



# **Field Radio 3 Joint Engineering Test Acceptance Plan**

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## Revision History

Revision	Date	Summary of Changes
1.0	12/12/12	First draft

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## Acronyms

Acronym	Description
BO	Back Office
CLI	Command Line Interface
CSMA	Carrier Sense Multiple Access
DHCP	Dynamic Host Control Protocol
DQPSK	Differential Quadrature Phase Shift Keying
FDMA	Frequency Division Multiple Access
FM	Frequency Modulation
FW	Firmware
HW	Hardware
IP	Internet Protocol
ITC	Interoperable Train Control
PTC	Positive Train Control
RF	Radio Frequency
RX	Receive or Receiver
SW	Software
TCP/IP	Transmission Control Protocol/Internet
TX	Transmit or Transmitter

## 1. Purpose

This document the Joint Engineering tests that will be carried out on 220 MHz PTC Field Radio (F3) for Base, Locomotive, and Wayside radios.

## 2. Radio Performance Measurements

Tests will be conducted to evaluate the ability of the radios to transmit and receive wireless communications within specific parameters, as defined in references 1 and 2 (ITC 1.0 220 MHz Radio Hardware Performance Test Procedures, 00001434-A and TC 220MHz Radio Hardware Specification Product Release 1.0, 00001040-E Tests will be made under normal and extreme conditions for voltage and temperature.

### 2.1 General

Table 1 lists the normal conditions, temperature extremes, and voltage extremes used for the radio tests.

Table 1: Radio Test Conditions

Humidity: 45% to 75%

Radio	Normal Conditions	Temperature Extremes	Voltage Extremes	Power Levels
Base - 24V	+25C / 24.0 VDC	-30C / +70C	21 VDC / 42 VDC	+42.75 dBm / +48.75 dBm
Base - 48V	+25C / 48.0 VDC	-30C / +70C	27 VDC / 54 VDC	
Locomotive	+25C / 74.0 VDC	-40C / +70C	45 VDC / 100 VDC	+41 dBm / +47 dBm
Wayside	+25C / 13.6 VDC	-40C / +70C	10.9 VDC / 15.5 VDC	+38 dBm / +44 dBm

Table 2: Test Frequencies

Bottom, Middle, Top (B,M,T) Frequencies	ITC Frequencies	Additional Phase Bin Frequencies
217.6125 MHz	220.1375 MHz	218.4875 MHz
219.8125 MHz	220.4125 MHz	219.3625 MHz
	220.4375 MHz	220.2375 MHz
	220.7125 MHz	221.1125 MHz
	220.7375 MHz	
	220.7625 MHz	
	220.8625 MHz	
	220.8875 MHz	
	220.9875 MHz	
	221.1375 MHz	
	221.4125 MHz	
	221.4375 MHz	
	221.7125 MHz	
	221.7375 MHz	
	221.7625 MHz	
	221.8625 MHz	
	221.8875 MHz	
221.9875 MHz		

**Note:** RX frequencies may be offset by 100kHz as necessary to mitigate laboratory interference.

## 2.2 References

- [1] *ITC 1.0 220 MHz Radio Hardware Performance Test Procedures*, 00001434-A.
- [2] *ITC 220MHz Radio Hardware Specification Product Release 1.0*, 00001040-E



## 2.3 Testing Parameters

Tests performed according to Reference [1]. Specification limits according to Reference [2].

The following tables are separated into prioritized testing.

Table 3 shows the tests must be performed on-site at the facility where the radios are manufactured. The tests are conducted by or under direct supervision of MCC staff.

Table 4 shows the tests that may be completed at the radio manufacturing facility, or at MCC, conducted by or under the direct supervision of MCC staff.

The tests described in Table 3 and Table 4 must be completed before a “ship-to-customer” decision is made.

Table 5 shows the remainder tests to be completed for Joint Acceptance testing, ideally before radio shipments to customers but are not gating any shipment decision.

**Table 3: Factory Build Verification Test (BVT) [performed at factory by MCC, before PP1 shipment]**

	Test Method	Specification Limits	# DUT Normal Conditions	# Tx Power Levels	# DUT Temperature Extremes	# DUT Voltage Extremes	B, M, T Frequencies	ITC Frequencies	Additional Phase Bin Frequencies
TX									
Conducted Carrier Output Power	per 1434-A	per 1040-E	2	2	-	-	X	-	X
TX Error Vector Magnitude	per 1434-A	per 1040-E	2	2	-	-	X	-	X
Carrier Frequency Stability	per 1434-A	per 1040-E	2	2	-	-	X	-	X
Sideband Spectrum	per 1434-A	per 1040-E	2	2	-	-	X	-	X
Switching Spurious	per 1434-A	per 1040-E	2	2	-	-	X	-	X
Conducted Spurious Emissions	per 1434-A	per 1040-E	2	1	-	-	X	-	-
Adjacent Channel Power Ratio	per 1434-A	per 1040-E	2	2	-	-	X	-	X
Intermodulation Attenuation (Base Radio Only)	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Transmitter Stability into VSWR	per 1434-A	per 1040-E	-	-	-	-	-	-	-
TX Power Versus Time (PVT)	per 1434-A	TBD	-	-	-	-	-	-	-
RX									
Conducted Spurious Output Power	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Maximum Usable Sensitivity (Reference Sensitivity)	per 1434-A	per 1040-E	2	-	-	-	X	X	-
Error Behavior at High Input Levels	per 1434-A	per 1040-E	2	-	-	-	X	-	-
Co-channel Rejection, Type 1	per 1434-A	per 1040-E	2	-	-	-	X	-	-
Co-channel Rejection, Type 2	per 1434-A	per 1040-E	2	-	-	-	X	-	-
Adjacent Channel Selectivity	per 1434-A	per 1040-E	2	-	-	-	X	-	-
Adjacent Channel Selectivity – Half-Rate on Half-Rate	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Adjacent Channel Selectivity – Full-Rate On Full-Rate	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Adjacent Channel Selectivity – Narrowband Interferer	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Blocking	per 1434-A	per 1040-E	2	-	-	-	X	-	-
Intermodulation Response Rejection	per 1434-A	per 1040-E	2	-	-	-	X	-	-
RX Spurious Response Rejection	per 1434-A	per 1040-E	-	-	-	-	-	-	-
RX Noise Floor Scan	per 1434-A	NA	-	-	-	-	-	-	-
GPS Sensitivity	per 1434-A	per 1040-E	1	-	-	-	-	-	-
Ethernet and SD Card Functionality	per 1434-A	NA	-	-	-	-	-		
Radio to Radio (Need to create)	TBD	NA	-	-	-	-	-		

Table 4: Priority 1 Tests (PR1) [tests must be performed before PP1 shipment]

	Test Method	Specification Limits	# DUT Normal Conditions	# Tx Power Levels	# DUT Temperature Extremes	# DUT Voltage Extremes	B, M, T Frequencies	ITC Frequencies	Additional Phase Bin Frequencies
TX									
Conducted Carrier Output Power	per 1434-A	per 1040-E	5	2	2	2	X	-	X
TX Error Vector Magnitude	per 1434-A	per 1040-E	5	2	2	2	X	-	X
Carrier Frequency Stability	per 1434-A	per 1040-E	5	2	2	2	X	-	X
Sideband Spectrum	per 1434-A	per 1040-E	5	2	2	2	X	-	X
Switching Spurious	per 1434-A	per 1040-E	5	2	2	2	X	-	-
Conducted Spurious Emissions	per 1434-A	per 1040-E	5	1	-	-	X	-	-
Adjacent Channel Power Ratio	per 1434-A	per 1040-E	5	2	2	2	X	-	X
Intermodulation Attenuation (Base Radio Only)	per 1434-A	per 1040-E	2	1	2	2	X	-	-
Transmitter Stability into VSWR	per 1434-A	per 1040-E	2	1	2	2	X	-	-
TX Power Versus Time (PVT)	per 1434-A	TBD	-	-	-	-	-	-	-
RX									
Conducted Spurious Output Power	per 1434-A	per 1040-E	1	-	-	-	X	-	-
Maximum Usable Sensitivity (Reference Sensitivity)	per 1434-A	per 1040-E	5	-	2	-	X	X	-
Error Behavior at High Input Levels	per 1434-A	per 1040-E	5	-	2	-	X	-	-
Co-channel Rejection, Type 1	per 1434-A	per 1040-E	5	-	2	-	X	-	-
Co-channel Rejection, Type 2	per 1434-A	per 1040-E	5	-	2	-	X	-	-
Adjacent Channel Selectivity	per 1434-A	per 1040-E	5	-	2	-	X	-	-
Adjacent Channel Selectivity – Half-Rate on Half-Rate	per 1434-A	per 1040-E	5	-	2	-	X	-	-
Adjacent Channel Selectivity – Full-Rate On Full-Rate	per 1434-A	per 1040-E	5	-	2	-	X	-	-
Adjacent Channel Selectivity – Narrowband Interferer	per 1434-A	per 1040-E	5	-	2	-	X	-	-
Blocking	per 1434-A	per 1040-E	5	-	2	-	X	-	-
Intermodulation Response Rejection	per 1434-A	per 1040-E	5	-	2	-	X	-	-
RX Spurious Response Rejection	per 1434-A	per 1040-E	-	-	-	-	-	-	-
RX Noise Floor Scan	per 1434-A	NA	-	-	-	-	-	-	-
GPS Sensitivity	per 1434-A	per 1040-E	2		1	-			
Ethernet and SD Card Functionality	per 1434-A	NA	1		-	-			
Radio to Radio (Need to create)	TBD	NA			-	-			

Table 5: Priority 2 Tests (PR2) [tests will be performed before shipment as time allows, otherwise performed as part of F3RAP]

	Test Method	Specification Limits	# DUT Normal Conditions	# Tx Power Levels	# DUT Temperature Extremes	# DUT Voltage Extremes	B, M, T Frequencies	ITC Frequencies	Additional Phase Bin Frequencies
TX									
Conducted Carrier Output Power	per 1434-A	per 1040-E	-	-	-	-	-	-	-
TX Error Vector Magnitude	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Carrier Frequency Stability	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Sideband Spectrum	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Switching Spurious	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Conducted Spurious Emissions	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Adjacent Channel Power Ratio	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Intermodulation Attenuation (Base Radio Only)	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Transmitter Stability into VSWR	per 1434-A	per 1040-E	-	-	-	-	-	-	-
TX Power Versus Time (PVT)	per 1434-A	TBD	3	1	1	1	X	-	-
RX									
Conducted Spurious Output Power	per 1434-A	per 1040-E	-	-	-	-	-	-	-
Maximum Usable Sensitivity (Reference Sensitivity)	per 1434-A	per 1040-E	-	-	-	2	X	X	-
Error Behavior at High Input Levels	per 1434-A	per 1040-E	-	-	-	2	X	-	-
Co-channel Rejection, Type 1	per 1434-A	per 1040-E	-	-	-	2	X	-	-
Co-channel Rejection, Type 2	per 1434-A	per 1040-E	-	-	-	2	X	-	-
Adjacent Channel Selectivity	per 1434-A	per 1040-E	-	-	-	2	X	-	-
Adjacent Channel Selectivity – Half-Rate on Half-Rate	per 1434-A	per 1040-E	-	-	-	2	X	-	-
Adjacent Channel Selectivity – Full-Rate On Full-Rate	per 1434-A	per 1040-E	-	-	-	2	X	-	-
Adjacent Channel Selectivity – Narrowband Interferer	per 1434-A	per 1040-E	-	-	-	2	X	-	-
Blocking	per 1434-A	per 1040-E	-	-	-	2	X	-	-
Intermodulation Response Rejection	per 1434-A	per 1040-E	-	-	-	2	X	-	-
RX Spurious Response Rejection	per 1434-A	per 1040-E	1	-	-	-	-	-	-
RX Noise Floor Scan	per 1434-A	NA	2	-	1	1	-	-	-

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	Test Method	Specification Limits	# DUT Normal Conditions	# Tx Power Levels	# DUT Temperature Extremes	# DUT Voltage Extremes	B, M, T Frequencies	ITC Frequencies	Additional Phase Bin Frequencies
GPS Sensitivity	per 1434-A	per 1040-E	-	-	-	1			
Ethernet and SD Card Functionality	per 1434-A	NA	-	-	-	-			
Radio to Radio (Need to create)	TBD	NA	2	-	2	-	X		
OTHER									
TX Radiated Spurious Emissions (out of house)	per 1434-A	per 1040-E	1	-	-	-	-	-	-