METEORCOMM LLC

PTC Radio Functional Specification

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220 MHZ PTC Radio System Overview

Three radio types:

- **Base Stations** – Installed at fixed locations to provide radio network coverage

- Remotes
  - **Locomotive Radios** - Mobile radio elements of the ITC 220 MHz network
  - **Wayside Radio**s - Fixed-location radios installed at waysides

Primary purpose – Ensure the locomotive receives timely track status messages

220 MHz PTC Radio System
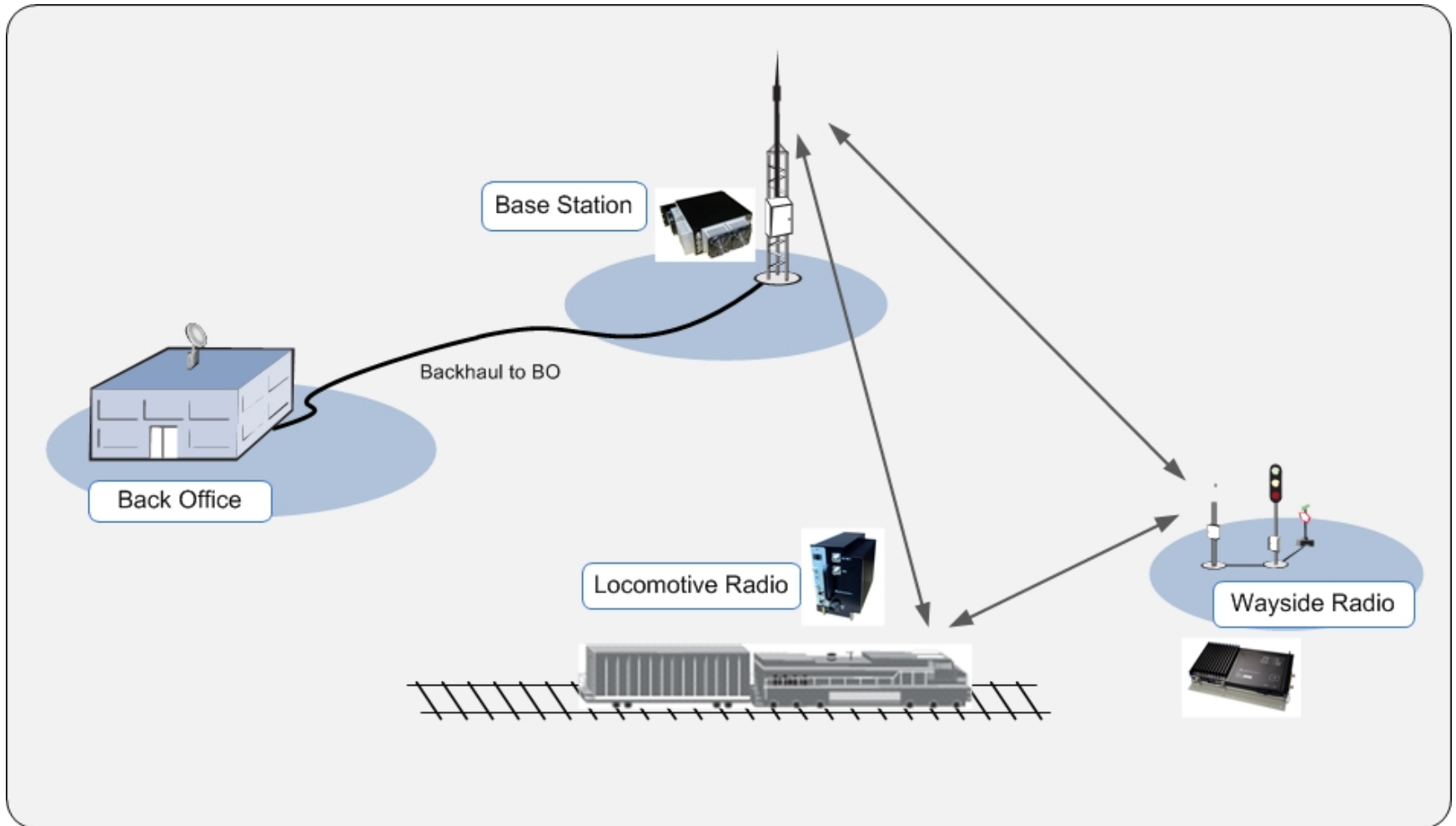
Base Station Radio

- Installed at fixed locations

- Provides RF connectivity between the Back Office and remote areas

Locomotive Radio

- Mobile radio elements of the ITC 220 MHz network

- Installed in the cab of locomotives

Wayside Radio

- Remote, fixed-location radios installed at waysides

- Provides wayside signal status, switch position, and track integrity information to locomotives via a 220 MHz RF link

PTC Radio Functional Specification

MCC Specification Document

ITCR 1.0 Functional Product Specification, MCC DCN 00001056-D, January 12, 2012.

This document defines the 220 MHz PTC radio functional specifications. This includes:

- Ethernet connections and IP configuration
- Front panel indicators and CLI command summary
- Radio configuration and software download
- Special operating modes
- Slot timing, GPS, and base station selection
- Data logging and radio status

Specifications and Primary References

- ITCC Radio Requirements Baseline, REQ-PTC-00001007-F, March 18, 2011.

- ITC 220 MHz Radio Hardware Specifications, MCC DCN 00001040-E, August 29, 2011.

- ITC 220 MHz Radio System Architecture Specification. MCC DCN 00001049-A, December 22, 2010.

- ITCM 1.0 HRX Specifications, DCN: 00001043-C, v0.98.

Network Connections

Each radio has two Ethernet ports

- ## Network Port
  - Primary use is data connection to the BO

- ## Maintenance Port
  - Primary use is for local connection to the radio

- ## Both ports can be configured
  - DHCP server
  - DHCP client
  - Static IP address

- ## Radios communicate with messaging servers via Ethernet using the HRX protocol

User Interface – Front Panel Visual Indicators

LED	Description	Color
Power	Constant illumination indicates normal radio operation.	GREEN
Fault	Used for Indicating a variety of fault conditions	RED
Transmit	Illuminated when the radio is keyed	RED
Receive	Illuminated when the radio is receiving a valid 220 MHz PTC signal.	AMBER
VSWR	Illuminated when the VSWR of the TX port exceeds approximately 3:1 or the TX forward power is not within 25% of the RF output power setting	RED
Standby	Indicates the radio is in standby mode and TX is disabled	RED
RF Link	Indicates an RF link has been established between two radios	AMBER
Data Terminal Link (DTL)	Illuminated when the radio has a connection to an ELM through the Ethernet network port.	AMBER

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User Interface – CLI Commands

Examples of common CLI commands

Command	Description
BOOT	Restart the radio
CHANNEL	Query or configure channel table
CONFIG	Display basic parameters of radio
HELP	Provide command list or help on a specific command
LINKSTAT	Query RF network link statistics
LOGON	Initiate password protected command session
LOGOFF	Exit command session
PING	Test IP connectivity
REV	Display software revision information
SAVE	Save modified configuration data in nonvolatile memory
STAT	Display basic radio status information

Power On Self Test Summary

Test	Description
RAM	Dynamic RAM is tested for correct operation.
Image	The firmware image is checked for corruption. Failure at this point can result in automatic rollback to a previously stored image.
CONFIG	The internally stored configuration parameters are checked for corruption.
CIM	A test is performed to ensure that the CIM is present and can be read.
DC Voltage	Voltage levels of all internal power supplies are tested to ensure they are within the allowable range.
Firmware Operation	A hardware watchdog timer ensures that the firmware is running properly.

Radio Configuration

Each radio contains a configuration information module (CIM)

- Removable memory device (SD card)

- The CIM stores the following information:
    - Site specific information
    - Radio configuration data

- A CIM with valid configuration data must be installed for a radio to go online after power up

- Three separate configuration parameter files, only one of which is used at a time

- Changes can be accomplished either by loading in a new configuration file onto the radio or by manually making changes to individual parameters.

Radio Configuration cont.'d

The radio has three sets of configuration parameter values:

File	Description
Current Configuration Parameter Settings	• Active radio configuration parameter values • Copied into radio memory at the time of boot up
Rollback Configuration Parameter Settings	Configuration values parameters used if a rollback to a previous version of the radio configuration is desired
Factory Default	• Configuration values set at the time of manufacture • These values are locked and cannot be altered

Basic Configuration Elements

Area	Description
Identification	radio ID, customer ID, site name, and serial number
RF Configuration	ITC channel numbers, transmit power level, various network parameters, parameters that control the selection of base stations are configurable
I/O Configuration	IP address, subnet mask, default router, and DHCP configuration
Security Features	The selection of which parameters are locked and the use of passwords
Time	The time and date, time zone, synchronization source (e.g. internal clock, base station, or a GPS receiver)
Diagnostic Information	The types of diagnostic information generated, level of detail, and where it is stored or routed

Software Download

- Firmware image – radio software file installed on a radio

- Firmware images can be upgraded with specific file downloads to the radio

- A firmware image can be loaded into the radio via the maintenance port or remotely via a broadband network connection

- For remotes, firmware images can be downloaded over the air via the 220 MHz RF link from a base radio

- There is sufficient memory to store four firmware images in the radio. This includes the factory default image.

- If a failure is detected during the firmware update and installation process the radio will automatically roll back to the previous software version

Special Operating Modes

Standby

- Excluding some test mode transmissions, while in standby the radio all radio transmissions are inhibited.

- Other than to transmit, the radio is able to receive and operate otherwise normally during standby.

- While the radio is in standby mode, it has a special indicator LED on in its front panel. The standby status can be queried from the radio.

Sniffer

- Specific operational mode that allows all air interface packet traffic on the common channel and one user specified local channel to be logged to an external device

- While in the sniffer mode the radio ceases normal operation and the transmitter is disabled

- Sniffer mode can be invoked through the command line interface locally via the maintenance port and remotely via the data port

Remote Radio Base Station Selection

Base station selection is based on a weighted metric of multiple parameters calculated for each candidate base

	Parameter Description
Distance	Distance from the remote radio to the base station
RSSI	Base station signal level at the remote radio
Base Utilization	Amount of available RF bandwidth at a base station
Hold-Off Time	A base that has been dropped by a remote cannot be reselected for a time determined by hold-off
A/T Ratio	This is the ratio of packets sent to packets acknowledged and is an indicator of link quality
Base Bacon Count	Ignore base stations for which the base beacon messages received by the remote is below a threshold

Data Logging

- Radio activity can be logged and the level of detail is configurable.

- Data can be logged to an external device via the maintenance port

- Logged data may include:
  - Commands received from the maintenance port and the corresponding responses to those commands
  - Informational messages concerning radio activity including message traffic and air interface packet traffic
  - Diagnostic information
  - The logged data is controlled by enabling various levels of traces on the radio maintenance port connection.

Radio Status and Diagnostics

- The radio collects statistics on RF link quality and throughput for both RF and Ethernet links

- Except those parameters which have been specifically masked for security reasons (e.g. passwords), the status of configurable parameters is accessible through the maintenance connection

- The radio can be queried for version information via the maintenance connection

- Key parameters monitored by the radio:

  - Supply voltage
  - Voltage under transmit load
  - RF power output, temperature
  - RF link connectivity
  - Ethernet link connectivity
  - Processor operation