconds to open an XtermW session. Use the Edit/Configure Port window to set Port Type = TCP/IP, Protocol = Stream, TCP/IP Settings Host = 10.10.1.254, Port 4000. Select Device Type = MCC 6100 SDR (which also applies to ITC radios). Return Character = CR, Data Format = ASCII.

4. Attach a 100W 30 dB RF attenuator to the TX/RX N-type antenna connector. Attach an (e.g., Agilent MXA or PXA) vector spectrum analyzer or similar to the transmitter port for power and frequency measurements. The VSA should contain either a precision stability reference oscillator or attach an external rubidium reference to the VSA external reference input.

4.3 Measure and Calibrate Reference Crystal Oscillator Parameters

The instructions below allow you to change the factory calibration settings for the master reference oscillator crystal. The new setting is stored in volatile memory and will revert to factory settings when the radio is powered off and then on.

To check the master reference crystal oscillator frequency calibration:

1. Open an XtermW session.
2. Put the radio into test mode by typing:

   i. `dsp,watchdog,off`

   ii. `dsp_mode,test`

3. Reduce output power to approximately 2W by typing:

   i. `cal,set,igain,-1000`

   ii. `cal,set,qgain,-1000`

4. Begin transmitting a test tone offset +8kHz from the carrier:

   i. `l1_test,stop`

   ii. `l1_test,set,txmod,cw`

   iii. `l1_test,set,txfreq,220012500`

   iv. `l1_test,start,tx`

5. Use the frequency counter or frequency counting marker on the VSA to measure the output frequency. The measured value is exactly 8 kHz greater than the actual carrier frequency. The carrier frequency is normally well within 22 Hz (0.1 ppm) of the carrier frequency.
6. Alternate to the test tone: Substitute the following π/4-DQPSK modulation command for the second line in step 4.

   i. `l1_test,set,txmod,dqpsk`

7. Set the VSA to the center frequency of the channel and set it to demodulate the 16 ksym/second π/4-DQPSK emission and measure the error frequency which is referenced to the VSA center frequency.

To adjust the master crystal reference oscillator parameters:

1. First, check the factory default setting for the crystal reference parameter by typing

   i. `cal`

2. Note the value for "xo" in the cal factors table that is displayed.
3. At the XtermW command line, type:

   i. `cal,set,xo,xx`

   ii. where xx is some value close to the original factory set value.

4. Use trial and error to determine the set point for the xo value to achieve the desired carrier frequency accuracy.

To reset the XO tuning parameter to the factory setting:

Power cycle the radio.

4.4 Measure and Adjust Output Power

Caution: Avoid unnecessary adjustments. Exercise caution when setting I and Q gain values as damage to the radio can occur if gains are set too high.

Base radios are rated for 75W PEP. To achieve this power radios are pre-calibrated at the factory. If additional tuning is required, use an appropriate method to determine PEP for a π/4-DQPSK signal and slowly increase/decrease I and Q gain levels from their nominal set point, as determined by issuing the command 'cal'.

A step of 100 points (for example, -250 to -150) is approximately equivalent to an increase of 2dB in power.

To measure and adjust output power:

1. At the XtermW command line, begin transmitting a π/4-DQPSK signal by typing:

   i. `dsp,watchdog,off`

   ii. `dsp_mode,test`

   iii.
   ```
   l1_test,stop
   l1_test,set,txmod,dqpsk
   l1_test,start,tx
   ```

2. View the calibration settings by typing:

   i. `cal`

3. Note the values for igain and qgain. They are normally matched.

4. Increase the output level by entering larger matched values or reduce output level using smaller matched values. Use cal command in between to verify the new settings.

   i. `cal,set,igain,xxxx`

   ii. `cal,set,qgain,xxxx`

5. Tune the VSA to the center of the channel frequency and use the CCDF function to measure the peak envelope power, average power and peak to average ratio.

4.5 Check and Adjust RF Output Channel

You can adjust the RF output channel by stopping transmission, setting transmission frequency, and then starting transmission again.

To adjust RF output channel:

1. Tune the radio to the bottom channel (220.0125MHz) by typing:

   ```
   l1_test,stop
   l1_test,set,txfreq,220012500
   l1_test,start,tx
   ```

2. Tune the radio to the mid-channel (221.0125MHz) by typing:

   ```
   l1_test,stop,
   l1_test,set,txfreq,221012500
   l1_test,start,tx
   ```

3. Tune the radio to the high channel (221.9875MHz) by typing:

```
l1_test,stop
l1_test,set,txfreq,221987500
l1_test,start,tx
```

5. Operations

This section provides commands used during normal operation of the Base radio.

5.1 Restore Factory Settings

To restore factory settings without cycling the radio:

- At the XtermW command prompt, type:

  ```
  factory
  ```

5.2 Display Software and Firmware Revision Numbers

To display what software and firmware versions are installed on your radio:

- At the XtermW command prompt, type:

  ```
  rev
  ```

5.3 Display Radio Identification Information

This section provides you with commands to display serial number and identification information.

To display serial number information:

- At the XtermW command prompt, type:

  ```
  serialnumber
  ```

To show current ID setting:

- At the XtermW command prompt, type:

  ```
  ID
  ```