Futurecom Systems Group, ULC

a Motorola Solutions Company

PDR8000® Portable Digital Repeater Product Planner

Document: 8K088X02
Revision: R5.06
Date: December 2023

Note: PDR8000 is sold exclusively by Motorola Solutions, Inc. worldwide

MOTOROLA SOLUTIONS

Subscribe to our newsletter if you want to be informed about new releases and updates. Please visit http://futurecom.com/support/newsletter/

Proprietary Statement

Table of Contents

List of Figures

List of Tables

Glossary

TERM	DEFINITION
ASTRO	P25-compliant digital communication system offered by Motorola Solutions
BER	Bit Error Rate; identifies the quality degradation of a data stream over a communication channel. Typically altered due to noise, interference, distortion, or bit synchronization errors.
BSI	Base Station Identifier / Call Sign; sent over-the-air, sometimes as Morse Code, to identify the originating transmitter
CAI	Common Air Interface (P25 standards-based RF Signaling)
CCGW	Conventional Channel Gateway (Conventional Channel Interface to ASTRO 7.x system)
CTCSS	Continuous Tone-Coded Squelch System (In band signaling controlling squelch control in analog radio systems), also known as Motorola PL
DCS	Digital Coded Squelch (In band signaling controlling squelch control in analog radio systems), also known as Motorola DPL
DFSI	Digital Fixed Station Interface – Radio over IP interface protocol as defined in TIA-102.BAHA-A standard document.
DIU / DIU3000	Digital Interface Unit; Provides wireline vocoding and encryption in ASTRO 3.1 systems
DST	Daylight Saving Time
Duplexer	An electronic device that allows bi-directional (duplex) communication over a single path. It isolates the receiver from the transmitter while permitting them to share a common antenna.
Full-Duplex	Bidirectional simultaneous communications
FBICR	Fallback In-Cabinet Repeat: A mode of operation when PDR8000 activates a local-repeat function if it's wireline link becomes impaired
FRC	Futurecom Repeater Configurator: The application for configuring PDR8000 (formerly known as Tweaker)
GPS	Global Positioning System
GTR 8000	A model of Motorola Solutions base/repeater stations
Half-Duplex	Bidirectional communications utilizing two paths/frequencies, but only one at a time
LED	Light Emitting Diode
Mixed-mode channel	A radio channel carrying both P25 (CAI) and Analog FM radio traffic. (Usually provided to help support legacy, non-P25 subscriber units that need to operate at an incident scene where P25 subscriber units are in use.)
NAC	Network Access Code; identifier driving squelch operation on received Digital channels. Replaces PL/DPL (CTCSS/DCS) functionality from analog radio systems.

TERM	DEFINITION
OTAR	Over The Air Rekeying (method of updating encryption keys in devices via encrypted over-the-air transport)
P25	Project 25; a suite of standards for digital radio communications for use by federal, state/province and local public safety agencies, enabling communication within and between agencies during emergencies.
PDR	Portable Digital Repeater
PL/DPL	Private Line / Digital Private Line (In band signaling controlling squelch control in analog radio systems); also known as CTCSS (Continuous Tone-Coded Squelch System) or DCS (Digital Coded Squelch).
PTT	Push-To-Talk
QUANTAR	A model of Motorola Solutions base/repeater stations
RF	Radio Frequency: carrier and information sent via Electromagnetic energy, "over-the-air"
RSSI	Relative Received Signal Strength Indication
Rx	Receive
Simplex	Communications on a single path/frequency, allowing only one transmitter at a time
Supplementary Data services	"Lightweight" data services that supplement voice communications, e.g., Talker ID, Status Update, Emergency indication, etc.
TEI	Terminal Endpoint Identifier (used in Message addressing on a wireline interface)
Tx	Transmit
V.24	A digital link described as a physical V.24 link with HDLC (High-level Data Link Control). Used to connect PDR8000 to other infrastructure elements (e.g., CCGW, DIU, comparator)
Voting / Comparator	Communication system elements that observe multiple received signals and choose the best (highest quality) to present to receiving users.

1   INTRODUCTION

Special ops and security detail teams requiring enhanced, Conventional, two-way radio network coverage can look to the PDR8000 Portable Digital Repeater as their solution of choice when on the move. Designed by Futurecom Systems Group in collaboration with Motorola Solutions with these special teams in mind, the lightweight suitcase is suited for discreet travel whereas the Rackmount form factor is designed to fit in a standard 19" rack.

Figure 1: PDR8000 Suitcase

Set up the PDR8000 suitcase at a special event or incident to swiftly provide local P25 or analog FM, on-scene portable radio coverage. Connect to your dispatch console wherever it may be via a V.24 (for P25) or Ethernet IP (Analog or P25) connection.

The platform the PDR8000 is based on has been in the field since 2006. Known generically as the DVR (Digital Vehicular Repeater), this platform has an installed base of 30,000+ units serving public safety first responders worldwide. For the PDR8000, the DVR's transceiver has been optimized to minimize its weight and size, taking advantage of high efficiency fans not available in the vehicle repeater application.

Figure 2: Rackmount PDR8000

Futurecom's PDR8000 transceiver platform benefits from over a decade of harsh field service and proven success.

1.1   KEY FEATURES & BENEFITS

- All Bands – VHF, UHF, * 700 MHz and * 800 MHz
- Lightweight construction - less than 28 lbs. (including duplexer)
- Rapid deployment with AC or DC power source capability
- Closed case operation at 50% Transmit duty cycle
- Easy to swap internal duplexer
- Able to use external duplexer
- End-to-end Encryption supported
- Voting and Comparator operation
- Standard output power of up to **20 watts (configurable) without duplexer
- Optional Booster Pack provides pre-duplexer output power of 50 watts
- Platform support for future interfaces including Bluetooth and Wi-Fi
- Wireline V.24 serial connection to Motorola Solutions P25 system infrastructure
- Wireline Ethernet IP connection to consoles supporting Digital Fixed Station Interface Protocol Version 1 (analog and digital)
- Standalone repeater for P25, analog FM, and mixed-mode operation

- LCD screen & keypad allow easy access to Channel Change and other features

* Only available in Suitcase model

** PDR8000 *attempts* to adjust its transmit power level to compensate for duplexer losses, however it is limited by maximum power output.

1.2 APPLICATIONS

- Special events
- Interoperability
- Dignitary protection
- In-building coverage
- Natural disaster
- Incident Scene response
- Discreet reconnaissance

2 PDR8000 HARDWARE FORM FACTORS

2.1 PDR8000 SUITCASE

PDR8000 suitcase form factor is typically a self-contained device but is easily modified to utilize an alternate duplexer and/or a transmit power Booster Pack when required. Different RF hardware combinations are supported, using accessible internal and external connection points to enable the desired configuration. Note that the PDR8000 internal duplexer is easily accessible and swappable. The cavity housing the internal duplexer is easily accessed by removing a panel of the PDR8000 faceplate via four thumbscrews.

Figure 3: Internal Duplexer Cavity

The need to field-swap a duplexer depends upon the range of RF frequencies being used on the different channels configured in a PDR8000. Duplexers have a defined Bandpass, meaning that if widely diverse RF frequencies are used within the same RF band, it may be necessary to install a different duplexer into the PDR when traversing frequencies (changing channels) to another portion of the RF band. Duplexers typically cover a broad band of frequencies, but if the frequencies on different channels are outside of the tuning parameters of the duplexer, it is necessary to substitute a different duplexer when the channel is changed.

If a different Duplexer is substituted, the Tx/Rx Duplexer Losses in the 'Deployment General Configuration' in FRC should be adjusted. The values entered in this field should match the values shown on the label affixed to each Futurecom-supplied duplexer (See Figure 4). If a collection of duplexers is used, it may be convenient to program different Deployment Profiles for each duplexer, so a user can easily switch Deployment Profile when switching duplexers.

Figure 4: Duplexer Label (with indicated Insertion Losses)

Several different duplexers are available, in different RF bands, and factory-tuned to customer specified frequencies. Those available for purchase with the PDR8000 are listed below (see Table 1). Custom filters are also available at different specifications; contact Futurecom for details. Customer supplied duplexers (installed inside the duplexer cavity, or outside of the PDR8000 case) may also be used.

RF Band/Frequencies	Tx to Rx Separation	Bandpass Width
VHF	4.5-5.5 MHz	300 KHz
UHF 380 – 430 MHz	9.5-10.5 MHz	300 KHz
UHF 380 – 430 MHz	4.5-5.5 MHz	300 KHz
UHF 450 – 470 MHz	4.5-5.5 MHz	300 KHz
700 MHz	30 MHz (minimum)	11 MHz
800 MHz	45 MHz (minimum)	10 MHz

Table 1: Duplexer Specifications for PDR8000 Suitcase

Note that the following diagrams illustrate the adaptability of PDR8000 suitcase by use of its internal and external connection points. These diagrams do not represent a detailed view of the circuitry within each of the elements.

2.1.1 INTERNAL DUPLEXER

Figure 5: Internal Duplexer Hardware Topology

2.1.2 SIMPLEX
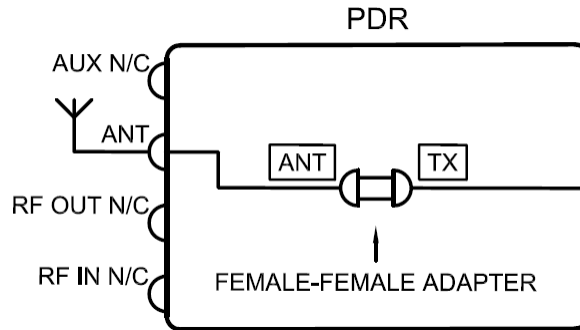
Figure 6: Simplex Hardware Topology

2.1.3 SIMPLEX WITH BOOSTER PACK
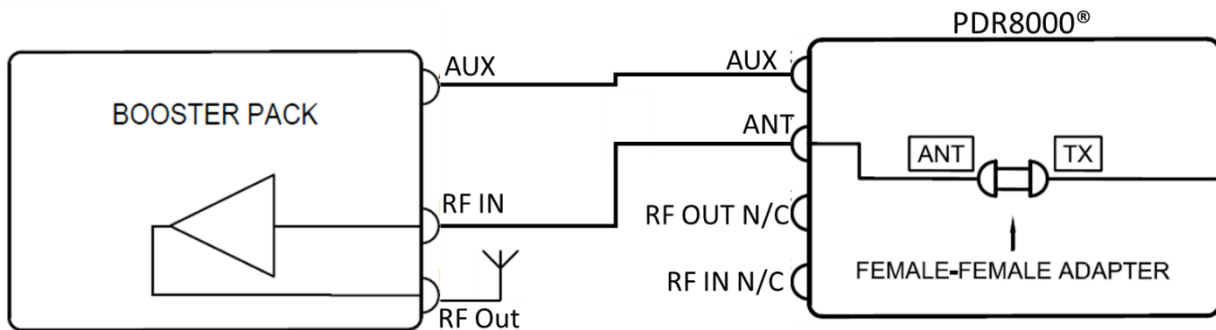
Figure 7: Simplex with Booster Pack Hardware Topology

2.1.4 INTERNAL DUPLEXER AND BOOSTER PACK
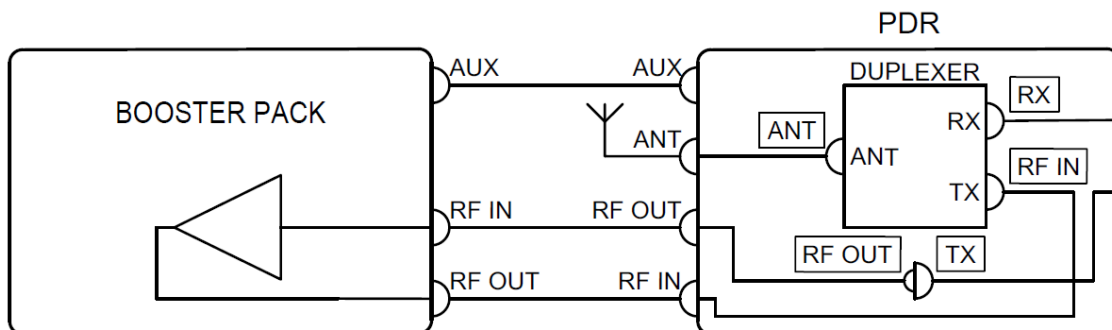
Figure 8: Internal Duplexer and Booster Pack Hardware Topology

2.1.5 EXTERNAL DUPLEXER
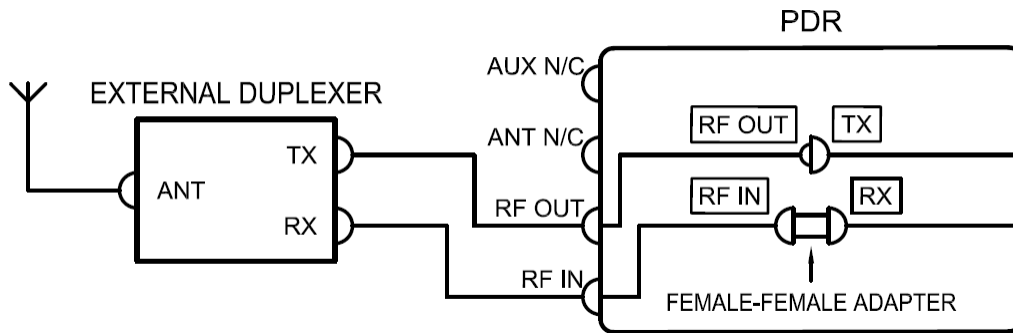
Figure 9: External Duplexer Hardware Topology

External Duplexer cabling supplied by user.

2.1.6 EXTERNAL DUPLEXER AND BOOSTER PACK
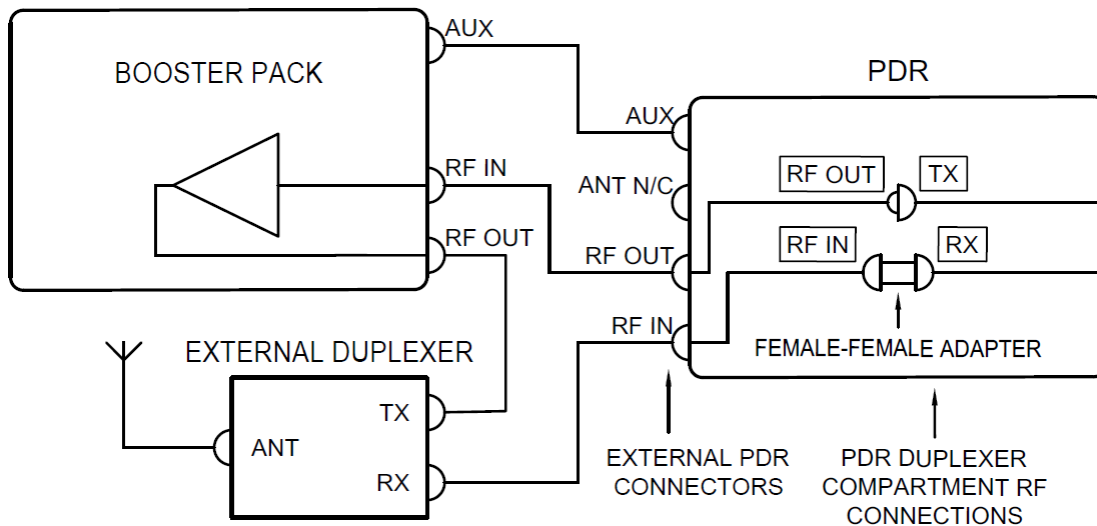
Figure 10: External Duplexer and Booster Pack Hardware Topology

External Duplexer cabling supplied by user.

2.1.7 BOOSTER PACK

PDR8000 natively provides a pre-duplexer output power configurable up to max 20 watts depending on the Frequency Band. (Please refer to the product specifications)

If higher output power is needed, configurations using an external Booster Pack can be utilized (see sections 2.1.4, 2.1.6). The Booster Pack configuration utilizes the standard PDR8000 suitcase hardware/software and adds an additional suitcase (same dimensions/colors as the PDR8000) which provides additional transmit power. The PDR8000 suitcase and Booster Pack are connected via RF cables and a control cable. Output power of *50 watts (pre-duplexer) is provided when using the Booster Pack.

When a Booster Pack is connected, the Tx Duplexer Losses configured in FRC are not compensated for, since the Booster Pack transmits a constant power level. Therefore, with the duplexer connected, the power at the PDR's antenna port is the power at the PDR8000's RF Out port plus duplexer losses. For example: if the Booster Pack's output power is 45dBm and the duplexer loss is -1.5dB, the output power at the PDR8000's antenna port is 43.5dBm.

Figure 11: Booster Pack

During operation of PDR8000 suitcase with a Booster Pack, the PDR8000 automatically detects the presence of the Booster Pack and adjusts its output signal to be compatible with the Booster Pack. The adjusted signal is then received by the Booster Pack which boosts the output signal to 50W. (Note that the same PDR8000 can be used with or without a Booster Pack, allowing the additional suitcase to be deployed only when needed.)

Addition of the Booster Pack to an existing (before Release 4) PDR8000 requires a firmware update to the PDR8000 and its configuration software (Futurecom Repeater Configurator (FRC).

Note that a Booster Pack can only be used with a PDR8000 built for the same RF band as the Booster Pack. Different order codes are used to purchase Booster Packs for each of PDR8000's supported RF Bands. (Booster Packs are ordered for bands: VHF, UHF 380-430, UHF 450-470, 700/800). A Booster Pack must not be connected to a PDR8000 built for a different RF band.

For more details of the Booster Pack, see the product specifications.

2.2 RACKMOUNT PDR8000

Some applications other than tactical use require added flexibility, which can be achieved with the use of a Rackmount PDR8000 which is designed to fit into a standard 19" rack. Typical use case for such applications are in-building coverage or remote areas having standard IT racks to host Rackmount PDR8000.

The Rackmount PDR8000 gives you the flexibility of having the PDR8000 with options of internal duplexers and/or 50 watts power amplifier, all packaged in a single 19" rack mountable unit as shown on Figure 12 below.

The Rackmount PDR is powered by connecting it directly to a user supplied 12VDC Power Supply.

Figure 12: Rackmount PDR8000 Front Panel

The Rackmount PDR8000's front panel provides the same display keypad, LED panel and USB connection as available on the suitcase form factor. In addition, the V.24 and the LAN connections are also accessible on the front panel. The power supply, RF and optional alarm connections are available at the back of the unit as shown in Figure 13.

Figure 13: Rackmount PDR8000 Back Panel

Rackmount PDR8000 offers several different duplexers, in different RF bands, and factory-tuned to customer-specified frequencies. These internal duplexers are secured in an enclosure. Those available for purchase with the Rackmount PDR8000 are listed below (see Table 2).

RF Band/Frequencies	Tx to Rx Separation	Bandpass Width
VHF	4.5-5.5 MHz	300 KHz
UHF 380 – 430 MHz	9.5-10.5 MHz	300 KHz
UHF 380 – 430 MHz	4.5-5.5 MHz	300 KHz
UHF 450 – 470 MHz	4.5-5.5 MHz	300 KHz
800 MHz	45 MHz (minimum)	10 MHz

Table 2: Duplexer Specifications for Rackmount PDR8000

Custom filters from Futurecom and customer-supplied external duplexers open the possibility of utilizing other frequency separation and bandpass width.

Note that the following diagrams illustrate the adaptability of Rackmount PDR8000 by use of its internal and external connection points. These diagrams do not represent a detailed view of the circuitry within each of the elements.
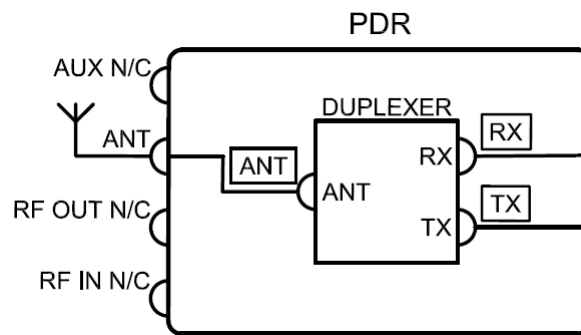
2.2.1 INTERNAL DUPLEXER
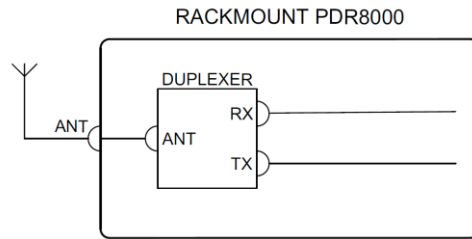
Figure 14: Internal Duplexer Hardware Topology

2.2.2 INTERNAL DUPLEXER AND 50W POWER AMPLIFIER
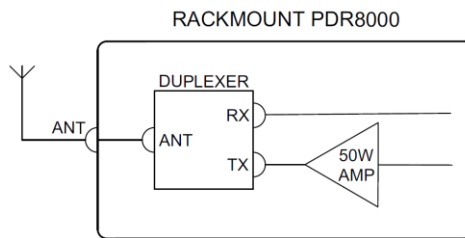
Figure 15: Internal duplexer with 50W Power Amplifier Hardware Topology

2.2.3 EXTERNAL DUPLEXER
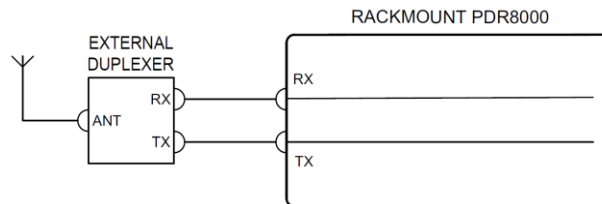
Figure 16: External Duplexer Hardware Topology

2.2.4 EXTERNAL DUPLEXER AND 50W POWER AMPLIFIER
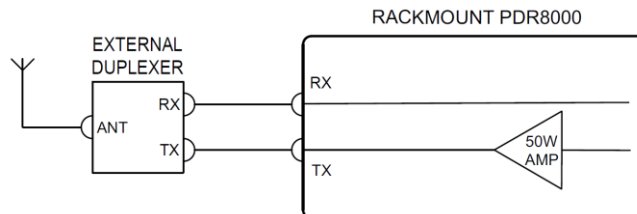
Figure 17: External duplexer with 50W Power Amplifier Hardware Topology

When a Rackmount PDR8000 is equipped with the optional 50W Power Amplifier, it provides full-duplex operation, or half-duplex mode with a duplexer. Rackmount PDR8000 with the 50W Power Amplifier is incompatible with simplex operation, or half-duplex operation without a duplexer. These restrictions only apply for Rackmount PDR8000 when equipped with 50W Power Amplifier.

3 PDR8000 USE CASES

PDR8000 is an RF Station capable of Local Repeat, Voice, Data, and Supplementary Data services operations for Digital Conventional radio systems, and capable of Local Repeat of Voice and Signaling (e.g., MDC 1200) for Analog Conventional radio systems.

The Project 25 Common Air Interface (CAI) standard specifies the type and content of signals transmitted by compliant digital radios. One radio using the P25 CAI is able to communicate with other P25 CAI radios, regardless of manufacturer.

PDR8000 can operate in a standalone mode or can connect via wireline interface to a Motorola system infrastructure potentially including a data gateway, voting comparator and/or consoles. The common PDR8000 use cases include:

- Wireline Station (Repeat or Base operation)
- Back to Back cross band Repeater (RT/RT)
- Standalone Repeater
- Wireline Satellite Transmitter or Receiver

3.1 WIRELINE STATION (REPEAT OR BASE OPERATION)

This is the primary use case of PDR8000, where a PDR8000 is connected to an ASTRO system infrastructure, including consoles and/or comparators.

3.1.1 V.24 WIRELINE REPEATER

This is the primary use case of PDR8000, where a PDR8000 is connected to an ASTRO system infrastructure, providing a means for fixed-end equipment (data interface, consoles, comparators) to have access to Digital Conventional RF channels. In ASTRO 3.1 (legacy) systems a PDR8000 is connected to the system infrastructure via V.24 connection to a DIU. In ASTRO 7.x systems a PDR8000 is connected to the system infrastructure V.24 connection to a CCGW (Conventional Channel Gateway)

In this use case the PDR8000 is a portable Base / Repeater capable of supporting most digital conventional services and site features provided by ASTRO 3.1/7.x conventional systems.
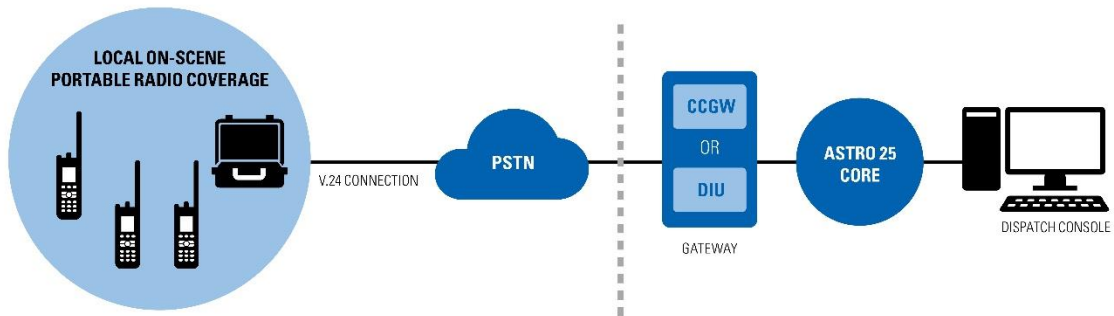
Figure 18: V.24 Wireline Station Use Case

3.1.2 ETHERNET WIRELINE REPEATER

PDR8000 can be connected to Motorola's ASTRO system or Consoles via the Ethernet Wireline interface. Implemented on the industry standard commonly known as Digital Fixed Station Interface (DFSI) Protocol Version 1, PDR8000 can connect to a console (either directly or via a gateway) which supports this standard.

Details of DFSI interface are provided in section 6.4.2.
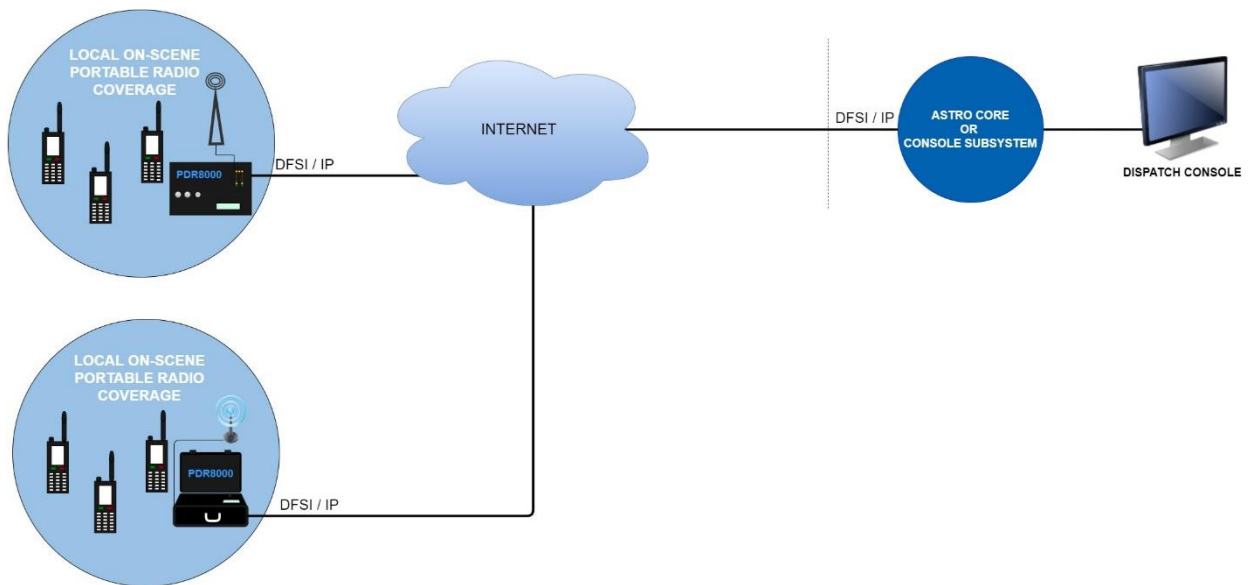
Figure 19: Ethernet Wireline Station Use Case

3.2 BACK TO BACK CROSS BAND REPEATER (RT/RT)

The Remote Repeater/Remote Repeater (RT/RT) configuration is a topology used to relay signals from one base radio to the next. One typical application for this configuration is a conversion between frequency bands. It is acceptable to have a mixture of PDR8000s, GTR 8000 Base Radio equipment and QUANTAR equipment interconnected in the RT/RT configuration. This interconnection is supported for repeaters operating in digital/P25 mode via the V.24 wireline interface only.
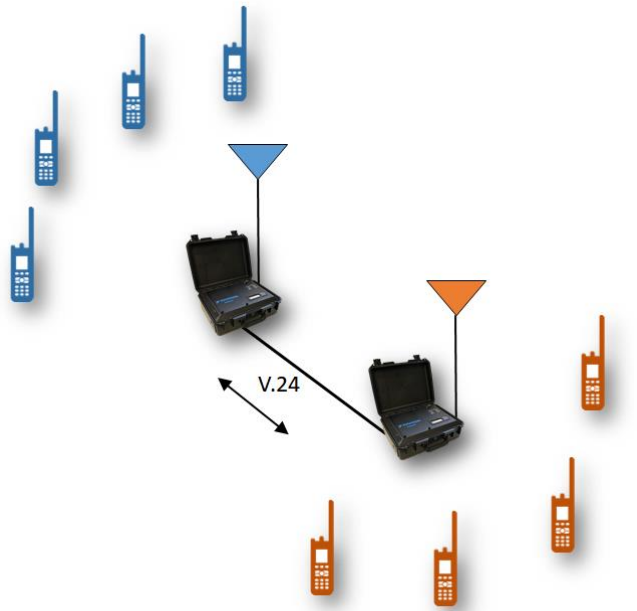
Figure 20: RT/RT Use Case

3.3 STANDALONE REPEATER

At times users may not desire or have access to a system connection utilizing the wireline interface. In these cases, PDR8000 can be configured to operate as a standalone repeater providing full-duplex, Local Repeat capabilities on the configured channel. When operating on a P25 digital channel PDR8000 typically repeats Voice and Supplementary Data services; repeating of Packet Data services is also a configurable option. When operating on an Analog channel, PDR8000 repeats voice services and Supplementary Service signaling (e.g., MDC 1200).[1]

---

[1] PDR8000 does not actively encode/decode MDC 1200 but does pass the signaling through its repeat path. Care should be taken when using MDC 1200 to ensure that PDR8000 has sufficient time to recognize the received RF signal, qualify its squelch (PL/DPL) and key up to repeat the signal. If MDC 1200 is received too quickly, its beginning may be truncated. Repeating of MDC 1200 works best if PL/DPL is not used on the channel, or more commonly, if transmit MDC pre-time of subscriber units is set sufficiently to allow time for PDR8000 to detect PL/DPL before MDC is started.

PDR8000 is also capable of providing mixed-mode operation when operating as a Standalone Repeater. This allows repeating of non-simultaneous P25 and Analog traffic on the same channel.

Figure 21: Standalone Repeater Use Case

3.4 WIRELINE SATELLITE RECEIVER/TRANSMITTER

Some user deployments require handling different coverage scenarios than typically provided by the PDR8000 Repeater configuration. Receive-only and Transmit-only capabilities are part of the suite of configurations supported by PDR8000 to allow customers to take advantage of these specialized solutions. These configurations are supported by PDR8000 operating in digital/P25 mode via the V.24 wireline interface only.

PDR8000 supports operation as part of a Voting/Comparator system, which is one of the methods used to provide an improved RF coverage solution. Voting solutions typically employ multiple receivers and a single transmitter. In this system configuration, a PDR8000 can serve as one of the Satellite Receivers (providing receive-only operation for a geographical area and allowing the comparator and a separate transmitter to provide outbound capability).

Other coverage scenarios may require one PDR8000 dedicated as a Satellite receiver, and another PDR8000 in a different location configured as a Satellite transmitter. If PDR8000's role in a voting system is to act as both a transmitter and receiver, it is configured as a wireline base station, as in section 3.1.

4 DEPLOYMENT PROFILES

PDR8000 is intended to be utilized in a variety of different scenarios, each supported by customizing PDR8000's configuration parameters to match the needs of a given deployment. Since PDR8000 is intended to be an easily re-deployed unit, it offers an optional feature allowing multiple Deployment Profiles to be pre-programmed. The desired pre-configured Deployment Profile is easily activated from the unit's front panel keypad/display.

If the option for Deployment Profile Capability is enabled, PDR8000 can be programmed with up to ten different Deployment Profiles, each uniquely defining the operational characteristics of the PDR8000.

This capability can be used, for example, to pre-provision the PDR8000 with one Deployment Profile used when the unit is deployed as a Standalone Repeater, utilizing a set of frequencies, timings, access codes, etc., and then having a separate Deployment Profile defined for connecting the same PDR8000 to a Motorola comparator or infrastructure core utilizing a wireline link and potentially different RF frequencies. By utilizing the ten possible Deployment Profiles, PDR8000 can be ready to "pick up and go" for many common use case scenarios. The PDR8000 can be configured to power-up to a specific Deployment Profile or can boot to the "last active" Deployment Profile. During field use the active Deployment Profile can be changed, via activation through the front-panel display.

If multiple duplexers are required to be used (swapped in/out as needed), different Deployment Profiles can be created for the different duplexers. This allows users to swap the physical duplexer and then change to the specific Deployment Profile through the PDR8000's front panel.

The Deployment Profile capability also makes it possible to keep some common configurations on-board in PDR8000's Deployment Profile set, and then utilize one or more of the other Deployment Profiles as "temporary" set-ups, which can be configured without having to overwrite the commonly used ones.

PDR8000's Futurecom Repeater Configurator (FRC) provides the ability to create new Deployment Profiles from scratch, or to duplicate a known Deployment Profile and allow minor modifications to it, for use when operational requirements are similar but not the same.

If the Deployment Profile Capability is not enabled, PDR8000 can be programmed with a single set of configuration parameters. In this case, any need to switch to a different set of operational parameters requires a PC running the Futurecom Repeater Configurator (FRC) to modify/load the new set of configuration parameters into the PDR8000.

Note that within any Deployment Profile created to operate PDR8000 as a standalone repeater or with a DFSI wireline interface the PDR8000 can be configured with a mixture of P25/digital channels, analog channels, and mixed-mode channels. However, if a Deployment Profile is configured to utilize the V.24 wireline interface, that Deployment Profile can support P25/digital channels only.

5 SUPPORTED FUNCTIONAL CONFIGURATIONS

The functional behavior of a PDR8000 and its channels are defined by a multi-level set of configuration parameters. These parameters are modified using the PDR8000 configuration software tool, known as the Futurecom Repeater Configurator (FRC) (see 6.9). The range of operational scenarios covered by different combinations of these parameters is extensive, making PDR8000 a very versatile product, capable of being used in many different types of deployment. The high-level categories of configuration parameters are:

1. Platform Configurations
    o PDR (Portable Digital Repeater)
    o Satellite Receiver
    o Satellite Transmitter
2. RF Configurations
    o Repeater Operation
    o Base Operation
3. Channel Configurations
    o Full-Duplex
    o Half-Duplex (& Simplex)

Not all combinations of these are available. Definitions of each, and the popular combinations are described below.

5.1 PLATFORM CONFIGURATIONS

Each PDR8000 Deployment Profile (see section 4) has a single configuration parameter allowing it to operate in one of the following modes. Setting this configuration parameter further limits what may be chosen in later-listed parameters/configurations.

5.1.1 PDR (PORTABLE DIGITAL REPEATER)

The **PDR** configuration allows PDR8000 to be used as a Portable Digital Repeater. It is capable of RF receive and transmit, as well as supporting a wireline interface to the system infrastructure. Depending on additional configuration parameters (described below) the various transmit/receive/wireline behaviors are configured to provide desired operation.

5.1.2 SATELLITE RECEIVER

The **Satellite Receiver** configuration allows PDR8000 to receive from the RF channel and deliver information to the system infrastructure via the wireline V.24 interface. No RF transmit functionality is available when configured in this mode; the PDR8000 ignores any requests from the wireline to transmit a payload. The PDR8000 continues to service the V.24 wireline interface and execute commands that do not call for RF transmit activity.

This configuration is typically used when receive-only functionality is required, or when deployed as part of a voting system, where multiple devices work together to provide the total set of functionalities needed for 2-way radio communications.

Another potential use is connecting two stations together in a back-to-back configuration as illustrated in Figure 20, but only enabling one of the stations to repeat/transmit. This allows the receiver coverage area to be increased to the region covered by both receivers and utilizes a single transmitter to serve the entire area. This represents a low tier means of increasing an RF coverage area. Note that this solution does not include the "voting" function of a comparator which would compare the received signals from both receivers and pick the best one to retransmit. Instead, the transmitted signal is determined by the PTT Priority settings described in 6.2.7.

This configuration is only supported for Deployment Profiles utilizing the V.24 wireline interface, and thus only applicable to P25/digital operation (not analog).

5.1.3 SATELLITE TRANSMITTER

The **Satellite Transmitter** configuration allows PDR8000 to receive information from the system infrastructure via the wireline V.24 interface and deliver information over-the-air via the RF transmitter. No RF receive functionality is available when configured in this mode; received RF carriers are ignored.

This type of configuration might be deployed when irregular terrain or coverage patterns require Transmit and Receive functions to be separated to different devices. One example is utilizing separate transmitter and receivers as part of a voting system, where multiple devices work together to provide the full gamut of functionality needed for 2-way radio communications.

This configuration is only supported for Deployment Profiles utilizing the V.24 wireline interface, and thus only applicable to P25/digital operation (not analog).

5.2 RF CONFIGURATIONS (BASE OR REPEATER)

There is one (Repeater Operation) parameter configured to define a PDR8000 Deployment Profile as either a Repeater or as a Base. It should be noted that operation as a Repeater supports only full-duplex channels (as described in 5.3.1), whereas Base operation can be used with either half-duplex or simplex channels (see 5.3.2), or full-duplex (see 5.3.1) channels. If a PDR8000 is configured with a combination of half-duplex/simplex and full-duplex channels, then only those channels consistent with the current Repeater Operation configuration can be enabled and available for use. This allows a system technician to program a combination of different channel types (simplex/half-duplex/full-duplex) into a PDR8000, and then selectively enable/disable those that are desired for use in a given installation.

The following table illustrates the possible combinations of channel types in different configuration.

Repeater Operation	Wireline Interface	Channel Mode	Channel Type
Base	V.24	Digital Only	Full Duplex Half Duplex or Simplex
	Ethernet IP (DFSI)	Analog Digital Mixed-Mode	Full Duplex Half Duplex or Simplex
Repeater	V.24	Digital Only	Full Duplex
	Ethernet IP (DFSI)	Analog Digital Mixed-Mode	Full Duplex

Table 3: PDR8000 RF Configuration

5.2.1 REPEATER OPERATION

In the **Repeater** mode of operation, a PDR8000 can simultaneously send and receive Voice, Data and Supplementary Data services between the P25 CAI and the wireline interface. The PDR8000 can also retransmit information received via RF (either analog or P25), back over the air. This ability to retransmit RF-received traffic back over the RF transmit path is why Repeater operation is only compatible with channels configured for full-duplex (simultaneous transmit/receive) operation. See the illustrative examples in 5.4.3 and 5.4.4.

Having a Repeater in the system allows subscriber unit transmissions to be delivered to a larger geographical area than the subscriber units could reach directly. Transmissions from a subscriber unit are received at the Repeater, and then rebroadcast to the entire area within coverage of the Repeater's transmitter.

The desire to have a PDR8000 retransmit RF-received information back over the RF-Transmit path (a.k.a. Local Repeat) is controlled in a variety of ways:

- A console can command the PDR8000 to Activate or Deactivate its Local Repeat functionality by sending a wireline command to the PDR8000. The command itself (Repeat Enable or Repeat Knockdown) indicates the desired behavior of the PDR8000. If a console commands the PDR8000 to Knockdown Repeat operation, it prevents subscriber units from hearing each other. This is typically desired only temporarily, and the dispatcher can re-enable repeat operation when desired.
- The PDR8000's initial/power-on state for Local Repeat is configurable via the service/configuration software and can be set to start the PDR8000 with Local Repeat Enabled, Local Repeat Disabled, or revert to the state previously requested by a console (locally cached within the PDR8000).

It is also possible to configure a PDR8000 to automatically activate Repeat mode in the case of certain system outages. (This operation is known as Fallback In-Cabinet Repeat; see 6.5.)

When a PDR8000 is receiving RF-sourced information and repeating it back over-the-air, it keeps its transmitter active for a configurable amount of time after the received signal stops. This configuration is known as the Repeater Drop-out Delay and can be set on a per-channel basis.

The ability of a PDR8000 to repeat P25 Packet Data is controlled by a separate configuration parameter (Repeat Packet Data). This allows the PDR8000 to be enabled/disabled for Packet Data Repeat separately from the mode controlling repeat of Voice and Supplementary Data. This single configuration parameter for P25 Packet Data applies across all channels of a Deployment Profile in the PDR8000.

5.2.2 BASE OPERATION

In the **Base** mode of operation, the primary function of a PDR8000 is to relay information between the wireline interface connection and the RF. In this case, the PDR8000 is acting as the RF MODEM between the system infrastructure and the RF carriers. Base mode is compatible with P25 channels when using V.24 wireline interface. However, when using Ethernet wireline interface, the Base mode is configurable for Analog, P25 or mix-mode channels. The channels may be configured as simplex, half-duplex or full-duplex. In the case of a full-duplex channel, the PDR8000 can simultaneously send information from wireline interface to RF, and from RF to wireline interface. In the case of a simplex or half-duplex channel, the PDR8000 only allows information transfer in one direction at a time; if activity is being received by the PDR8000 on both the RF and wireline link, then the information allowed to progress is dependent on a (PTT Priority) configuration parameter as described in 6.2.7. See Base illustrative examples in 5.4.1 and 5.4.2.

It is assumed that in a Base configuration, any required Repeat functionality is provided by an external entity connected to the PDR8000 (e.g., comparator or console). In Base mode, the PDR8000 administrator cannot enable Local Repeat options, and a console cannot control Repeat operation via wireline commands.

In system configurations that depend on Repeat functionality being provided by an external entity (e.g., comparator or console), it is often desired to utilize a backup mode in the PDR8000 to provide Repeat functionality should the external repeating entity fail, thus allowing subscriber units to continue communicating with each other through a backup repeat mechanism. For this situation, PDR8000 supports Fallback In-Cabinet Repeat functionality. This is configurable behavior that allows a PDR8000 to provide its own Repeat functionality during the time that the comparator/console is not reachable or not functional (see 6.5).

5.3 CHANNEL CONFIGURATIONS (FULL/HALF DUPLEX)

The V.24 wireline interface to PDR8000 is a full-duplex link, able to send and receive information at the same time. However, there are different configurations for the RF aspect of a PDR8000 that govern whether the PDR8000 can both Transmit and Receive on the RF channel at the same time (full-duplex), or whether only one side of the RF channel is serviced at once (half-duplex). This (Full/Half) Duplex mode is configurable on a per-channel basis.

Analog and Mixed-mode channels are supported for full-duplex operation only.

5.3.1 FULL-DUPLEX

A channel configured for **Full-Duplex** operation provides simultaneous operation of the PDR8000's Transmit and Receive functionality on the RF channel. In the case of a full-duplex

channel, there may be contention by two sources of voice/data for the RF transmit path. For example, a wireline transmission may be delivered to the PDR8000 via the wireline interface at the same time a Received CAI transmission is being considered for Local Repeat operation. In these scenarios, the information chosen by PDR8000 to be passed to the outbound RF path is governed by a (PTT Priority) configuration parameter (see 6.2.7).

5.3.2 HALF-DUPLEX (& SIMPLEX)

A channel configured for **Half-Duplex** operation is limited to either Transmitting or Receiving CAI at any given time. On a half-duplex configured channel, if the PDR8000 is receiving information/voice from both the CAI receiver for delivery to wireline link, and from the wireline link for delivery over CAI, then the half-duplex nature of this configuration dictates that only one of these directions is possible at a time. The PDR8000 will determine which direction takes priority and is allowed per a (PTT Priority) configuration parameter (see 6.2.7).

Some radio systems operate such that the CAI Transmit Frequency is equal to the CAI Receive Frequency (only one frequency is available/used for both inbound and outbound communications). This specialized version of half-duplex is referred to as **Simplex** operation. In Simplex operation, if more than one user tries to transmit at any time, the RF Signals interfere with each other. This can result in communications with degraded voice quality, in the worst case having the communication be unintelligible or not received at all. This is avoided by having users listen for other activity before they initiate a new transmission, or by enabling certain options in the subscriber units that prevent initiation of a transmission if another is already in progress. Customers configure these options in the subscriber units according to their specific needs. Some customers may wish to avoid contention in all situations (in which case they program the subscriber unit to block a new transmission attempt while a received signal exists). Other customers may want to allow the conflict, which gives the second talker some chance of being heard in a situation deemed critical by the user. The PDR8000 is also configurable as to whether it should allow a wireline-sourced transmission to occur when other activity is being received on the CAI. This PDR8000 behavior is governed by a (PTT Priority) configuration parameter (see 6.2.7).

5.4 ILLUSTRATIVE EXAMPLES

5.4.1 BASE OPERATION – HALF-DUPLEX CHANNEL

Base Operation –
Half-Duplex channel with wireline interface

- Full-Duplex wireline interface
- PDR8000 Transmits OR Receives at a moment in time

Antenna

- OR -

PDR8000
Wireline Interface

System Infrastructure
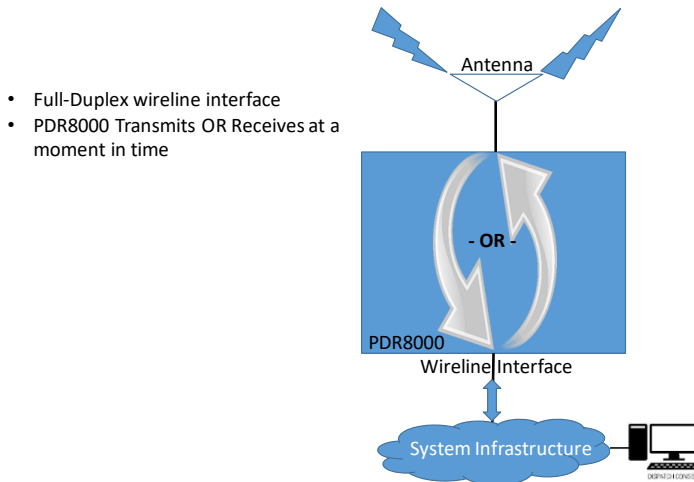
Figure 22: Half-Duplex Base Operation Example

5.4.2 BASE OPERATION – FULL-DUPLEX CHANNEL

Base Operation –
Full-Duplex channel with wireline interface

RF Signals

Antenna

- Full-Duplex wireline interface
- PDR8000 can transmit and receive simultaneously
- System infrastructure *may* provide Repeat functionality
- Failure of wireline link can activate automatic Fallback In-Cabinet Repeat

RF Signals

Antenna

Fallback In-Cabinet Repeat

PDR8000
Wireline Interface

PDR8000
Wireline Interface

System Infrastructure

System Infrastructure

Figure 23: Full-Duplex Base Operation Example

5.4.3 REPEATER OPERATION WITH INFRASTRUCTURE

Repeater Operation with wireline interface

- Full-Duplex wireline interface
- PDR8000 can transmit and receive simultaneously
- PDR8000 provides Local Repeat functionality (per configuration or on command from console)
- Failure of wireline link can activate automatic Fallback In-Cabinet Repeat (to ensure Local Repeat capability even if temporarily disabled by console)
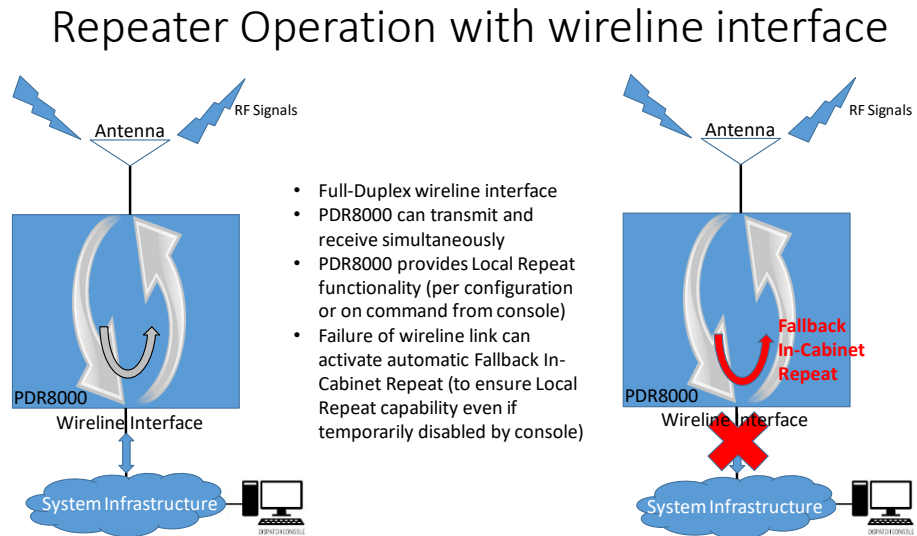
Figure 24: Repeater Operation with Infrastructure Example

5.4.4 STANDALONE REPEATER OPERATION

Standalone Repeater Operation (no wireline interface)

- No wireline interface
- PDR8000 can transmit and receive simultaneously
- PDR8000 always provides Local Repeat functionality
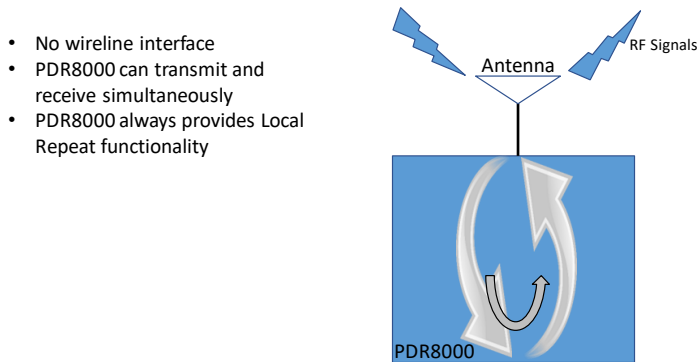
Figure 25: Standalone Repeater Operation Example

6 PRODUCT CAPABILITIES

6.1 RADIO SYSTEM SUPPORT

PDR8000 currently supports P25 Digital Conventional radio systems on 12.5 kHz channels. The Project 25 Common Air Interface (CAI) standard specifies the type and content of signals transmitted by compliant radios. One radio using the P25 CAI can communicate with other P25 CAI radios, regardless of manufacturer. PDR8000 supports features defined in the standard along with several Motorola-specific extensions.

PDR8000 also supports Analog Conventional radio operation on 12.5 kHz and 25 kHz channels.

PDR8000's wireline support is via Motorola's AIS protocol on the V.24 interface or DFSI Protocol Version 1 on the Ethernet interface. Analog operation (or Mixed-mode operation) is supported on Ethernet (DFSI) interface or when PDR8000 operates as a standalone repeater.

6.2 MULTIPLE-CHANNELS

PDR8000 is capable of being programmed for up to 64 different Conventional channels in each of its Deployment Profiles (see section 4). Any one of these may be selected for use at a given time. The currently active channel can be initialized via configuration parameters, and later be modified via commands from a console via the wireline interface, if so connected. The active channel is also selectable locally via PDR8000's keypad/display.

A PDR8000 can be programmed to have all 64 channels defined, and then have each selectively enabled or disabled by an overriding configuration parameter on each channel. This makes it easy to pre-configure the PDR8000 with many channels, and then easily enable the pre-configured channels as the situation warrants.

The channel that is active upon PDR8000 start-up is configurable to be either a particular channel, or the channel last active before the previous reset.

Each channel can be configured with its own set of operational characteristics, including:

6.2.1 TRANSMIT FREQUENCY

RF Frequency used to transmit by PDR8000 when active on this channel. Allowable frequencies are within the bands specified in 6.3. Transmit and Receive frequencies must be in the same RF band.

6.2.2 RECEIVE FREQUENCY

RF Frequency used for receiving by PDR8000 when active on this channel. Allowable frequencies are within the bands specified in 6.3. Transmit and Receive frequencies must be in the same RF band.

6.2.3 TRANSMIT POWER LEVEL

Power output provided by PDR8000 when transmitting on this channel. The configured power (1-20 watts) is desired at the PDR8000 Antenna. The internal transmitter is connected to an antenna, internal duplexer, external duplexer, or transmit Booster Pack. Each entity connected affects the output power by attenuating or boosting the signal.

When connected to Internal or external Duplexers, PDR8000 attempts to adjust its transmit power level to compensate for duplexer losses, however it is limited to the transmitter's maximum power output.

When a Booster Pack is connected, the Tx Duplexer Losses configured in FRC are not compensated for, since the Booster Pack transmits a constant power level. Therefore, with the duplexer connected, the power at the PDR's antenna port is the power at the PDR8000's RF Out port plus duplexer losses. For example: if the Booster Pack's output power is 45dBm and the duplexer loss is -1.5dB, the output power at the PDR8000's antenna port is 43.5dBm.

PDR8000 can be configured to present an alarm if the measured RF transmit power differs* from the programmed output power by a user-specified amount (dB) programmed in FRC.

* The difference in the measured RF transmit power and the programmed output power could be caused by limits of the PDR8000 hardware or when internal/external duplexers are connected to the PDR8000.

6.2.4 WIRELINE TIME-OUT TIME

The maximum amount of time the transmitter may be continuously activated via the wireline interface (e.g., by a console).

6.2.5 REPEATER TIME-OUT TIME

The maximum amount of time the transmitter may be continuously activated in order to repeat subscriber audio arriving via the PDR8000 receiver.

6.2.6 REPEATER DROP-OUT DELAY

The amount of time the transmitter remains active when in Repeater mode, following loss of the received signal.

6.2.7 PTT PRIORITY

There are certain conditions that can cause contention situations in the PDR8000. For instance, the PDR8000 might be simultaneously receiving a call from two different sources (e.g., RF and wireline link) but only be able to pass one of those sources forward. This might be because both messages are destined to the same output (e.g., the PDR8000 transmitter), or because the PDR8000 has been configured in a way that limits the simultaneous paths through the device (e.g., half-duplex or simplex). In these cases, a configuration parameter (PTT Priority) determines which of the competing sources is allowed to be processed. The configurable PTT Priority parameter is chosen from:

- **Wireline Priority (W>R)**: Call from wireline interface has priority over RF repeat audio.

- **Radio/Repeat Priority (R>W)**: Call from RF has priority over wireline interface originated call.
- **First Call Priority (W=R)**: Whichever call starts first has priority over the other source.

When competing signals bring these prioritization rules into effect, the prioritized signal is passed through the PDR8000 to its intended destination, and the non-prioritized signal is stopped. No indication is seen/heard by the originator of the "lower-priority" signal to show that their message was not successfully delivered.

Each channel is independently configured to use one of these priority schemes.

6.2.8 BSI (BASE STATION IDENTICATION)

PDR8000 can be configured to automatically transmit an audible signal (Morse code) over the air that identifies the station by call sign (up to 20 alphanumeric characters). Each channel of the PDR8000 can be configured to transmit a different Identifier (call sign).

The periodic interval between sending the ID signals is configurable. The configured interval is used across all channels of the PDR8000. This functionality is not available for Receive-only configurations.

6.2.9 MONITOR BEFORE DATA TRANSMIT

Configured on/off. This functionality is intended for use when connected via wireline to a data system. Data applications typically create bi-directional traffic. In many cases data is sent in one direction, and then an acknowledgement flows in the other direction. This means that both transmit and receive paths are needed to have effective data communications. If the Monitor Before Data Transmit option is enabled, then PDR8000 can assist the data system infrastructure by giving it information to help it decide when to send data transmissions. When this option is enabled, the PDR8000 monitors the receive frequency and notifies the data infrastructure about co-channel user activity. This allows the data system to pause data transmissions when other traffic exists on the channel, and to resume data transmissions when the other activity has ended.

If the Monitor Before Data Transmit option is not enabled, then PDR8000 does not provide this activity information to the data system infrastructure. The data system might then send out data successfully, but be unable to receive the corresponding acknowledgements due to other activity on the channel. This results in data retries, and overall poor performance for data transmissions.

6.3 RF FREQUENCY BANDS

PDR8000 supports RF communications on VHF, UHF, 700 MHz and 800 MHz bands, as summarized below:

- VHF: 136 - 174 MHz
- UHF: 380 - 430 MHz
- UHF: 450 - 470 MHz
- 700 MHz[2]:
    - Tx: 768 - 775 MHz
    - Rx: 798 - 805 MHz, and 768 - 775 MHz to monitor direct subscriber-to-subscriber activity
- 800 MHz[2]:
    - Tx: 851 - 869 MHz
    - Rx: 806 - 824 MHz, and 851 - 869 MHz to monitor direct subscriber-to-subscriber activity

---

[2] Not available in Rackmount PDR8000

There is a different model of PDR8000 for each of the above RF frequency bands. A specific order code is available for each.

6.4 WIRELINE INTERFACES

PDR8000 provides two wireline interface options

- V.24 supporting Motorola's AIS protocol
- Ethernet supporting Digital Fixed Station Interface (DFSI) Protocol version 1

6.4.1 V.24 WIRELINE INTERFACE

PDR8000 is equipped with a V.24 wireline interface allowing it to optionally be connected to other Futurecom & Motorola equipment supporting Motorola's AIS protocol over V.24. Connections may be to another PDR8000 or Motorola station to support an RT/RT configuration (see 3.2), or to a system infrastructure including consoles, data interface, and/or a voting comparator (see 3.1, 3.4). Depending on the distance between the devices being connected, external V.24 MODEMs (not provided) may be required. Installations requiring a link distance of 50 feet or less generally do not require MODEMs.

Futurecom has tested several MODEMs with the PDR8000 product:

- Raymar-Telenetics V.3600 SA Modems
- Paradyne 325
- Motorola UDS V.3225
- Motorola Codex 3260 Fast Data Modem

Visual indications reflecting activity on the V.24 wireline interface are visible via the PDR8000's status LEDs (see 6.10).

The V.24 wireline interface is optional functionality of the PDR8000. Deployment Profiles created that utilize the V.24 interface are allowed to contain only digital/P25 channels. Deployment Profiles that do not use the V.24 interface (i.e., Deployment Profiles intended for use as a standalone repeater) can contain a mixture of P25, analog, and mixed-mode channels.

6.4.1.1 SITE/SUBSITE NUMBER, TEI (TERMINAL ENDPOINT IDENTIFIER)

When there are many pieces of equipment connected via V.24 interfaces, it is allowable for common infrastructure signaling information/messages to be delivered to many infrastructure endpoints, even when it is desired for only some of the endpoints to act on the message (commands, data, or audio). To allow for selective addressing/processing of the infrastructure signaling, an intended target address (TEI: Terminal Endpoint Identifier) is identified in the messaging. TEI values are 6 bits long and are examined by each receiving entity to determine whether the message should be processed by that entity. All 6-bit values of TEI are valid. Most values target a specific device, but two values have special meaning:

TEI = %000000 = $00 (Null Address)
TEI = %111111 = $3F (Broadcast Address)

When a PDR8000 receives an infrastructure message on the V.24 wireline interface, it processes the message if the message's TEI is set to the "Broadcast" value or to the TEI/Site configured into the PDR8000. If a message is received by PDR8000 that is directed to any other TEI, the message is ignored.

Subsite/TEI addressing has many different uses and is most commonly utilized in voting systems (where this value is used as a Subsite identifier) and data systems. PDR8000 applies TEI addressing techniques to filter all incoming AIS messages received on the V.24 wireline interface.

When a PDR8000 sends an infrastructure message on the V.24 wireline interface, it always inserts the TEI/Site value that is configured into the PDR8000.

6.4.1.2 V.24 TRANSMIT CLOCK SYNCHRONIZATION

The V.24 wireline interface on PDR8000 is a synchronous interface. One end of the connection provides a clock signal that is used to allow the link to remain operable.

In some scenarios a PDR8000 is configured to use an internally generated clock. This is typically done when the PDR8000 is connected to a local device (e.g., DIU or comparator). However, other situations exist requiring the PDR8000 to sync up to the clock of the other connected device. This is the typical configuration when connected to a remote device (e.g., microwave link).

In some cases, such as the RT/RT configuration where PDR8000s are connected back-to-back (see 3.2), one station is configured to use its internal clock, and the other is configured to use an external clock, that of the other connected station.

6.4.2 ETHERNET WIRELINE INTERFACE

The PDR8000 provides Ethernet interface option which utilizes Digital Fixed Station Interface (DFSI) to connect the PDR8000 to the Morotola ASTRO Systems and other devices and systems which support the DFSI as per the standard defined in TIA Standard TIA-102.BAHA-A titled "Project 25 Fixed Station Interface Messages and Procedures" published in June 2017.

This interface allows users to rapidly deploy PDR8000s as stations on an IP based network and connect to a Conventional Fixed Station Host (CSFH). These types of deployments are ideal for:

- **Natural Disasters** – Hurricanes, Tornadoes, Earthquakes, Floods
- **Dignitary Protection** – Diplomatic Security, Heads of State, Military Leadership
- **Special Events** – Political Conventions, Sporting Events, Parades
- **In-Building Coverage** – Hotels, Arenas, Convention Centers
- **Interoperability** – Federal, State & Local Agencies
- **Rapid Deployment** - Military bases, Border control, National Guards, Incident Management

PDR8000 may be directly connected to any console supporting DFSI Protocol Version 1, for example Motorola's AVTEC Scout Console. Connection to Motorola's ASTRO Core can be made via a gateway device.

Visual indications reflecting activity on the Ethernet wireline interface are visible via the PDR8000's status LEDs (see 6.10).

The Ethernet/DFSI wireline interface is optional functionality of the PDR8000. Deployment Profiles created that utilize the DFSI interface are allowed to contain a mixture of P25, analog, and mixed-mode channels.

6.4.2.1 DFSI FEATURES

The following list describes the features supported by PDR8000 when connected to a host which supports DFSI (Digital Fixed Station Interface) Protocol version 1.

- IP based interface between a station and a Conventional Fixed Station Host (CFSH)
- Transport of clear audio between a station and its host providing capabilities for full-duplex, half-duplex and simplex communications at the discretion of the station
- Transport of encrypted audio between a digital station and its host
- Control signaling between a station and its host to provide a simple "Push-to-talk" (or begin and end voice transmit/receive signals)
- Control signaling from a host to a station to provide a variety of control functions including channel control, squelch control and monitor control
- Caller-ID information between a digital station and its host. This includes Unit ID from field units to consoles, and "Console ID" from consoles to field units
- Talk-group information between a digital station and its host
- NAC code information between a digital station and its host
- Emergency Alert messages from the digital station to its host
- Emergency indications along with the voice stream between the digital station and its host
- Advanced Control of the station by its host including the disabling of all squelch (monitor function)

6.5 FALLBACK IN-CABINET REPEAT

In configurations where a PDR8000 is not normally repeating CAI received information back through its CAI transmitter (e.g., in a full-duplex Base configuration, or in Repeater configuration after console has issued a Repeater Knockdown command), the PDR8000 can be configured to temporarily activate its Repeat functionality in certain failure conditions. This ability is provided to handle cases where the Repeat functionality normally provided by the system is curtailed due to an unexpected event. If the PDR8000 gets disconnected from the comparator or console, the PDR8000 can temporarily activate its own Fall Back In-Cabinet Repeat functionality to allow subscriber-to-subscriber communications to continue.

Fallback In-Cabinet Repeat is configurable to be automatically triggered by different events. A PDR8000 can be configured to automatically begin Fallback In-Cabinet Repeat if the wireline

link goes down. If desired/configured Fallback In-Cabinet Repeat can also be triggered by detecting a lack of audio repeat activity (by an external entity) on the wireline link, based on expiration of a configurable timer. (For instance, if received RF audio is sent to the wireline, and no observed repeat of audio is received on the wireline for a configurable time, Fall Back In-Cabinet repeat behavior can be activated.) In these cases, Fallback In-Cabinet Repeat functionality is automatically curtailed when the link is restored (and if so configured, when repeated audio is once again detected on the wireline interface).

6.6 SQUELCH AND CHANNEL ACCESS

As PDR8000 monitors the receive frequency of its actively selected channel, it continuously evaluates the signal being received in terms of several different attributes, including signal strength, signal quality, and content. Based on whether the received signal passes the provisioned acceptance criteria, the PDR8000 determines whether the received signal should be accepted and processed (and thus repeated over-the-air and/or to the wireline connection). This ensures that the PDR8000 only passes along traffic of sufficient quality and intended for the correct listeners.

In addition, PDR8000 can be configured to add certain access-control information to its transmitted signals, to allow receiving units to decide whether that signal is intended for their reception.

A variety of configuration parameters are available to tailor this behavior to achieve the desired functionality. This operation, and the corresponding configuration parameters are explained below. Note that the Squelch operation for Analog and Digital channels are found below in 6.6.1 and 6.6.2. For a mixed-mode channel, both sections apply.

6.6.1 ANALOG SIGNAL SQUELCH & ACCESS OPERATION

When evaluating an analog radio signal, PDR8000 can be configured to process the received signal based on the Signal Strength (RSSI), Signal Quality (SINAD Equivalent) or both. The determination of which of these criteria should be used is configured on a per-channel basis.

The RSSI threshold level[3] can be set independently for each channel. If RSSI has been configured as a receive criteria for a channel, then a common setting (across the active Deployment Profile) is used to determine the measurement integration time (speed) and hysteresis value for RSSI un-detect.

If Signal Quality is configured as a relevant receive criteria, the SINAD Equivalent On and Off threshold values can be set independently for each channel. A common setting (across the active Deployment Profile) is used to determine the measurement integration time (speed) for this measurement.

Once PDR8000 determines that the received signal has passed the configured Signal Strength and/or Signal Quality criteria, it next evaluates the signal contents to determine whether it should further process the signal. This content analysis is based on configuration of whether the

---

[3] RSSI Threshold levels correspond to the level at the PDR8000 antenna port. PDR8000 attempts to compensate for configured Duplexer Losses but is limited to the maximum receiver sensitivity.

PDR8000 should be additionally dependent on receiving sub-audible signaling on the analog carrier. This signaling commonly takes the form of CTCSS (Continuous Tone-Coded Squelch System; aka Motorola PL) or DCS (Digitally Coded Squelch: aka Motorola DPL). Sophisticated configuration capability exists to set up the PL/DPL criteria using Access Code Tables (see sections below).

When PDR8000 transmits an analog RF signal, it can be configured to include sub-audible signaling (PL/DPL) to control which subscriber units receive/process the call. This is also configured through the Access Code Tables explained below.

PDR8000 supports both PL and DPL on a given channel. Configuration parameters drive the operation governed by these squelch/access methods.

6.6.1.1 MULTI-CODED SQUELCH (PL/DPL)

Multi-Coded Squelch is a feature commonly used in analog radio operation. Operation is driven by the addition of a sub-audible tone on the RF carrier in addition to the voice payload. When an RF signal is received, the receiver checks for presence of PL/DPL, and modifies its behavior based upon detection of the decoded PL/DPL tones. In most cases, the receiving radio will choose to either unsquelch, or mute the incoming signal based on the presence of the detected PL/DPL.

PDR8000 allows each of its analog-enabled channels to be configured with a desired behavior for utilizing PLs/DPLs. These behaviors are captured in Access Code Tables. Each configured channel in the PDR8000 can point to one of the configured analog Access Code tables. Each table can be used to define PL/DPL operation for a specific channel or may capture behavior shared by multiple channels.

Within each analog Access Code Table, exists a Multi-PL/DPL table defining the PL/DPL values used to govern squelch operation on the configured channel. The table consists of 14 rows, having an Rx Squelch, a corresponding Tx Squelch, as well as parameters to control Squelch Tail Elimination. In most cases, the table is configured for **Normal** operation, allowing only the first row of the table to be used (see 6.6.1.2). If, however, the table is configured for **Multi-PL/DPL** operation (see 6.6.1.3) then all 14 rows are available for use (each row can then be individually enabled/disabled as desired.)

Rx PL Operation	Normal / Multi-PL/DPL

Row Enabled	Rx Squelch Tail Elimination (STE)	Rx Squelch Code	Tx Squelch Code	Tx Squelch Tail Elimination (STE)
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 1	Tx Code 1	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 2	Tx Code 2	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 3	Tx Code 3	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 4	Tx Code 4	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 5	Tx Code 5	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 6	Tx Code 6	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 7	Tx Code 7	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 8	Tx Code 8	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 9	Tx Code 9	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 10	Tx Code 10	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 11	Tx Code 11	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 12	Tx Code 12	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 13	Tx Code 13	Off / DPL / -135 / +135 / 180
Y/N	Off / DPL / -135 / +135 / 180	Rx Code 14	Tx Code 14	Off / DPL / -135 / +135 / 180

Table 4: Analog Access Code Table

PL and DPL codes are predefined in a common way, to allow use across radios manufactured by multiple vendors. The Rx and Tx squelch code entries in the table can be set to a defined PL Code, a defined DPL Code, or set to OFF (Carrier Squelch operation).

Squelch Tail Elimination is a method used to prevent the receiving radio from hearing a brief noise (squelch tail) at the end of each transmission. By having the transmitter provide a phase-shifted signal (for PL), or a specific tone (for DPL), the receiver can quickly detect the end of the transmitted signal and mute the unwanted noise. When PL is used, Tx STE and Rx STE can be set to Off, -135° phase shift, +135° phase shift, or -180° phase shift. When DPL is used, Tx STE and Rx STE can be set to either Off or DPL (enabled).

6.6.1.2 MULTI-CODED SQUELCH: NORMAL (MULTI-PL/DPL NOT ENABLED)

If the active PDR8000 channel is configured to use an Access Code Table for **Normal** PL/DPL operation, then the first row of the PL/DPL table is enabled. That row defines the Tx and Rx behavior associated with all traffic on the channel.

The PDR8000 only processes analog signals received over the air with PL or DPL that is equal to the Rx PL/DPL code entry found in the first row of the table. In the first row, if the Rx Squelch Code is set to OFF (Carrier Squelch), then all received signals on that channel that meet the Signal Strength and/or Signal Quality criteria (see 6.6.1) defined for this channel are processed by the PDR8000 (i.e. no PL/DPL filtering is done). Received signals not meeting the strength/quality criteria are ignored. At the end of a received signal, PDR8000 can be configured to quickly mute by recognizing a PL/DPL STE (Squelch Tail Elimination) indication sent by the transmitting subscriber unit. PDR8000's Rx STE should be set to match the Tx STE sent by the subscriber units.

When the PDR8000 sends a transmission, it encodes Tx Squelch Code configured in the first row of the Access Code table. At the end of the transmission, PDR can be configured to send a configured (STE: Squelch Tail Elimination) signal to help receiving radios quickly mute at the

end of the transmission. The configuration for PDR8000's Tx STE should be set to match the Rx STE expected by the subscriber units.

6.6.1.3 MULTI-CODED SQUELCH: MULTI-PL/DPL

If the active PDR8000 channel is configured to use an Access Code Table configured for **Multi-PL/DPL** operation, then the PDR8000 utilizes the full table to define filtering and translation. The PDR8000 only processes analog signals received over the air with PL or DPL that is equal to any of the Rx PL/DPL code entries found in any enabled row of the table. At the end of a received signal, PDR8000 can be configured to quickly mute by recognizing a PL/DPL STE (Squelch Tail Elimination) indication sent by the transmitting subscriber unit. PDR8000's Rx STE in that row of the table should be set to match the Tx STE sent by the subscriber units.

When the PDR8000 repeats an over-the-air analog transmission it encodes the Tx PL/DPL found in the same table row as the received signal's Rx PL/DPL. At the end of the transmission, PDR can be configured to send a configured (STE: Squelch Tail Elimination) signal to help receiving radios quickly mute at the end of the transmission. The configuration for Tx STE should be set to match the Rx STE expected by the subscriber units.

6.6.2 DIGITAL SIGNAL SQUELCH & ACCESS OPERATION

When evaluating a digital/P25 radio signal, PDR8000 is configured to process the received signal based on having the Received Signal Strength (RSSI) surpass a configured threshold.

The RSSI threshold level[4] can be set independently for each channel. A common setting (across all channels in the active Deployment Profile) is used to determine the RSSI measurement integration time (speed) and hysteresis value for RSSI un-detect.

Once PDR8000 determines that the received signal has met the configured Signal Strength criteria, it next evaluates the signal content to determine whether it should further process the signal. This content analysis is based on configuration of whether the PDR8000 should be additionally dependent on receiving specific access codes in the digital bitstream. This signaling comes in the form of a P25 NAC (Network Access Code). Sophisticated configuration capability exists to set up the NAC criteria using Access Code Tables (see sections below).

When PDR8000 transmits a digital RF/CAI signal, it is configured to include a Network Access Code to control which subscriber units receive/process the call. This is also configured through the Access Code Tables explained below.

Note that another method also exists that may be used to selectively share/hide signals on P25 conventional channels to allow different user groups to cooperatively share an RF channel; this is the concept of Conventional Talkgroups (further discussed in 6.20).

---

[4] RSSI Threshold levels correspond to the level at the PDR8000 antenna port. PDR8000 attempts to compensate for Duplexer Losses but is limited to the maximum receiver sensitivity.

6.6.2.1 NETWORK ACCESS CODE (NAC)

The Network Access Code or NAC is a feature of Project 25 digital radios that operates similarly to PL/DPL codes for analog radios. NAC codes minimize co-channel interference and allow repeater addressing by keeping the receiver squelched unless a signal with a matching NAC arrives. NACs are programmed as a 3-digit hexadecimal code that is broadcast along with the digital signal (Voice, Data, or Supplementary Data) being transmitted.

Since the NAC is 3-digit hexadecimal number (12 bits), it gives 4096 possible NACs for programming.

Three of these NACs have special meaning:

$293 - the default NAC

$F7E - Receiver Monitor; a receiver set for this NAC will unsquelch on any NAC received

$F7F - Community Repeater; a repeater receiver set for this NAC will allow all incoming signals to be repeated with the NAC intact.

PDR8000 allows each of its digital-enabled channels to be configured with a desired behavior for utilizing NACs. These behaviors are captured in Access Code Tables. Each configured channel in the PDR8000 can point to one of the configured Access Code Tables. Each Access Code Table can be used to define NAC operation for a specific channel or may capture behavior shared by multiple channels.

Within each digital Access Code Table, exists a Multi-NAC table defining the particular NAC values used to govern squelch operation on the configured channel. The table consists of 8 rows, having an Rx NAC and corresponding Tx NAC value (each value 0-$FFF). In most cases, only one row of values is used. If the configured operation is for Multi-NAC (see Table 5) then all 8 rows are available for use (each row can be enabled/disabled for use during configuration.)

Rx NAC Operation	Normal / Rcvr Monitor / Community Rptr / Multi-NAC
Tx Last Rcvd NAC	Enabled / Disabled
Tx Last Rcvd NAC Duration	Time (minutes)

Rx NAC	Tx NAC
Rx NAC 1	Tx NAC 1
Rx NAC 2	Tx NAC 2
Rx NAC 3	Tx NAC 3
Rx NAC 4	Tx NAC 4
Rx NAC 5	Tx NAC 5
Rx NAC 6	Tx NAC 6
Rx NAC 7	Tx NAC 7
Rx NAC 8	Tx NAC 8

Table 5: Digital Access Code Table

Within each digital Access Code Table is a setting for the **Rx NAC Operation** mode to be utilized by channels pointing to this table. The four modes of Rx NAC Operation are:

- Normal
- Receiver Monitor
- Community Repeater
- Multi NAC

6.6.2.1.1   Rx NAC Operation: Normal

If the active PDR8000 channel is programmed for Rx NAC Operation of **Normal** then the PDR8000 only processes messages received over the air with Rx NAC that is equal to the PDR8000's configured Rx NAC found in the first enabled row of the Multi-NAC table. (Packets received with other NAC values are ignored.) When the PDR8000 sends a transmission, it typically uses Tx NAC found in the first enabled row of the Multi-NAC table. Console-originated transmissions initiated via DFSI may either provide the specific Tx NAC to be used as part of the transmission information, or the console may defer to the PDR8000's configured Tx NAC by specifying a Tx NAC of $F7E.

Note that in many radio systems, no degree of filtering based on NAC is desired. In these systems, the Tx NAC and Rx NAC codes are set to use the Default NAC ($293). In systems where there may be adjacent radio agencies on the same RF Frequency, it is suggested that each agency utilize a different NAC code, to keep radios in the adjoining systems from unsquelching on unintended traffic.

6.6.2.1.2   Rx NAC Operation: Receiver Monitor

If the active PDR8000 channel is programmed for Rx NAC operation of **Receiver Monitor** then the PDR8000 receives <u>all</u> incoming transmissions (regardless of NAC embedded in the received packet). If this PDR8000 is configured as a Repeater, it retransmits using the Tx NAC found in the first enabled row of the Multi-NAC table. Any infrastructure-originated (e.g., console) calls are also sent with Tx NAC from the first enabled row of the Multi-NAC table. Console-originated transmissions initiated via DFSI may either provide the specific Tx NAC to be used as part of the transmission information, or the console may defer to the PDR8000's configured Tx NAC by specifying a Tx NAC of $F7E.

It may be desired that console-originated transmissions utilize the previously received NAC code, to allow a dispatcher to reply to the previous call. This functionality is provided if the channel is configured to **Tx Last Rcvd NAC**. For that configuration, for a configurable duration of time since the last received call, the PDR8000 sends outbound wireline-originated transmissions encoded with the NAC of the last received message. (A DFSI-connected console may utilize this functionality by specifying Tx NAC of $F7E, or may override this behavior by providing a specific Tx NAC as part of the transmission information.)

6.6.2.1.3   Rx NAC Operation: Community Repeater

If the active PDR8000 channel is programmed for Rx NAC operation of **Community Repeater** then the PDR8000 receives <u>all</u> incoming transmissions (regardless of NAC embedded in the received packet). If this PDR8000 is configured as a Repeater, it retransmits all messages with

the same NAC as that received. When the PDR8000 sends a transmission originating from the wireline interface, it is sent with Tx NAC from the first enabled row of the Multi-NAC table. Console-originated transmissions initiated via DFSI may either provide the specific Tx NAC to be used as part of the transmission information, or the console may defer to the PDR8000's configured Tx NAC by specifying a Tx NAC of $F7E.

It may be desired that console-originated transmissions utilize the previously received NAC code, to allow a dispatcher to reply to the previous call. This functionality is provided if the channel is configured to **Tx Last Rcvd NAC**. For that configuration, for a configurable duration of time since the last received call, the PDR8000 sends outbound wireline-originated transmissions encoded with the NAC of the last received message. (A DFSI-connected console may utilize this functionality by specifying Tx NAC of $F7E, or may override this behavior by providing a specific Tx NAC as part of the transmission information.)

6.6.2.1.4   RX NAC OPERATION: MULTI NAC

If the active PDR8000 channel is programmed for Rx NAC operation of **Multi NAC**, then the PDR8000 utilizes the full Multi-NAC table to allow filtering and translation. The PDR8000 only processes messages received over the air with Rx NAC that is equal to any of the RxNAC entries found in any enabled row of the Multi-NAC table. (Packets received with other NAC values are ignored.)

When the PDR8000 repeats an over-the-air transmission it uses Tx NAC found in the same row as the corresponding Rx NAC of the Multi-NAC table. When the PDR8000 sends a transmission originating from the wireline interface, it is sent with Tx NAC from the first enabled row of the Multi-NAC table. Console-originated transmissions initiated via DFSI may either provide the specific Tx NAC to be used as part of the transmission information, or the console may defer to the PDR8000's configured Tx NAC by specifying a Tx NAC of $F7E.

It may be desired that console-originated transmissions utilize the previously received NAC code, to allow a dispatcher to reply to the previous call. This functionality is provided if the channel is configured to **Tx Last Rcvd NAC**. For that configuration, for a configurable duration of time since the last received call, the PDR8000 sends outbound wireline-originated transmissions encoded with the NAC of the last received message. (A DFSI-connected console may utilize this functionality by specifying Tx NAC of $F7E, or may override this behavior by providing a specific Tx NAC as part of the transmission information.)

6.7 DATA SERVICES

PDR8000 is an infrastructure device capable of supporting Motorola's data services including GPS Location services, Text Messaging services, Encryption services, and subscriber Over-The-Air Rekeying (OTAR). While PDR8000 is not actively involved in these services, it allows the data services to pass through, providing needed end-to-end delivery through its bearer services.

When sending data originating from the infrastructure, a PDR8000 can be configured to send a certain duration of Idle packets after the last infrastructure-originated data message is sent. This configurable Wireline Data Drop-out Delay prevents rapid key/dekey sequences of the PDR8000 during a data session.

A PDR8000 can be configured to provide local repeat functionality for Packet Data services. This capability is useful in remote deployment scenarios where subscriber units need to pass data to each other without involvement of a data server/infrastructure (e.g., Fireground deployment).

Data Services are supported on V.24 wireline interface but not on DFSI over Ethernet wireline interface.

6.8 ADAPTIVE POWER CONTROL

A critical factor in the operation of portable radio units is the ability of their batteries to last for a full shift, or longer. While improvements in battery technology continue to be developed, there are also methods for the fixed-end equipment of a radio system to aid the portable unit in achieving battery savings.

The concept of Adaptive Power Control enables the PDR8000 (and other equipment it may be connected to, e.g., comparator) to evaluate the inbound signal received from subscriber units (namely BER and RSSI) and provide that information back to the sourcing subscriber unit at the end of its transmission. The subscriber unit uses this information to determine whether subsequent transmissions can be made at a reduced power level. This allows the subscriber unit to operate at full power when far from the repeater site, and at a reduced power level as it comes into a strong signal coverage area. By reducing the subscriber units transmit power when possible, battery savings are realized.

PDR8000 supports Motorola-specific digital signaling between itself and Motorola P25 subscriber units to enable this battery-saving capability. In the case of a wide area voting system, PDR8000 provides signal quality information to the voting comparator to enable this operation in the system.

6.9 SERVICE/CONFIGURATION SOFTWARE (FUTURECOM REPEATER CONFIGURATOR (FRC))

PDR8000 is supported using Futurecom's service/configuration software known as the Futurecom Repeater Configurator (FRC). This PC-based software application allows a technician to configure PDR8000 for different uses and provides diagnostic capabilities such as technician-viewable reports and logs.

Configuration aspects of the Futurecom Repeater Configurator (FRC) include setup of the various frequencies, access codes, timing values, and other operational parameters associated with PDR8000. See the PDR8000 Programming Guide for detailed information regarding configuration of the product.

Service aspects of the Futurecom Repeater Configurator (FRC) include the ability to monitor real-time aspects of PDR8000's operation on a PC screen. This is done by connecting a PC running the Futurecom Repeater Configurator (FRC) to the PDR8000's USB programming port during operation. The Futurecom Repeater Configurator's Monitoring Window can then be used to observe many operational aspects of the product, including aspects of the RF and wireline input/output signals. The Futurecom Repeater Configurator's service functions can also be used

to initiate various coverage tests by controlling PDR8000's ability to transmit various carrier, tone, or test patterns (see 6.11.1).

The Futurecom Repeater Configurator (FRC) software package is supported on Windows 10 and Windows 11.

6.10   STATUS INDICATION LEDS

To provide a very high-level visual indication of the PDR8000's status and health, a set of LED indicators is provided. One set of LEDs is inside the PDR8000 suitcase's open lid, or the Rackmount PDR8000's front panel, and the other indicator is on the PDR8000 suitcase's side panel (adjacent to the external cable connections). The state of the LEDs (off, on, blinking slow, blinking fast) indicates the current state of the function being represented.

6.10.1 FRONT PANEL INDICATORS
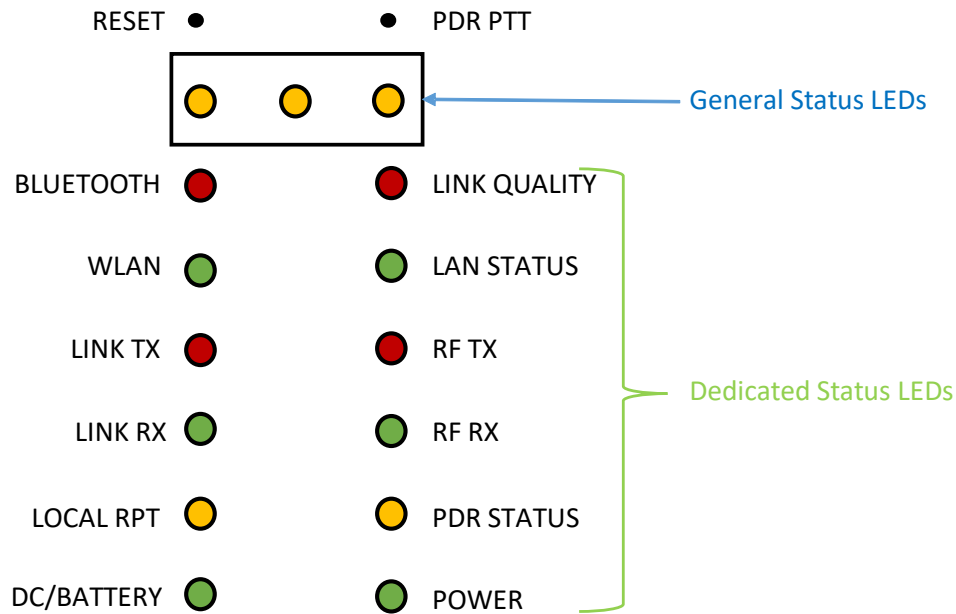
Figure 26: Front Panel LEDs and Switches

The front panel status LEDs fall into two categories:

- **Dedicated Status LEDs** These LEDs have permanent labels beside them indicating the represented PDR8000 functionality:
  - o BLUETOOTH: For future use
  - o WLAN: For future use
  - o LINK TX: Indicates status and activity on the Transmit Wireline (Ethernet or V.24) Interface
  - o LINK RX: Indicates status and activity on the Receive Wireline (Ethernet or V.24) Interface
  - o LOCAL RPT: Indicates whether PDR8000 is currently repeating due to initial configuration or received wireline command
  - o DC/BATTERY: Indicates whether DC Power is normal, above/below operational threshold, or approaching lower threshold (configurable indication thresholds)
  - o LINK QUALITY: Indicates the quality of the network (Ethernet or V.24 interface)
  - o LAN STATUS: For future use
  - o RF TX: Indicates Transmitter activity
  - o RF RX: Indicates Receiver activity
  - o PDR STATUS: Indicates whether PDR is operating normally, or whether a pending Warning or Error exists. Warnings and Errors are clearly captured in the Tech Log, accessible via the service software (Futurecom Repeater Configurator (FRC)).
  - o POWER: Indicates whether PDR is powered on

- **General Status LEDs** These LEDs use a combination of 3 LEDs (in on/off/blinking states) to expose more general states of the PDR8000. The states indicated include:
  - o Normal Operating State (no warnings or errors)
  - o Operating in Fallback In-Cabinet Repeat mode
  - o Operating in Service mode
  - o Operating in Test mode
  - o Internal software image error
  - o Low Transmit power (configurable threshold)
  - o Temperature alarm (RF Power Amplifier temperature; configurable threshold)
  - o Calendar/Time error (possible clock battery failure)

The combinations of on/off/blinking of the 3 General Status LEDs to indicate these states is described in detail in the PDR8000 Deployment Guide.

PDR8000 keeps an internal log of events that is viewable via the configuration/service software (Futurecom Repeater Configurator (FRC)). This log captures a large variety of notifications (Status, Errors and Warnings) for troubleshooting. Problem indications seen on the Status LEDs have more detailed information available in the log. The Futurecom Repeater Configurator (FRC) application is used to retrieve logs that are saved in the PDR8000 and can also monitor real-time activity of the PDR8000 while it is actively processing radio traffic.

6.10.2 SIDE PANEL INDICATOR (PDR8000 SUITCASE ONLY)

In addition to the LED indicators on PDR8000 suitcase front panel, a status indicator also exists on the PDR8000 side panel, near the unit's cable connectors. This indicator can be enabled or disabled via configuration in the Futurecom Repeater Configurator (FRC) application. The side-panel status indicator allows a high-level view of the PDR8000's operational status, which remains visible even when PDR8000 is operating case-closed. Some users prefer to disable this indicator to preserve "dark" operation in certain operational scenarios, but when the status indicator is enabled, it provides the following information:

- LED On Solid: PDR8000 is operating normally
- LED Slow Flash: PDR8000 is operating, but under an abnormal or warning condition. This includes operating in Fallback In-Cabinet Repeat when the wireline link has ceased communication. (See front panel LEDs, front panel display, or technicians log to gain further insight.)
- LED Fast Flash: PDR8000 is not functioning. A major error has occurred. (See front panel LEDs, front panel display, or technicians log to gain further insight.)
- LED Off: PDR8000 is powered down (or LED has been disabled via configuration)

The location of the Side Panel Indicator is illustrated in Figure 31.

6.11 LOCAL (FRONT PANEL) CONTROL

PDR8000 provides several different means of locally controlling its functionality using its front panel controls. These are useful for changing the operational mode of the PDR8000 to suit the situation at hand, or to initiate certain transmission/coverage tests.

6.11.1 LOCAL PTT TESTS

PDR8000 is equipped with a local PTT switch that can be used to help set up or test a field deployment. The PTT switch is accessed via a small opening (requiring insertion of an implement, to avoid accidental activation) on the PDR8000 front panel, just above the Status LEDs (see Figure 26). When activating this local transmit functionality, PDR8000 is configured as to whether it transmits just an RF carrier, or alternatively the signal transmitted is a 1 kHz test tone. (The test tone transmitted is a 1000 Hz tone on an analog channel, or the representation for a 1011 Hz P25 encoded tone on a digital or mixed-mode channel.)

It is also possible to initiate transmitter tests on PDR8000 via the Futurecom Repeater Configurator (FRC) application, which is running on a PC and connected to PDR8000's programming port. The Futurecom Repeater Configurator (FRC) can be used to begin and end the analog and digital test signals (carrier or tone) as described above, or instead can begin/end the transmission of a well-defined (V.52 / O.153) digital test pattern from PDR8000.

6.11.2 KEYPAD/DISPLAY

PDR8000 is equipped with an LCD display, providing a means to access and control several aspects of the unit. Access to various functions is available utilizing on-screen menus and set of navigation buttons.

The PDR8000's display menus can be configured for presentation in either English, French, or Spanish. Customer programmed labels (e.g., Channel Names) also support accented or international characters used in these languages.

Figure 27: Front Panel Keypad/Display

Functionality available through the Keypad/Display includes:

- View and select the active Channel (see 6.2)
- View and select the active Deployment Profile (see section 4)
- Adjust brightness (backlight) & contrast of the display & buttons
- Set Date / Time / Time zone / DST

- View Received Signal Strength (RSSI) value
- View Firmware version numbers (for reference & troubleshooting)
- View PDR8000 serial number
- View Wireline Link information and Status
    - o LINK Status (on/off)
    - o LINK Quality
    - o DFSI Parameters (IP Address, Ports etc.)

If the PDR8000 is used in a location allowing it to be physically accessed by people who are not desired to view/modify data via the keypad/display, a Keypad Lockout mechanism is available to restrict access. The PDR8000 can be configured with a keypad sequence that must be entered to unlock access to the keypad/display functions. If an access code has been configured, those trying to access the keypad/display menus are prompted to enter the access code before being granted access to the menus. This code is a sequence of up/down/left/right button depresses on the keypad and is configured via the (Futurecom Repeater Configurator (FRC)). The use of an access code is optional and may be configured as a sequence of 4-10 of key depresses, if desired by the administrator.

6.12   INPUT POWER OPTIONS AND INDICATIONS

PDR8000 suitcase and the Booster Pack can be run on 12VDC, 120VAC, or 220VAC (for detailed specifications External Battery Pack in Appendix B: References). An optional External Battery w/case is available for purchase (see 6.12.1).

If connected to both an AC and DC power source, PDR8000 Suitcase and/or the Booster Pack will switch between them in the event of an AC power failure, allowing uninterrupted battery backup operation.

Rackmount PDR8000 only runs on an external 12VDC power supply.

PDR8000 provides warnings when the supply voltage deviates from acceptable limits. This includes providing visual indications on the PDR8000 status LEDs (see 6.10). The thresholds used to drive high/low voltage warning indications are configurable.

6.12.1 OPTIONAL EXTERNAL BATTERY PACK

Figure 28: Optional External Battery Pack

The External Battery Pack enclosure contains batteries, a battery voltage indicator and a DC input/output connector. The Battery Pack can be used to supply DC power to a PDR8000 or Booster Pack where an AC supply is not available.

An AC to DC external battery charger is used to charge the internal batteries from an AC source.

The Battery Pack case is black and has dimensions of 245mm (9.65") x 280mm (11.0") x 175mm (6.9").

For detailed specifications of the External Battery Pack, including charging/discharging times, please consult External Battery Pack in Appendix B: References.

Figure 29: PDR8000 Closed Case

PDR8000 suitcase form factor is housed in a lightweight, injection molded, strong resin case manufactured by Pelican Products, Inc. The case is provided with two hasps for padlocks and is outfitted with a double-layered, soft-grip handle. External connections are accessed under a removable cover on the case's side.

Case dimensions are 488 mm (19.2") x 386 mm (15.2") x 185 mm (7.3"). Cases are available in black or yellow colors.

The Booster Pack is provided in the same cases available for PDR8000. (The same dimensions and colors apply.)

Figure 30: Booster Pack Closed Case

6.13　EXTERNAL PORTS - PDR8000 SUITCASE

PDR8000 connects to its external environment via several connection ports. These are located on the side and top (lid open) of the case. The external connection points are illustrated below.

Note that an LED Status indicator is included to indicate whether the PDR8000 is operating under normal/warning/error conditions. This indicator can be disabled via configuration in the Futurecom Repeater Configurator (FRC), as some users may want to operate in "dark mode" with no visible power/activity indicators.
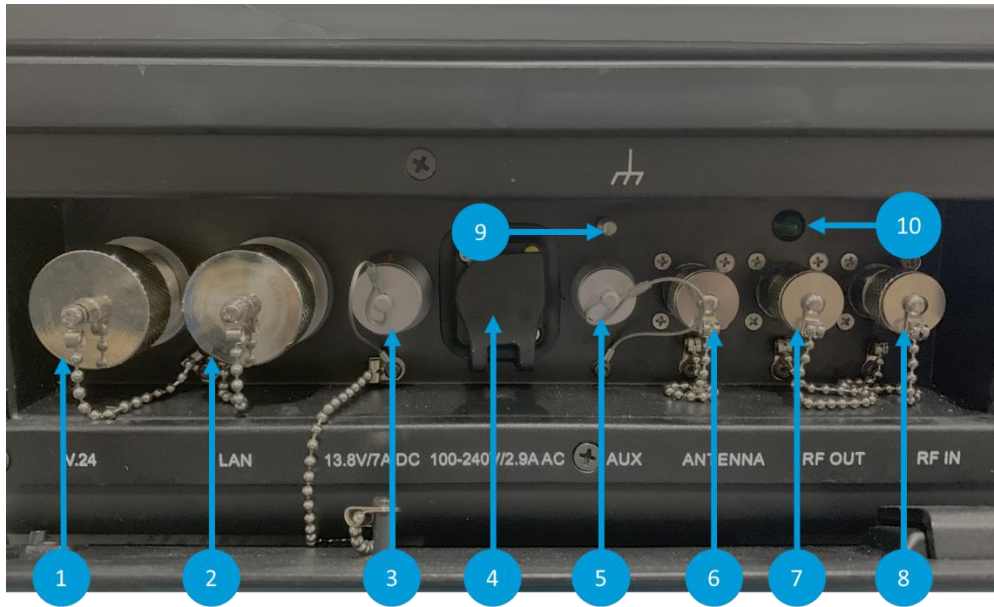
Figure 31: PDR8000 External Ports

Side Panel					
Connector	**Label**	**Type**	**Manufacturer**	**Model Ref***	**Open/Close Mechanism**
1	V.24	RJ-45	CONEC	17-111574	Screw/Unscrew Dust Cap
2**	LAN	RJ-45	CONEC	17-111574	Screw / Unscrew Dust Cap
3	13V/7A DC	DC Power Input	LEMO	EGL.2K.302. CLA	Push Pull Dust Cap
4	100-240V/4A AC	AC Power Input	NEUTRIK	NAC3MPX	Push Pull Sealing Cover
5	AUX	Circular Receptacle	LEMO	EGG.1K.308. CLL[5]	Push Pull Dust Cap
6	ANTENNA	N Female	N/A	N/A	Screw/Unscrew Dust Cap
7	RF OUT	N Female	N/A	N/A	Screw/Unscrew Dust Cap
8	RF IN	N Female	N/A	N/A	Screw/Unscrew Dust Cap
9		Ground Lug 10-32x12.7mm (0.5")	NA	N/A	N/A
10		Green LED Indicator	N/A	N/A	N/A

---

[5] Connector was EGG.1K.306.CLL on releases prior to PDR8000 Release 4

Front Panel (lid open)		
Label	Type	Open/Close Mechanism
USB	USB Type B	Screw/Unscrew Dust Cap

Table 6: PDR8000 External Ports

6.14   EXTERNAL PORTS - BOOSTER PACK

The Booster Pack also connects to its external environment via several connection ports. These are located on the side of the case. The external connection points on the Booster Pack are illustrated below.

Note that an LED "Power" indicator is included to indicate whether the Booster Pack is powered on. This indicator can be disabled via the adjacent switch, as some users may want to operate in "dark mode" with no visible power/activity indicators.

Figure 32: Booster Pack External Ports

Side Panel					
Connector	Label	Type	Manufacturer	Model Ref	Open/Close Mechanism
1	RF OUT	N Female	N/A	N/A	Screw/Unscrew Dust Cap
2	RF IN	N Female	N/A	N/A	Screw/Unscrew Dust Cap
3	AUX	Circular Receptacle	LEMO	EGG.1K.308. CLL	Push Pull Dust Cap
4	100-240V/4A AC	AC Power Input	NEUTRIK	NAC3MPX	Push Pull Sealing Cover
5	13V/7A DC	DC Power Input	LEMO	EGL.2K.302. CLA	Push Pull Dust Cap
6	⏚	Ground Lug 10-32x12.7mm (0.5")	N/A	N/A	N/A
7	POWER	LED Indicator	N/A	N/A	N/A
8	(no label) [LED enable/disable]	Toggle switch	N/A	N/A	N/A

Table 7: Booster Pack External Ports

6.15   OPEN/CLOSED CASE OPERATION (SUITCASE ONLY)

PDR8000 has been designed to support both open-case and closed-case operation. PDR8000 can operate at full temperature specs with case-closed at 50% transmit duty cycle, and with case-open at 100% transmit duty cycle.

The Booster Pack has also been designed to support both open-case and closed-case operation. Booster Pack can operate at its full temperature specs with case-closed at 50% transmit duty cycle, and with case-open at 100% transmit duty cycle.

When operating closed-case, the PDR8000 and/or Booster Pack should be standing on its hinged side, allowing the case to provide better cooling efficiency. When operating open-case (providing the best cooling capability), the PDR8000 or Booster Pack is to be placed flat on its large surface. Note that the PDR8000 and Booster Pack are not water resistant when operating open-case.

6.16   ZIPPERED ACCESSORY POUCH

The design of PDR8000 within its closed-case is optimized for maximum airflow and cooling capabilities. As such, it is not intended that accessories (cables, connectors, manuals, etc.) be stored inside the case. An optional Zippered Accessory Pouch is offered to allow more convenient storage and transport of items that may be needed to accompany a PDR8000 site

deployment. This zippered pouch is buckled around the exterior of the PDR8000 case and is easily removed during operation.

Figure 33: Zippered Accessory Pouch

6.17   RT/RT CONFIGURATION (V.24 INTERFACE ONLY)

The ability to connect a PDR8000 back-to-back with another repeater to allow cross-band or cross-frequency communication is explained in section 3.2. The PDR8000 must be configured to work in this mode (via the Futurecom Repeater Configurator (FRC)), because the PDR8000 must process different messaging on the V.24 interface between it and the connected station.

6.18   ANTENNA SWITCH

PDR8000 supports a variety of operational channel modes (simplex, half-duplex, full-duplex; see 5.3), and a variety of hardware configurations (internal duplexer, external duplexer, no duplexer; internal PA, external/Booster Pack PA; see section 2). It is important to have a degree of isolation (min. 80 dB) between the transmit and receive RF paths in each configuration, to avoid routing the PDR8000's transmitted signal back into the PDR8000 receiver. There are several different means of accomplishing this isolation:

- In a **full-duplex** configuration:
  - A common antenna is typically used for transmit and receive, in which case a duplexer is employed to provide the needed isolation between the Tx/Rx paths.
- In a **half-duplex** configuration:

- o If a common antenna is used for transmit and receive, then transmit/receive isolation must be provided by either a duplexer, or other circuitry that can break connection to the receive path during a transmission.
- o A standalone PDR8000 has internal circuitry used to isolate transmit and receive paths. When the external transmit Booster Pack is added, the PDR8000 also provides control for an antenna switch located in the Booster Pack to provide the needed isolation.
- o A configuration parameter is provided in the Futurecom Repeater Configurator (FRC) to control the operation of the Antennal Switches in PDR8000 and Booster Pack for half-duplex channels. Antenna Switch control logic should be set to Enabled for operation with a single-antenna and no duplexer and set to Disabled for operation with two antennas or a duplexer.
- In a **simplex** configuration:
  - o Simplex operation utilizes the same antenna for both transmit and receive operation.
  - o A standalone PDR8000 utilizes its internal circuitry to isolate transmit and receive paths. When the external transmit Booster Pack is added, the PDR8000 provides control for an antenna switch located in the Booster Pack that keeps the Booster amplifier in-line during a transmission but bypasses the Booster amplifier during receive.

PDR8000 has an external Auxiliary port, which provides a control mechanism between the PDR8000 and a Booster Pack, as needed for some of the scenarios explained above (see example hardware topologies in 2.1.3, 2.1.4 and 2.1.6).

6.19 ASTRO FADE TOLERANCE

When receiving a digital P25 RF signal, PDR8000 continuously determines whether an ongoing transmission is being received. The loss of a certain number of consecutive ASTRO superframes is treated like the end of a transmission. Due to environmental factors in the area surrounding the PDR8000 antenna, certain fade conditions may occur which cause the RF signal to temporarily drop out. PDR8000 has a configurable ASTRO Fade Tolerance configuration parameter to provide a means of setting sensitivity to lost packets before the PDR8000 assumes that a transmission has ended.

6.20 CONVENTIONAL TALKGROUP OPERATION

In some cases, multiple agencies or user groups may share a transmit/receive channel, and yet require the conversations from each group to be heard only by other members of that group. The P25 concept of Conventional Talkgroups allows this sharing of the physical channel and provides a level of group partitioning of the voice traffic. This is like the way that PL/DPL is sometimes used on analog conventional channels.

In addition, some consoles from Motorola Solutions also support the ability for a dispatcher to selectively activate/deactivate the Repeat functionality of a digital conventional channel on a per-talkgroup basis. So, if a channel is shared by two agencies, Agency A can control "Repeat Enable/Disable" functionality for the talkgroups being used by Agency A, and Agency B can

control the "Repeat Enable/Disable" functionality for talkgroups under control of Agency B. This provides a distinct ability for each agency to control the conversations on their respective work groups, without affecting the ability of the other groups to communicate with each other. The Motorola Solutions infrastructure can support up to 20 Conventional Talkgroups on a channel when providing console connectivity and talkgroup-based Repeat Enable/Disable control.

When a Digital Conventional Channel is configured to support Conventional Talkgroup operation in the Motorola Solutions system infrastructure, then this "per talkgroup" Repeat Enable/Disable operation is used instead of the operation that invokes Repeat Enable/Disable on the entire channel (previously introduced in 5.2.1). "Per talkgroup" repeat is only supported on V.24 wireline interface.

Support of multiple Conventional Talkgroups on a channel and per-talkgroup Repeat Enable/Disable is supported on Motorola Solutions ASTRO infrastructure releases 7.15 or later.

6.21 PURCHASABLE SOFTWARE OPTIONS

PDR8000 is an evolving product and is continually updated to provide more functionality and value. PDR8000 firmware, and the Futurecom Repeater Configurator (FRC) are available for download at Futurecom's web site (www.futurecom.com).

Certain capabilities of PDR8000 can be enabled by purchasing software options initially, or in the future as needs change (e.g., Wireline Interface and Deployment Profile Capability). Fielded units can activate these features after installing enablement keys provided by Futurecom. For information regarding activation of purchasable software options after initial product delivery please contact Futurecom.Sales@motorolasolutions.com .

6.22 CONFIGURATION SAFEGUARDING

There are many configuration aspects of the PDR8000 that are specific to a user's detailed system deployment. Information such as the repeater's channel frequencies, access codes (PL/DPL/NAC), and RF thresholds may be sensitive, and desired to be kept private by the owner. To facilitate this, each PDR8000 can be password-protected by its administrator. PDR8000 units are shipped without a password, but a password can be easily set within each PDR8000 using the Futurecom Repeater Configurator (FRC) application. Once a PDR8000 has a password set, its configuration data is protected, and can only be read from or written to the PDR8000 by someone having that unit's password.

If personality image backup or template files are created by the Futurecom Repeater Configurator (FRC) for a PDR8000, those files can be encrypted, and protected using a user-provided passphrase.

These methods allow PDR8000 configuration parameters to remain private, even when a unit is left unattended, or shipped for service.

PDR8000 also allows real-time modification of certain operating parameters through its keypad/display (e.g., channel selection). Access to view/modify these parameters via the keypad/display can be restricted by configuring a unit-specific access code. (See 6.11.2 for details.)

Appendices

7 APPENDIX A: REVISION HISTORY

Document Revisions

Revision	Date	Revision
1.0	2017-04-28	Initial Version
1.1	2017-05-17	
1.2	2017-06-05	
1.3	2017-06-08	
2.0	2017-08-08	Add Voting/Comparator operation
2.1	2017-08-28	Update Specification Summary
2.2	2017-09-19	Clarify "PTT Priority" description
2.3	2017-10-02	Add Newsletter Signup information
3.0	2018-03-02	Preliminary version for Release 3. Add Analog & Mixed-Mode Operation, Deployment Profile Capability, Display/Keypad User Interface and its operations
3.1	2018-07-25	Remove support of UHF 470 – 512 MHz. Add duplexer descriptions, backpack sling, configuration safeguarding.
3.2	2018-08-30	Update PDR8000 Safety Certification
4.0	2019-10-18	Add Booster Pack specifications, side-panel LED indicator, keypad lockout capability
5.0	2021-05-03	Updated DFSI features and Rackmount PDR8000
5.01	2022-09-20	Add FRC support of Windows 11
5.02	2022-10-31	Updated available suitcase colors Update description of Antenna Switches & Isolation
5.03	2022-12-07	Updated logo
5.04	2023-04-28	Clarify duplexer choices Replace specifications with references
5.05	2023-08-24	Replace Battery Pack specifications with reference Update Frequency Band specifications
5.06	2023-11-30	Describe Duplexer Loss settings and affect on Tx Power and Rx Sensitivity

8 APPENDIX B: REFERENCES

Data Sheets:

PDR8000 Suitcase & Booster Pack:

Futurecom Website → Support → Documentation and Software → PDR8000 Portable Digital Repeater → Datasheets – PDR8000 → Datasheets – PDR8000 - Suitcase

PDR8000 Rackmount

Futurecom Website → Support → Documentation and Software → PDR8000 Portable Digital Repeater → Datasheets – PDR8000 → Datasheets – PDR8000 - Rackmount

External Battery Pack

Futurecom Website → Support → Documentation and Software → PDR8000 Portable Digital Repeater → User Guide → PDR8000 Documentation – Battery Pack and Charger User Guide (Data sheet is within this document)

User Guides:

PDR8000 Programming Guide

Futurecom Website → Support → Documentation and Software → PDR8000 Portable Digital Repeater → User Guide → PDR8000 Documentation - PDR8000 Programming Guide

PDR8000 Deployment Guide

Futurecom Website → Support → Documentation and Software → PDR8000 Portable Digital Repeater → User Guide → PDR8000 Documentation - PDR8000 & Booster Pack Deployment Guide

Battery Pack and Charger User Guide

Futurecom Website → Support → Documentation and Software → PDR8000 Portable Digital Repeater → User Guide → PDR8000 Documentation – Battery Pack and Charger User Guide

Ordering Guides:

PDR8000 Suitcase & Booster Pack

Futurecom Website → Support → Documentation and Software → PDR8000 Portable Digital Repeater → Ordering Guide → Ordering Guide – PDR8000 Ordering Guide

PDR8000 Rackmount

Futurecom Website → Support → Documentation and Software → PDR8000 Portable Digital Repeater → Ordering Guide → Ordering Guide – PDR8000 Rackmount Ordering Guide