METEORCOMM LLC

ITC RADIOS

BASE RADIO MANUFACTURING TEST REQUIREMENTS SPECIFICATION

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1 INTRODUCTION

1.1 Purpose

The purpose of this document is to establish the manufacturing functional test requirements for the ITC Base Radio.

1.2 Scope

This document defines functional test requirements to be implemented for the Base radio. It does not document how the requirements are to be implemented. Such design implementation criteria is defined in a separate document. This document is intended for design engineers, and test development engineers.

1.3 Definitions, Acronyms, and Abbreviations

Item	Entry	Description
T2. 01	MCC	Meteorcomm LLC
T2. 02	CA	CalAmp Corp
T2. 03	FCT	Functional Circuit Test
T2. 04	PCBA	Printed Circuit Board Assembly
T2. 05	VDC	Voltage Direct Current
T2. 06	VAC	Voltage Alternating Current
T2. 07	DUT	Device Under Test
T2. 08	NA	Not Applicable
T2. 09	Base	Base Radio
T2.10	ITC	Interoperable Train Control
T2.11	DFS	Degradation from Full Scale
T2.12	ppm	parts per million
T2.13	ND	Not Defined
T2.14	PEP	Peak Envelope Power
T2.15	VSA	Vector Signal Analyzer
T2.16	N/A	Not Applicable
T2.17	TBD	To Be Determined
T2.18	TX	Transmit
T2.19	RX	Receive
T2.20	RSSI	Receive Signal Strength Indicator

Table 1 – Definitions, Acronyms, and Abbreviations

1.4 Reference Documents

Item	Reference Document	Doc. No.
T3.01	Base Radio Top Level BOM	6303000X
T3.02	CLI Command Reference Document	TST-MCC-00001009-I
T3.03	ITC 220MHz Radio Hardware Specification v1 4.pdf	00001040
T3.04	CalAmp Preproduction Loco & Base PA_MOD Cal/Tune Procedure	TBD
T3.05	ITC 1 0 220 MHz Radio Hardware Performance Test Procedures	00001434-A
T3.06	Manufacturing Test Specification (MTS) Hipot & Ground Continuity Tests Wayside, Locomotive, Base Station Radio	TBD
T3.07	ITCR 1.0 Radio & PCBA Serial Numbering Scheme	00001193-B

Table 2 – Reference Documents

1.5 Document Overview

This document describes the manufacturing functional test requirements for the ITC Base Radio. It is divided into sections:

Section 1 describes the purpose, scope, definition of acronyms and abbreviations, and references documents, and a brief overview of the document.
Section 2 presents a brief description of the radios
Section 3 presents the functional test requirements
Section 4 describes the PA/CML Tuning requirements.
Section 5 describes the unit level test requirements.

The requirements are tagged with the identifier “TRS##.” As the requirement identifiers are referenced by other documents, the identifiers should NEVER be changed without understanding the work involved in bringing all documents involved to consensus.

The “ITC 220MHz Radio Hardware Specification v1 4.pdf” (ref T3.03) Appendix A & B is the source for all unit level electrical requirements. This document may tighten certain limits in manufacturing to accommodate requirements that have no allowable DFS over unit environmental conditions.

2 OVERALL DESCRIPTION

This ITC Radio is used as part of a larger communication system used by the railroad industry. The test strategy for the radios includes a sub level functional test for tuning and also a final level device functional test.

3 TEST REQUIREMENTS

3.1 DUT Test Setup

The Base Radio may be tested within a sealed RF enclosure when testing at the unit level. The enclosure provides shielding against other ITC radios or other products that may produce interference within the ITC band. The enclosure is recommended but not required. Other tests may be done without the RF enclosure. If the enclosure is used all instrumentation connections to the DUT shall be made through the enclosures interface panel. TRS01 and TRS02 are tuning tests done on a subassembly of the Base radio that consists of the PA PCB, Frontend PCB, and mounting hardware.

In general the Radio is commanded through it's Maintenance port. A connection is made from a PC to the Maintenance port though Ethernet. ASCII commands, referred to as "CLI Commands" are sent to the radio over telnet. The radio will respond with ASCII over telnet when appropriate. The LAN port is also connected to a PC for validation of traffic.

Power is applied to the radio through the Power Interface Port.

The Receive unit level test setup will consist of a modulated signal source that is connected to either the Primary or Diversity RF Port.

The GPS until level test setup will consist of a multi-channel GPS simulator source that is connected to the GPS port of the unit.

The Unit Level Transmit test setup will consist of an RF attenuator and a Vector Signal Analyzer (VSA) (or similar) that is connected to Transmit RF Port. The attenuator shall be a 50 Ohm attenuator with sufficient attenuation (at least 50 dB) to protect the VSA from excessive RF levels from the 75W transmitter yet still give enough dynamic range for the TX measurements.

3.2 PA Tuning Test Setup

The PA/Modulator sub-assembly Test Setup for the TRS01 and TRS02 consists of the PA PWA and Frontend PWA. The PA PWA should be installed in chassis and Q1 installed with clamp torque to 5 in-lb before starting this procedure. DC Power (+12V) is applied through the ribbon cable connector (J4) and the 29V interface (J3). The PA connections to the Front End Board should also be made before starting this procedure.

The remaining PA tuning is done at the unit level. The Master Board is commanded through it's Maintenance port. A connection is made from a PC to the Maintenance port though Ethernet. ASCII command, refered to as "CLI Commands" are sent to the radio over telnet. The radio will respond with ASCII over telnet when appropriate. The CalAmp Preproduction Loco & Base PA_MOD/Cal Tune Procedure (T3.04) describes in detail the values for the CML registers and TX Baseband settings.

Unless otherwise specified, for each test Power is applied to the unit and the unit is allowed to Boot so that the CLI interface is available. Also all tuning shall be done at 219.8125 MHz unless noted otherwise.

4 PA TUNING

4.1 PA Subassembly Current Draw TRS01

The test verifies the Power Supply Current Draw of the PA subassembly after initially powered on. Apply +12V and 29V to the PA Sub-assembly test setup and verify the current is within the range specified in Table 3.

Test #	DUT Status	Radio Voltage	Min Current (A)	Max Current (A)
TRS01.1	Initial Power On	29VDC	0.001	0.01
		12VDC	0.001	0.1

Table 3 – PA Subassembly Current Draw TRS01

4.2 PA Subassembly Idq Amplifier Current Tuning TRS02

Execute the commands to drive the PA CML chip into a "bias" only state. This allows the manual adjustment of the potentiometers on the PA Board to set the nominal Idq current for the driver and final stages.

The potentiometers are adjusted until the expected voltage is reached at the specific measurement point. The Radio also provides a method to examine the PA current through a CLI command. When complete the Potentiometers should be "painted" to retain the tuned value.

Test #	Measurement Point	Potentiometer	Expected Voltage (VDC)	Expected Current (A)
TRS02.1	R8 to Chassis GND	VR2	0.45+/- 0.04	0.225 +/- 0.02
TRS02.2	R5 to Chassis GND	VR1	1.1+/-0.04	2.75 +/- 0.1

Table 4 – PA Subassembly Idq Amplifier Current Tuning TRS02

4.3 Open Loop PA Check TRS03

Verify that the Signal Analyzer is connected to the Transmit output of the Front End Board. Execute the commands to drive the PA CML chip into the “Open Loop” state with pi/4 DQPSK for modulation.

Verify the current draw to be less than the maximum allowable current and the output RF power to be within the specified limits shown in Table 5.

Test #	Parameter	Min	Max
TRS03.1	Current Draw	0.1A	5A
TRS03.2	RF Output Power	12dBm	25dBm

Table 5 – Open Loop PA Check TRS03

4.4 Closed Loop PA Check TRS04

Verify that the Signal Analyzer is connected to the Transmit output of the Front End Board. Execute the commands to drive the PA CML chip into the “Closed Loop” state with pi/4 DQPSK for modulation.

Verify the current draw to be less than the maximum allowable current and the output RF power to be within the specified limits shown in Table 6.

Test #	Parameter	Min	Max
TRS04.1	Current Draw	0.1A	5A
TRS04.2	RF Output Power	22dBm	35dBm

Table 6 – Closed Loop PA Check TRS04

4.5 LO Leakage Tuning TRS05

Verify that the Signal Analyzer is connected to the Transmit output of the Front End Board. Execute the commands to drive the PA CML chip into the “Closed Loop” state with a CW Tone.

Set the span of the VSA to show the CW tone and the LO leakage component (carrier frequency) and measure the delta between the two. Adjust the I and Q DC offsets using the baseband tuning parameters command until the LO leakage is as low as possible. It should meet the minimum requirement of Table 7.

When finished save the calibration to the radio using the CLI command interface.

Test #	Parameter	Max
TRS05.1	LO Leakage	-35dBc

Table 7 – LO Leakage Tuning TRS05

4.6 CML Phase Tuning TRS06

Verify that the Signal Analyzer is connected to the Transmit output of the radio. Execute the commands to drive the PA CML chip into the “Closed Loop” state with pi/4 DQPSK Modulation.

Set up the VSA per the Phase Adjustment procedure and adjust the CML Phase register for optimal difference between the lower and upper sidebands. The delta should be no greater than the value in Table 8. When finished save the calibration data into the appropriate phase table and save the matrix to the radio using the specified CLI Commands.

Test #	Frequency	Parameter	Max
TRS06.1	217.6125	| Upper Sideband – Lower Sideband |	1dB
TRS06.2	218.7125	| Upper Sideband – Lower Sideband |	1dB
TRS06.3	219.8125	| Upper Sideband – Lower Sideband |	1dB
TRS06.4	220.9125	| Upper Sideband – Lower Sideband |	1dB
TRS06.5	221.9875	| Upper Sideband – Lower Sideband |	1dB

Table 8 – CML Phase Tuning TRS06

4.7 CML Forward Attenuator Tuning TRS07

Verify that the Signal Analyzer is connected to the Transmit output of the radio. Execute the commands to drive the PA CML chip into the “Closed Loop” state with pi/4 DQPSK Modulation.

Set up the VSA per the CML Forward Attenuator procedure and adjust the CML Forward Attenuator register for optimal difference between the lower and upper sidebands. The delta should be no greater than the value in Table 9. When finished save the calibration using the CLI command interface.

Test #	Parameter	Max
TRS07.1	| Upper Sideband – Lower Sideband |	1dB

Table 9 – CML Forward Attenuator Tuning TRS07

4.8 Power Output Tuning TRS08

Verify that the Signal Analyzer is connected to the Transmit output of the radio. Execute the commands to drive the PA CML chip into the "Closed Loop" state with pi/4 DQPSK Modulation.

Measure power output and adjust the Igain and Qgain as part of the baseband tuning command until the power out reaches the expected level. The Igain and Qgain should be adjusted together and be the same value. The current draw is monitored throughout the tuning process. When finished save the calibration using the CLI command interface.

Test #	Parameter	Expected	Min	Max
TRS08.1	Current Draw	NA	2A	12A
TRS08.2	Power Out	75W PEP (48.75dBm)	48.45 dBm	49.05 dBm

Table 10 – Power Output Tuning TRS08

4.9 Reference Clock Tuning TRS09

Verify that the Signal Analyzer is connected to the Transmit output of the Front End Board. Execute the commands to drive the PA CML chip into the "Closed Loop" state with pi/4 DQPSK Modulation.

Using the VSA demodulated output measure the frequency offset of the demodulated signal. Tune the XO until the frequency error is within the limit defined below.

Test #	Parameter	Expected (MHz)	Min (MHz)	Max (MHz)
TRS09.1	Frequency	219.812500Mhz	219.812495	219.812505

Table 11 – Reference Clock Tuning TRS09

5 UNIT LEVEL TEST

5.1 Base Power Supply Current Draw TRS10

The test verifies the Power Supply Current Draw with the DUT after initially powered on, when receiving, when transmitting at maximum power out, and in Power Save Mode. Note that the Power Save Mode is currently undefined for the Base Radio.

Test #	DUT Status	Radio Voltage	Min Current (A)	Max Current (A)
TRS10.1	Initial Power On	Base24 – 24V Base48 – 48V	0.6 0.2	1.2 0.6
TRS10.2	Receiving	Base24 – 24V Base48 – 48V	0.6 0.2	1.2 0.6
TRS10.3	Max Transmit	Base24 – 24V Base48 – 48V	4 2	11 6

Table 12 – Power Supply Current Draw TRS10

5.2 POST Test TRS11

This test is intended to verify that the radio has passed the internal POST.

With the unit booted up and an open telnet session, execute the CLI POST command and parse the DUT response for Pass/Fail indications. Note that the first time a unit is powered up the POST test for Serial Number verification will fail. This can be ignored as TRS08 programs and verifies the DUT Serial Number.

5.3 MAC Address Reporting Test TRS12

This test is intended to record the Ethernet MAC address for each Ethernet Port.

With the unit booted up and an open telnet session, execute the CLI command and to read each Ethernet Port's MAC address. Record the result in the Test Report.

5.4 SW/FW Image Verification Test TRS13

This test is intended to verify that the DUT has the correct version of CPLD code, Boot Launcher Code and Application code. It also verifies the DUT has been flashed and properly formatted with the Application load.

With the unit booted up and an open telnet session, execute the CLI commands to verify the version of the CPLD, Boot Launcher and Sprint Application Code. These versions of code are defined at the Top Level BOM – reference T3.01. Then execute the CLI commands to verify the proper formatting of the on-board flash.

The Board Type is also verified at this point, for Sprint 23.2b, it should be set to “PREPROD”.

5.5 Serial Number Programming & Verification Test TRS14

This test writes the DUT serial number to the radio then verifies it has been saved in the DUT.

With the unit booted up and an open telnet session, execute the CLI command to program the DUTs serial number. The serial number is bar coded on the DUT per T3.07. The serial number shall be saved to the unit then recalled to verify it was programmed correctly.

5.6 LED Test TRS15

With the Radio booted, send the CLI command to enable all LEDs. The operator will verify they are all on.

Send the CLI command to disable all LEDs. The operator will verify they are all off.

5.7 Temperature Sensor Test TRS16

This check is performed during the operation temperature audit to see if the radio’s static temperature is in line with the requirement. With the Radio booted and in receive mode send the command(s) to read the PA Final temperature.

Test #	Parameter	Cold (°C)	Hot (°C)
TRS16.1	Temperature Sensor Reading from the PA Final	-30 +/- 3	70 +/- 3

Table 13 – Temperature Sensor Test TRS16

5.8 RX RSSI Calibration TRS17

This test provides a calibration of the RX path RSSI. Connect a Signal Generator to the Diversity Receiver RF Port and generate an input signal for Full Rate DQPSK at -50 dBm, mid frequency band. Execute the commands to the maintenance port to set the radio up for Diversity Receive, this will include the channel, modulation type and frequency. Poll the Locomotive's RSSI and adjust both the Diversity and Primary RSSI Calibration parameter until the reading is within the limits of Table 14.

Next move the input signal to the Primary Input of the Locomotive. Set the Locomotive up to receive on the primary port. Set the channel modulation and frequency per the Table below. Poll the Locomotive's RSSI and adjust the Primary RSSI Calibration parameter until the reading is within the limits of Table 14.

Test #	Port	Supply Voltage	Modulation/ Input Level	Frequency (Mhz)	RSSI MIN (dBm)	RSSI MAX (dBm)
TRS17.1	RX1 (PRI)	13.6V	π/4 DQPSK -50 dBm	219.9125	49.9	50.1
TRS17.2	RX2 (DIV)	13.6V	π/4 DQPSK -50 dBm	219.9125	49.9	50.1

Table 14 – Receiver RSSI Calibration TRS17

5.9 Primary Receiver Sensitivity Tests TRS18

Connect a Signal Generator to the Primary Receiver RF Port and generate the appropriate input signal. Execute the commands to the maintenance port to set the radio up for Primary Receive, this will include the channel, modulation type and frequency. Execute the tests TRS14.1 to TRS14.9 and verify the Bit Error Rate through the appropriate CLI commands. Next move the RF Connection to the TX/RX (or ALTERNATE) Port. Execute the commands to the maintenance port to set the radio up for Primary Receive on the Alternate Port, this will include the channel, modulation type and frequency. Execute tests TRS14.10 to TRS14.18 and verify the Bit Error Rate through the appropriate CLI commands. The tests below are performed with the Base radio powered on at the mid voltage level.

Test #	Port	Supply Voltage	Modulation	Frequency (Mhz)	Input Level (dBm)	Max (BER)
TRS18.1	RX1 (PRI)	Mid Voltage BASE24 - 24V BASE48– 48V	π/4 DQPSK (1/2 Rate)	217.7125	-111[1]	1E-4
TRS18.2				219.9125	-111[1]	1E-4
TRS18.3				221.8875	-111[1]	1E-4
TRS18.4			π/4 DQPSK (Full Rate)	217.7125	-108[2]	1E-4
TRS18.5				219.9125	-108[2]	1E-4
TRS18.6				221.8875	-108[2]	1E-4
TRS18.7				217.7125	-7	1E-4
TRS18.8				219.9125	-7	1E-4
TRS18.9				221.8875	-7	1E-4
TRS18.10	TX/RX (ALT)	Mid Voltage BASE24 - 24V BASE48– 48V	π/4 DQPSK (1/2 Rate)	217.7125	-111[1]	1E-4
TRS18.11				219.9125	-111[1]	1E-4
TRS18.12				221.8875	-111[1]	1E-4
TRS18.13			π/4 DQPSK (Full Rate)	217.7125	-108[2]	1E-4
TRS18.14				219.9125	-108[2]	1E-4
TRS18.15				221.8875	-108[2]	1E-4
TRS18.16				217.7125	-7	1E-4
TRS18.17				219.9125	-7	1E-4
TRS18.18				221.8875	-7	1E-4

Table 15 – Main Receiver BER TRS18

1 – Target specification is -111dBm for < 1E-4, -109.5 dBm for <1E-4 will be accepted for PP1

2 – Target specification is -108dBm for < 1E-4, -106.5 dBm for <1E-4 will be accepted for PP1

5.10 Diversity Receiver Sensitivity Tests TRS19

Connect a Signal Generator to the Diversity Receiver RF Port and generate the appropriate input signal. Execute the commands to the maintenance port to set the radio up for Diversity Receive, this will include the channel, modulation type and frequency. Verify the Bit Error Rate through the appropriate CLI commands. The tests below are performed with the Base radio powered on at the mid voltage level.

Test #	Supply Voltage	Modulation	Frequency (Mhz)	Input Level (dBm)	Max (BER)
TRS19.1	Mid Voltage BASE24 - 24V BASE48– 48V	π/4 DQPSK (1/2 Rate)	217.7125	-111[1]	1E-4
TRS19.2			219.9125	-111[1]	1E-4
TRS19.3			221.8875	-111[1]	1E-4
TRS19.4		π/4 DQPSK (Full Rate)	217.7125	-108[2]	1E-4
TRS19.5			219.9125	-108[2]	1E-4
TRS19.6			221.8875	-108[2]	1E-4
TRS19.7			217.7125	-7	1E-4
TRS19.8			219.9125	-7	1E-4
TRS19.9			221.8875	-7	1E-4

Table 16 – Diversity Receiver 1 BER TRS19

1 – Target specification is -111dBm for < 1E-4, -109.5 dBm for <1E-4 will be accepted for PP1

2 – Target specification is -108dBm for < 1E-4, -106.5 dBm for <1E-4 will be accepted for PP1

5.11 Simultaneous Channel Test TRS20

Connect a Signal Generator to the Primary Receiver RF Port and generate the appropriate input signal. Execute the commands to the maintenance port to set the radio up for Primary Receive, this will include the channel, modulation type and frequency. Validate each of the eight (8) Base Channels for BER through the appropriate CLI commands. The tests below are performed with the Base radio powered on at the mid voltage level.

Test #	Supply Voltage	Modulation	Frequency (Mhz)	Input Level (dBm)	Max (BER)
TRS20.1	Mid Voltage BASE24 - 24V BASE48– 48V	π/4 DQPSK (Full Rate ch #3, Half Rate all other channels)	219.9125	-50	1E-4

Table 17 – Main Receiver, Simultaneous Channels BER TRS20

5.12 Transmit Output Power Test TRS21

Setup the radio for TX Testing per Section 3.1. Execute the commands to the maintenance port to set the radio up for Transmit, this will include the modulation type, frequency, and output power indicated in the table. For each set of inputs measure the power output and compare to the limits.

Test #	Supply Voltage	Modulation	Power Setting	Frequency (Mhz)	Min (dBm)	Max (dBm)
TRS21.1	Low Voltage BASE24 - 21V BASE48– 42V	π/4 DQPSK (1/2 Rate)	75W PEP (48.75dBm)	217.6125	48.25	49.25
TRS21.2				219.8125		
TRS21.3				221.9875		
TRS21.4			10W PEP (40.0dBm)	219.8125	39.5	40.5
TRS21.5		π/4 DQPSK (Full Rate)	75W PEP (48.75dBm)	217.6125	48.25	49.25
TRS21.6				219.8125		
TRS21.7				221.9875		
TRS21.8			10W PEP (40.0dBm)	219.8125	39.5	40.5
TRS21.9	Mid Voltage BASE24 - 24V BASE48– 48V	π/4 DQPSK (1/2 Rate)	75W PEP (48.75dBm)	217.6125	48.25	49.25
TRS21.10				219.8125		
TRS21.11				221.9875		
TRS21.12			10W PEP (40.0dBm)	219.8125	39.5	40.5
TRS21.13		π/4 DQPSK (Full Rate)	75W PEP (48.75dBm)	217.6125	48.25	49.25
TRS21.14				219.8125		
TRS21.15				221.9875		
TRS21.16			10W PEP (40.0dBm)	219.8125	39.5	40.5
TRS21.21	High Voltage BASE24 - 27V BASE48– 54V	π/4 DQPSK (1/2 Rate)	75W PEP (48.75dBm)	217.6125	48.25	49.25
TRS21.18				219.8125		
TRS21.19				221.9875		
TRS21.20			10W PEP (40.0dBm)	219.8125	39.5	40.5
TRS21.21		π/4 DQPSK (Full Rate)	75W PEP (48.75dBm)	217.6125	48.25	49.25
TRS21.22				219.8125		
TRS21.23				221.9875		
TRS21.24			10W PEP (40.0dBm)	219.8125	39.5	40.5

Table 18 – Transmit Output Power Test TRS21

5.10 Transmit Frequency Accuracy Test TRS22

Setup the radio for TX Testing per Section 3.1. Execute the commands to the maintenance port to set the radio up for Transmit, this will include the modulation type, frequency, and output power indicated in the table. The VSA shall be setup to demodulate the signal and provide the carrier frequency offset. The value will be converted to parst-per-million (ppm) and compared to the limits.

Test #	Supply Voltage (VDC)	Modulation	Power Setting (PEP)	Frequency (Mhz)	Min (ppm)	Max (ppm)
TRS22.1	BASE24 - 24V BASE48– 48V	π/4 DQPSK (1/2 Rate)	75W	217.6125	-0.025	+0.025
				219.8125	-0.025	+0.025
				221.9875	-0.025	+0.025
TRS22.2		π/4 DQPSK (Full Rate)	75W	217.6125	-0.025	+0.025
				219.8125	-0.025	+0.025
				221.9875	-0.025	+0.025

Table 19 – Transmit Frequency Accuracy Test TRS22

5.14 Transmit Error Vector Modulation Test TRS23

Setup the radio for TX Testing per Section 3.1. Execute the commands to the maintenance port to set the radio up for Transmit, this will include the modulation type, frequency, and output power indicated in the table. The VSA shall be setup to demodulate the signal and provide the EVM. The value shall be compared to the limits.

Test #	Supply Voltage	Modulation	Power Setting	Frequency (Mhz)	Max
TRS23.1	Low Voltage BASE24 - 21V BASE48– 42V	π/4 DQPSK (1/2 Rate)	75W PEP (48.75dBm)	217.6125	5%
TRS23.2				219.8125	
TRS23.3				221.9875	
TRS23.4			10W PEP (40.0dBm)	219.8125	
TRS23.5		π/4 DQPSK (Full Rate)	75W PEP (48.75dBm)	217.6125	5%
TRS23.6				219.8125	
TRS23.7				221.9875	
TRS23.8			10W PEP (40.0dBm)	219.8125	
TRS23.9	Mid Voltage BASE24 - 24V BASE48– 48V	π/4 DQPSK (1/2 Rate)	75W PEP (48.75dBm)	217.6125	5%
TRS23.10				219.8125	
TRS23.11				221.9875	
TRS23.12			10W PEP (40.0dBm)	219.8125	
TRS23.13		π/4 DQPSK (Full Rate)	75W PEP (48.75dBm)	217.6125	5%
TRS23.14				219.8125	
TRS23.15				221.9875	
TRS23.16			10W PEP (40.0dBm)	219.8125	
TRS23.17	High Voltage BASE24 - 27V BASE48– 54V	π/4 DQPSK (1/2 Rate)	75W PEP (48.75dBm)	217.6125	5%
TRS23.18				219.8125	
TRS23.19				221.9875	
TRS23.20			10W PEP (40.0dBm)	219.8125	
TRS23.21		π/4 DQPSK (Full Rate)	75W PEP (48.75dBm)	217.6125	5%
TRS23.22				219.8125	
TRS23.23				221.9875	
TRS23.24			10W PEP (40.0dBm)	219.8125	

Table 20 – Transmit Modulation Error Test TRS23

5.15 Transmit Sideband Spectrum TRS24

Setup the radio for TX Testing per Section 3.1. Execute the commands to the maintenance port to set the radio up for Transmit, this will include the modulation type, frequency, and output power indicated in the table. The VSA shall be setup to measure the Sideband Spectrum according to the Mask defined below. Pass/Fail is reported by the VSA. This measurement shall be done at 219.8125MHz, 75W PEP, 24VDC (BASE24) and 48VDC (BASE48) for Full Rate DQPSK. The measurement is set for Max Hold using Peak Detector, a minimum of four sweeps shall be taken.

Frequency	Rejection
kHz	dBc
-100	72
-13.75	72
-13.75	65
-12.25	35
-12	30
-12	0
0	0
12	0
12	30
12.25	35
13.75	65
13.75	72
100	72

Table 21 – Transmit Sideband Spectrum Mask TRS24

5.16 Adjacent Channel Power Ratio TRS25

Connect a Vector Signal Analyzer (VSA) to the Transmit RF Port of the DUT through the proper TX attenuator setup. Execute the commands to the maintenance port to set the radio up for Transmit, this will include the modulation type, frequency, and output power indicated in the table. The VSA shall be setup to measure the adjacent channel power. The value shall be compared to the limits. The measurement is taken at mid-level voltage (24VDC or 48VDC).

Test #	Modulation	Power (PEP)	Frequency(MHz)	Min (dB)
TRS25.1	π/4 DQPSK (Full Rate)	75W	217.6125	70
TRS25.2	π/4 DQPSK (Full Rate)	75W	219.8125	70
TRS25.3	π/4 DQPSK (Full Rate)	75W	221.9875	70

Table 22 – Adjacent Channel Power Ratio TRS25

5.17 LAN and Maintenance Ethernet Port Test TRS26

Ping the LAN and Maintenance Ethernet ports and verify a correct response with no packets lost.

5.18 SD Card TRS27

The SD Card interface is verified during the course of Testing and Flashing the unit. Initial boot-up of the unit is done through the application resident on the SD Card. Once the unit boots and displays the SW revisions the SD Card read operations are considered validated.

A second validation of reading from the SD Card occurs when the application is written from the SD card into the radio's FLASH.

A third verification of the SD Card occurs during the POST. The POST validates SDCARD Preset, SDCARD Fail Pin and SDCARD Access.

5.19 GPS TRS28

The Base Radio GPS connectivity and DC bias are validated through an RF check and a DC Bias measurement. Connect a bias tee to the Base Radio GPS Port. The bias Tee shall provide a DC Block to the RF Path and a 50mA DC load from the Base Radio GPS Port. The Bias Tee shall not adversely affect the RF performance of the Base Radio GPS.

The RF Path of the Bias Tee shall be connected to a GPS Simulator capable of simulating at least 4 GPS satellite signals. Enable the GPS Simulator at a level of -130 dBm and send the CLI commands to the radio that enable GPS Messaging. The GPS Messages are parsed for the C/No ratio of the satellites and GPS Fix. The test shall be considered a pass if the GPS has a fix at -130 dBm..

5.20 Cooling Fans TRS29

With the Radio booted and transmitting Full Rate DQPSK at 75W PEP, mid-band frequency and mid-level voltage send the CLI command to enable each cooling fan. The operator will verify they are all on and running un-obstructed.

Send the CLI command to disable each fan. The operator will verify they are all off.

5.21 Operational Temperature

A 10% sampling of PP1 radios will be tested at the temperature extremes of -30C and 70C. The tests outlined in section 5 of this document will be executed at the temperature extremes with the parametric deviations listed in the table below. Hipot, and ground continuity are not part of the Temperature testing. The cooling fans shall not be enabled during the cold extreme.

The radios will be put into a temperature chamber and remain unpowered while the oven is ramped to either extreme. The units shall be soaked a minimum of two hours at the dwell temperature The radios will be put into a temperature chamber and remain unpowered while the oven is ramped to either extreme. The units shall be soaked a minimum of two hours at the dwell temperature. Continue to soak the units until the first powered up radio's PA/MOD Final device temperature is within +/-3 degrees of the target temperature. Table 23 provides the de-rating allowed at the temperature extremes.

Note that the specification for TX ACPR and TX Sideband Spectrum are not defined at the temperature extremes. Data will be collected on ACPR and any TX Sideband Spectrum Failures.

Specification	Nom Limit	DFS	OverTemp Limit
RX Sensitivity (Half Rate)	-111dBm	6dB	-105dBm
RX Sensitivity (Full Rate)	-108dBm	6dB	-102dBm
RX Error Behavior At High	-7dBm	ND	ND
TX Output Pwr (TRS16)	75WPEP (48.75 dBm) 10WPEP (40.0 dBm)	+2/-3 dB	45.75 – 50.75 dBm 37 – 43.0 dBm
TX Frequency Accuracy (TRS17)	+/-0.025ppm[1]	ND	+/-0.1ppm
TX EVM (TRS18)	3%	ND	ND
TX Sideband Spectrum (TRS19)	Table	ND	ND
TX ACR (TRS20)	70 dB	ND	ND

Table 23 – DFS for Temperature Testing

1 – Note that the +/-0.025ppm Accuracy is for tuning and the specification for accuracy for the radio is +/-0.1ppm

5.22 ESS

TBD

5.23 Ground Continuity TRS30

A fully assembled Base Radio shall be tested for ground continuity by measuring the resistance between several contact points on the radio. The table below outlines the contact points and maximum allowable resistance.

Test#	Chassis Contact Points	Limit
TRS30.1	Ground Stud to R1 outer barrel.	< 1.0 Ω
TRS30.2	Ground Stud to R2 outer barrel.	< 1.0 Ω
TRS30.3	Ground Stud to TX outer barrel.	< 1.0 Ω
TRS30.4	Ground Stud to GPS outer barrel.	< 1.0 Ω
TRS30.5	Ground Stud to CIM knobs. CIM panel must be securely closed.	< 1.0 Ω
TRS30.6	Ground Stud to 4 corner screws on top cover.	< 1.0 Ω
TRS30.7	Ground Stud to NEG Power Input Post.	High Impedance
TRS30.8	Ground Stud to POS Power Input Post.	High Impedance

Table 24 – Ground Continuity Testing TRS30

5.24 HiPot TRS31

The Base Radio is not subject to Hipot testing.