WIN*RoLL 136* System Manual

Wireless Intelligent Network Radio Local Loop 136

1 System Description

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1 Introduction

This chapter provides an overview of the **WIN*RoLL 136*™ (Wireless Intelligent Network Radio Local Loop)** digital communication system, and enables you to recognize and understand its components.

System Overview, page 1–2, gives an overview of the system and provides background information about digital wireless communications.

Hardware, page 1–15, describes the system's hardware components and explains how they work.

Optional Equipment, page 1–47, describes optional equipment for the WIN*RoLL 136*.

Specifications, page 1–52, lists relevant technical specifications.

2 System Overview

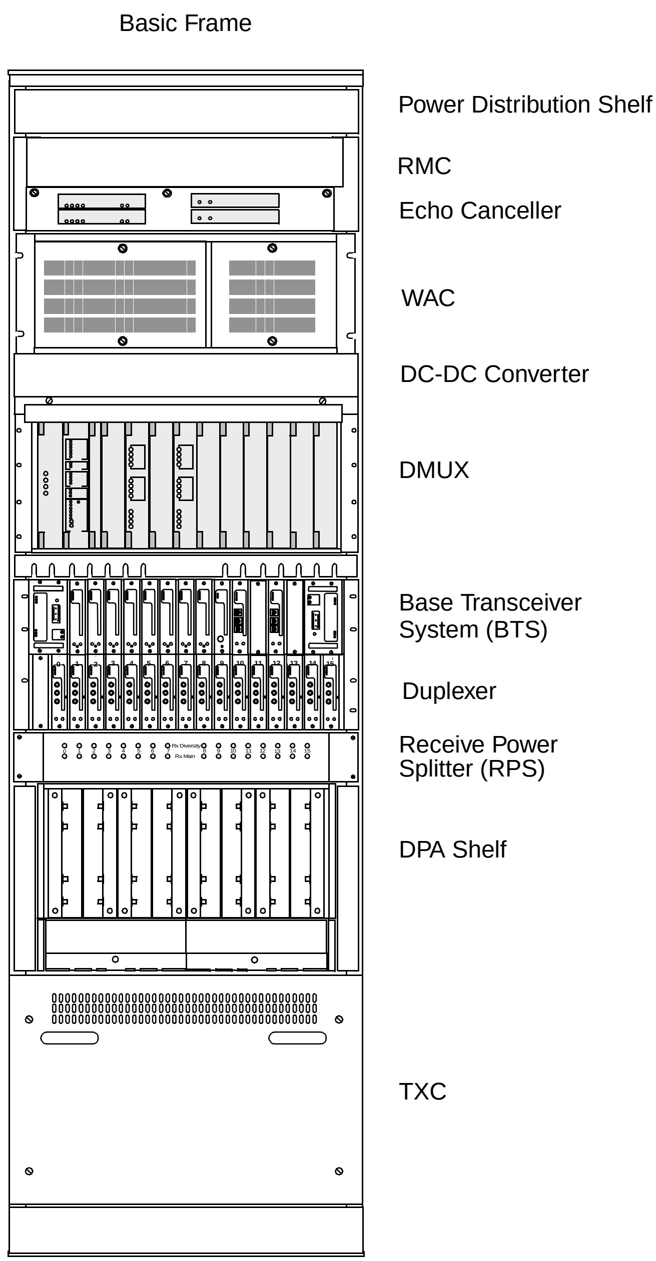
The WIN*RoLL 136* is a full-featured digital wireless local loop communications system. Some applications and features include:

- Public Telephone Service—A low-cost way to provide high-quality basic telephone service, replace existing facilities, or expand telephone services. The WIN*RoLL 136* connects to an existing PSTN with *digital* trunks.
- Private Wireless PBX—Private voice and data services can be set up using the WIN*RoLL 136* as the platform. For example, an oil or exploration company may require its own multi-site system to provide secure voice telephone service and data communications to its offices.
- Wireless Intelligent Network—System processors and services are distributed across a communication network. Because hardware and software are modular, the system is very flexible and can be customized to meet a service provider's specific needs.
- Wireless Exchange Services—Can be set up as a wireless digital exchange to provide data, facsimile, internet, and voice services. Data services up to 28.8 kbps (uncompressed) will be supported.
- Local Call Completion—Calls originating and terminating within the same service area can be routed locally within the WIN*RoLL 136*, instead of going through the PSTN. As a result, backhaul is reduced.
- Wired-line Service—Up to 96 local subscribers can obtain conventional wired service by connecting directly to the WIN*RoLL 136*. This feature enables service companies to provide economical wired telephone service to local subscribers, and it enables companies to set up their own private wired service.
- Centralized Operation and Administration—System operation, administration, and maintenance occur through a single (local or remote) operation centre called the RoLL Operations Centre (ROC).
- Multi-mode Operation—Supports both new digital (IS-136) and existing analog (EAMPS) terminals, as well as a variety of subscriber equipment.
- Increased efficiency and capacity—Up to three digital traffic channels are available per wireless channel. Up to 48 digital channels are available.

WIN*RoLL 136* offers a high degree of flexibility, low cost per subscriber, low cost of maintenance, and fast installation. Each WIN*RoLL 136* serves up to 4800 subscribers.

A basic 48-channel digital system is contained in a single primary frame. Figure 1–1 shows the basic frame.

Figure 1–1 WIN*RoLL 136* Basic Frame



Note: The ROC is not shown.

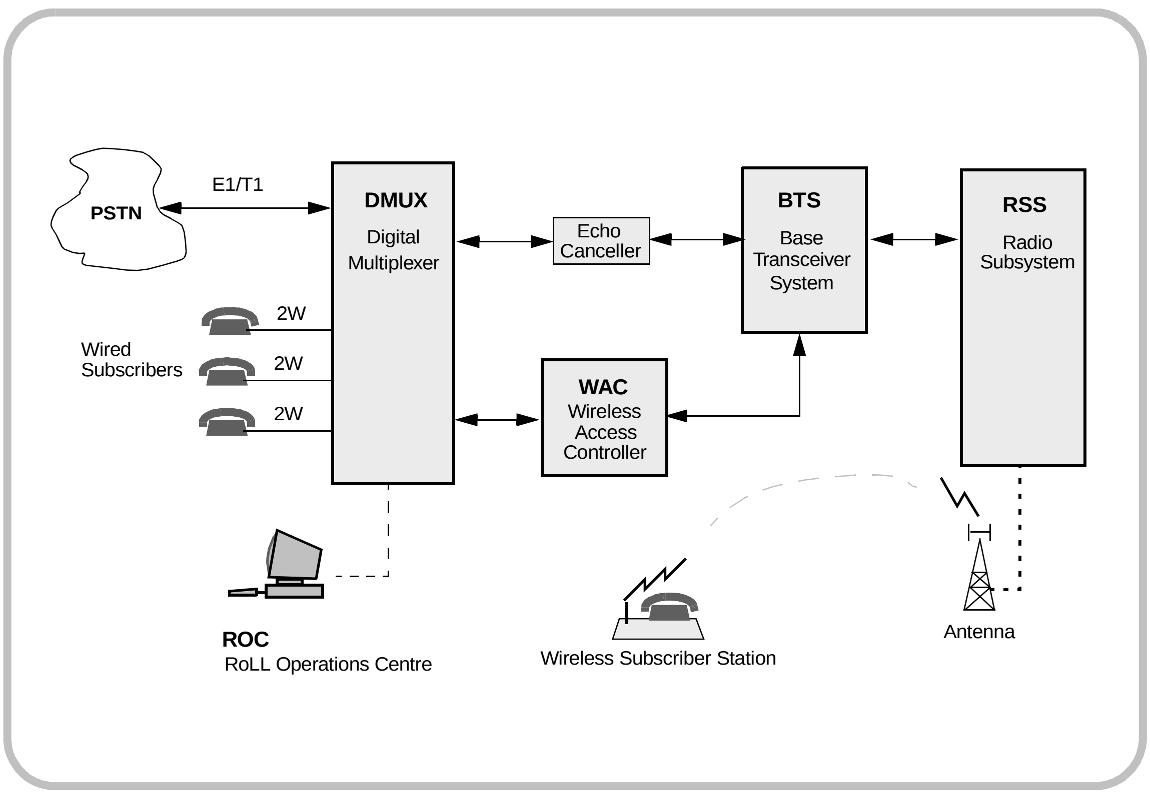
2.1 Hardware Subsystems

The WIN*RoLL 136* consists of five hardware subsystems and other equipment, shown in Figure 1–2:

- the *RoLL Operations Centre* (ROC)
- the *Wireless Access Controller* (WAC)
- the *Digital Multiplexer* (DMUX)
- the *Base Transceiver System* (BTS)
- the *Radio SubSystem* (RSS)
- *Other Equipment* (for example, echo canceller).

Hardware, page 1–15 describes each subsystem in detail.

Figure 1–2 WIN*RoLL 136* Subsystems



RoLL Operations Centre (ROC)

The ROC is the system's operation and administration centre. It is a Pentium™ graphics workstation with ROC*Pilot*™ application software, and has the following features:

- provides the Graphical User Interface (GUI) to operate and manage the system
- is the control centre for one or more WIN*RoLL 136* sites
- enables the operator to configure equipment, administer subscribers, download software, perform database backups, monitor operations, and analyze performance
- provides a remote terminal link to the WAC through the DMUX.

Wireless Access Controller (WAC)

The WAC is the *system control* centre of the WIN*RoLL 136*. It performs real-time call processing, manages DMUX switch matrix connections, and controls the BTS. The WAC contains the subscriber databases and digit translation tables; the WAC also handles call authentication, encryption (along with the BTS), and alarms.

Digital Multiplexer (DMUX)

The DMUX is the voice circuit transfer between the local telephone network trunks and the WIN*RoLL 136*. It links the WIN*RoLL 136* to the external communications network via digital E1/T1 trunks, or 2-wire loopstart trunks, and *cross-connects (multiplexes)* information between trunks and radio transceivers. A digital link (E1) connects the DMUX to the BTS.

Base Transceiver System (BTS)

The BTS translates wired-based messages into radio messages. It contains the transceivers and vocoders. Each transceiver supports one RF carrier, which can be used as a single analog channel, or as three full-rate digital channels. Vocoders convert voice into efficient data codes so that lower data rates can be transmitted on a wireless channel. The BTS also supports message encryption, diversity receive processing, and DPA control. BTS operation is controlled by the WAC.

Radio Subsystem (RSS)

The RSS consists of the following components:

- Receiver Multicoupler (RMC)—filters, amplifies, and distributes RF signals *received* from the antenna.
- Receive Power Splitter (RPS)—redistributes receive signals to the BTS radios (transceivers).
- Digital Power Amplifiers (DPAs)—amplify the power of the *transmitted* signal from the BTS transceivers to a level suitable for on-air transmission.
- Transmitter Combiner (TXC)—filters and combines the outputs from the DPAs into a single transmit output that goes to the antenna.
- Duplexer—isolates the transmit signal from the receive signal, making it possible to use a single antenna for both receiving and transmitting.

Other Equipment

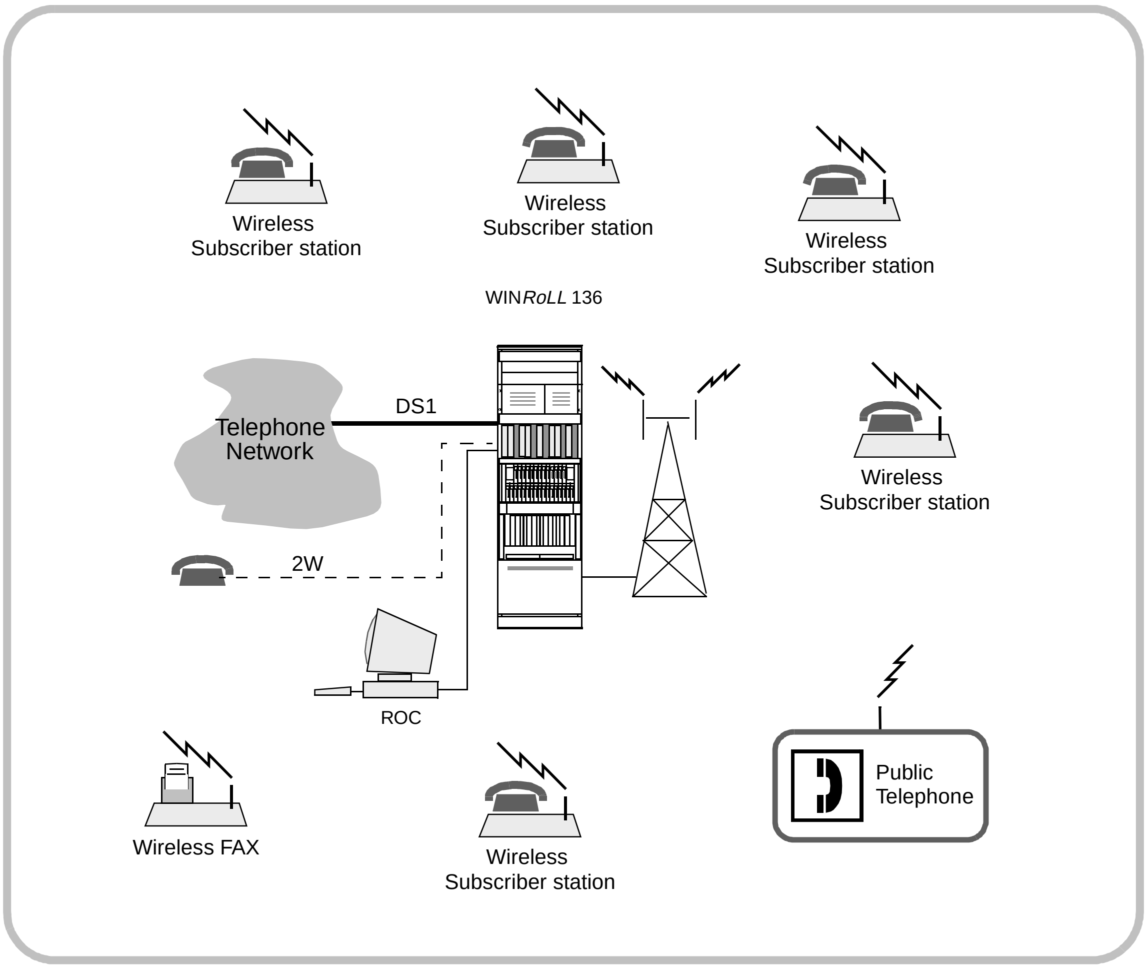
Other equipment includes:

- Power Distribution Shelf—distributes +27 Vdc (from the power plant) to the components in a frame, and provides circuit breaker protection for the components.
- Echo Canceller—minimizes echo on transmission lines caused by end-to-end propagation delays, signal processing delays, and impedance mismatches in telephone circuits.
- Power Plant (optional)—is the +27 Vdc power source for the system. AC voltage is converted to DC voltage and distributed to the frames through each frame's power distribution shelf. Power plants can be purchased from Harris, or provided by the customer (non-Harris power plants must meet Harris specifications). The power plant may have a battery backup.
- DC–DC converter—supplies power (–48 Vdc) to the DMUX and echo canceller.
- Antennas—must meet Harris specifications. The WIN*RoLL 136* primary frame requires a main (transmit/receive) antenna, and a diversity (receive) antenna.
- Wireless Subscriber Stations—are the human interface to the WIN*RoLL 136* (for example, microphone, speaker, display, and keyboard), and can function as an interface for other types of terminal equipment such as personal computers or facsimile machines. Subscriber stations can be digital (IS-136), or analog (EAMPS or IS-54), and may have special capabilities such as the ability to receive point-to-point short messages. Some subscriber stations have fixed locations, while others allow limited movement within the service area (portable radio phones with limited mobility are *not* considered to be mobile phones).

2.2 System Architecture

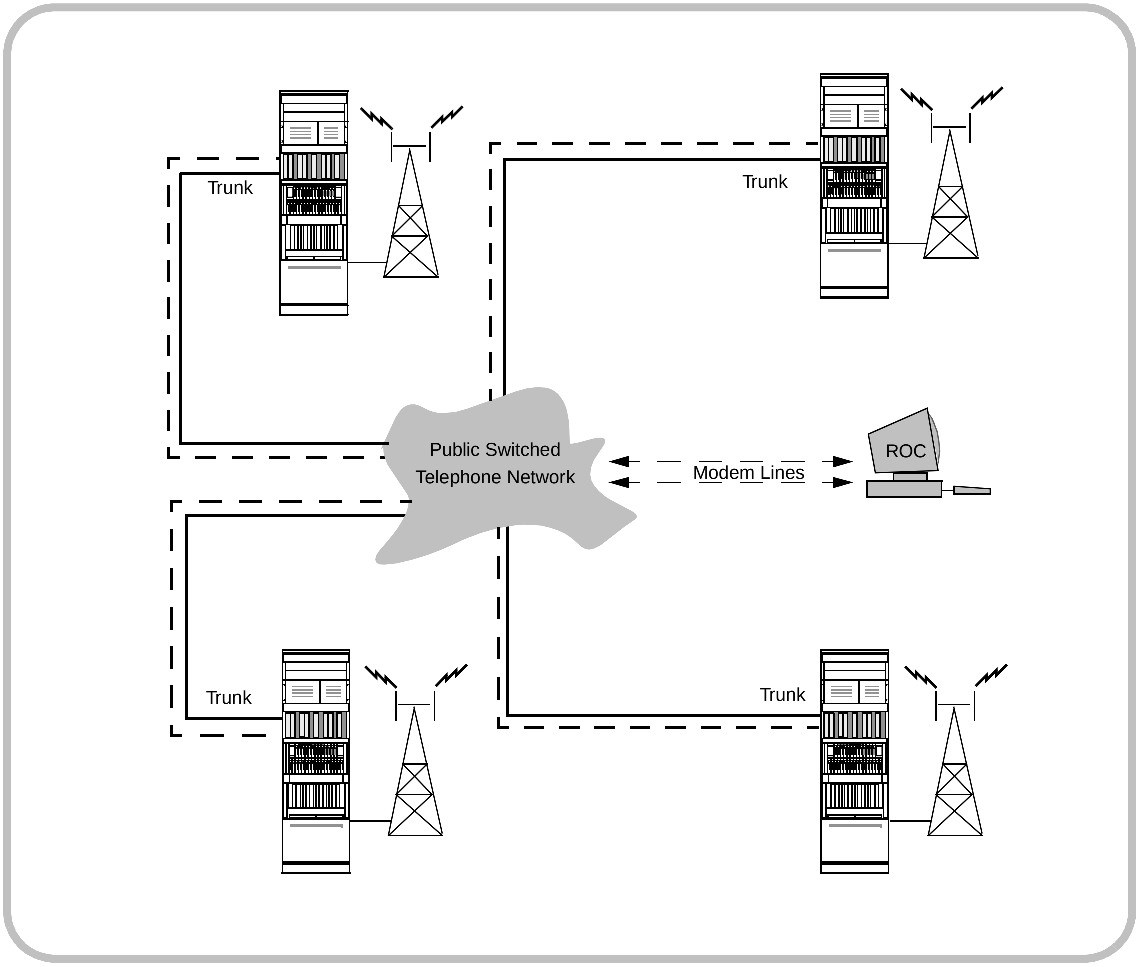
The WIN*RoLL 136* connects to a telephone network via one or more digital trunks. Figure 1–3 shows a basic system, which supports a variety of subscriber stations. (If the system is private, the WIN*RoLL 136* can simply be connected to another WIN*RoLL 136* system).

Figure 1–3 WIN*RoLL 136* System



The ROC controls single or multiple WIN*RoLL 136* systems via modem(s)—see Figure 1–4. A standard ROC with four modems can support four sites simultaneously, or up to 32 WIN*RoLL 136* sites with polled communication.

Figure 1–4   ROC with Multiple Sites



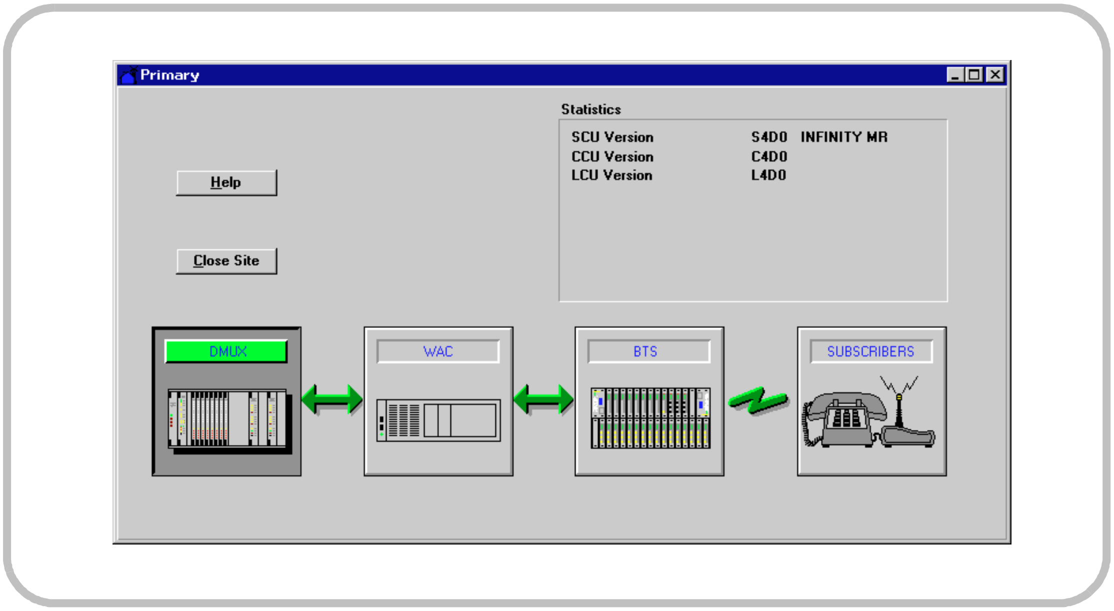
2.3   WINRoLL 136 Expansion

A basic WIN*RoLL 136* consists of a primary frame with a capacity of 16 analog or 48 digital channels. To add more channels, you add transceivers–each additional transceiver provides one more analog channel or three digital channels–and you may also have to add other components such as vocoders, DPAs, and TXCs.

2.4 User Interface

You use the ROC and ROC*Pilot* application software to perform operations, management, and administrative tasks. To perform most tasks, you simply click on an icon, menu, or button. Figure 1–5 shows a sample screen.

Figure 1–5   ROC*Pilot* Site Menu



Typical tasks performed with ROC*Pilot* application software include:

- adding, modifying, or removing subscribers
- configuring and maintaining equipment, such as taking individual transceivers in and out of service
- modifying system parameters
- shutting down and restarting the system
- transferring files or downloading software
- collecting information about system performance
- generating reports.

See *Introduction*, page 5–5 for further details.

2.5 IS-136 Overview

Digital wireless communication is based on IS-136 communication standards. The following section provides a brief overview of IS-136.

Note: IS-136 covers a large number of features. Not all features are available with the WIN*RoLL 136*—some features are under development, and some features are outside the scope of this product.

IS-136 is a communication standard based on TDMA (Time Division Multiple Access). TDMA increases the capacity of a wireless channel by dividing the channel into time slots. Subscriber stations, when transmitting, fill the time slots with tiny packets of information that are transmitted in a strict order. Multiple subscribers share the same frequency band by accessing the TDMA channel in non-overlapping time intervals. See Figure 1–6.

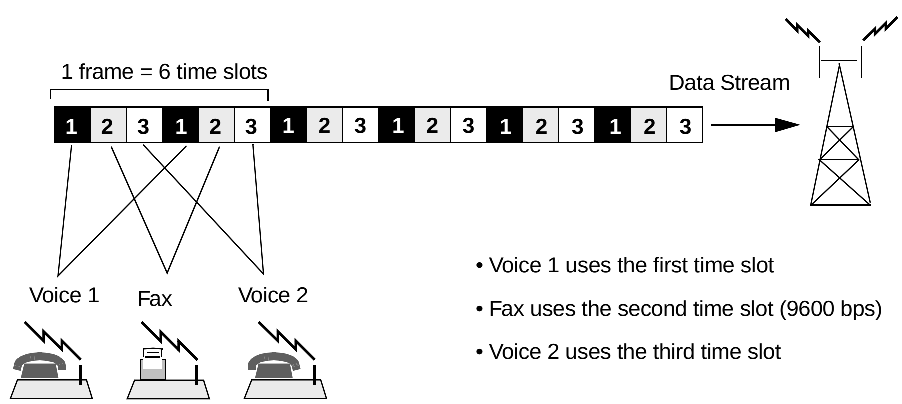
The BTS takes up to three conversations from the telephone network, digitizes them, and transmits them to subscriber stations over a single conventional wireless channel.

Figure 1–6 Time Division Concept

Transmit: A complex encoding and synchronization scheme that converts and compresses the voice signal to 1s and 0s. The digitized speech is inserted into frames and transmitted over-the-air in groups.

Receive: A complex process reconstructs the data stream into a signal that simulates the original voice.

The BTS adapts the data from “air” data to “internal” PCM data.



- Voice 1 uses the first time slot
- Fax uses the second time slot (9600 bps)
- Voice 2 uses the third time slot

2.6 Channels

Digital wireless systems have Digital Traffic Channels (DTCs) and a Digital Control Channel (DCCH). DTCs carry voice or data between a subscriber station and the BTS, along with a small amount of signalling data needed to process in-call events (such as disconnect, answer, and flash request). DCCHs use a complicated, layered protocol to assign traffic channels and manage calls. In an analog system, one transceiver (one wireless channel) is dedicated to control functions only. In a digital system, the control channel does not require a dedicated radio—it requires only two time slots in a TDMA frame. A special bit pattern identifies these control channel time slots.

If the system is operated in dual mode (digital and analog mode at the same time), at least one transceiver functions as the analog control channel, and at least one transceiver operates in digital mode, with digital channel #1 assigned as a DCCH and digital channels #2 and #3 assigned as traffic channels.

The digital control channel is the heart of IS-136 communications. The control channel can support a number of features:

- Short messaging service enables a subscriber to receive short messages of text.
- Traffic channels that normally use two out of six slots (full-rate) may use only one slot (half-rate)—for data applications, up to six slots can be assigned to a single user.
- Private systems (e.g., wireless PBX) with permanently assigned frequencies and low-power transmission are supported.
- Groups of subscriber stations can be paged by their group identification number, and short messages can be broadcast to them.
- Encryption of the control channel protects against fraud, tracking, eavesdropping, and identification of phone users.
- Subscriber stations can have both an International Mobile Station Identification (IMSI) number, and a MIN for subscriber station identification.

Note: For information about the availability of these features, please contact a Harris sales representative.

The DMUX cross-connects trunks to ports call-by-call, and passes voice and control information to and from the BTS. The BTS sets up and completes calls to and from subscriber stations.

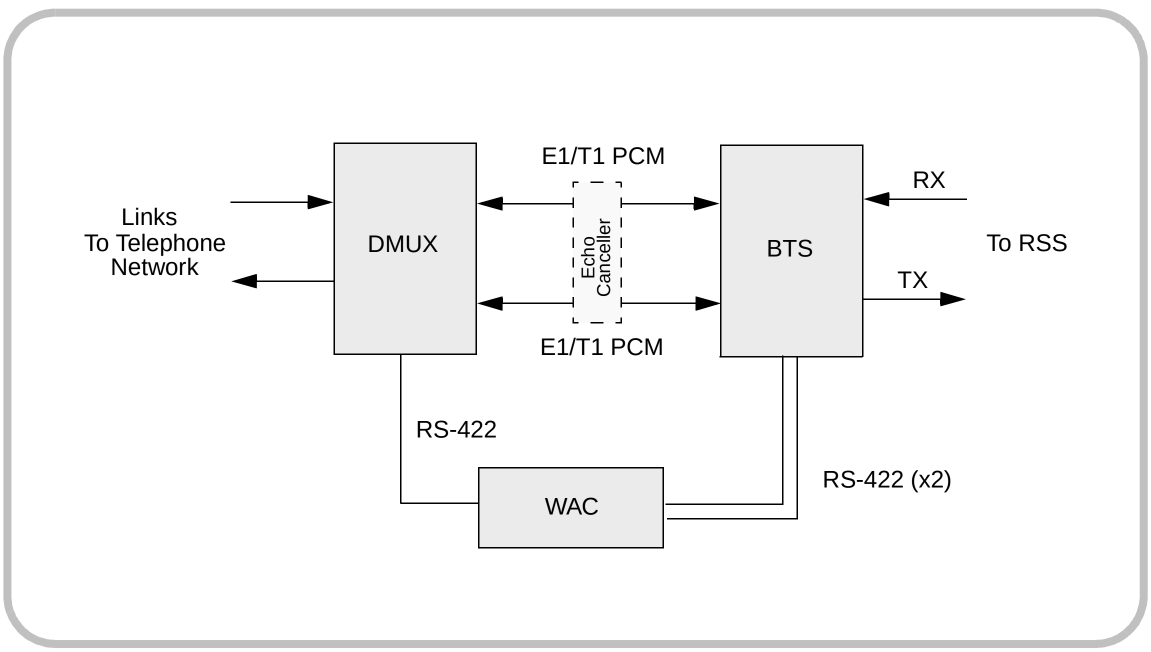
2.7 WINRoLL 136 Internal Links

IS-136 standards are followed up to the BTS, at which point the “air” data stream is converted to a Pulse Coded Modulation (PCM) data stream. E1 (2.048 Mbps) or T1 (1.554 Mbps) trunks route most internal voice and data information. RS-422 lines enable the WAC to control the DMUX and BTS—see Figure 1–7.

The main *internal* links are:

- *WAC-to-BTS*—the DMUX connects to the WAC with dual RS-422 data links.
- *DMUX-to-BTS*—E1 trunks connect the DMUX to the BTS through the echo canceller. Voice, data, and signalling information travel through these trunks.
- *WAC-to-DMUX*—a single RS-422 link enables the WAC to control the DMUX.
- *BTS-to-RSS*—RF lines connect the BTS to the radio equipment. Each BTS contains up to 16 transceivers, which support up to 48 full-rate digital channels.

Figure 1–7 Internal Links



2.8 Call Processing

When an *analog* subscriber station originates a call, the ACC in the BTS passes the request to the WAC. The WAC checks the subscriber, and if the subscriber passes the authentication process, the WAC assigns an unused BTS transceiver as an AVC. At the same time, the WAC sends a message over the control channel to the subscriber station, assigning the voice channel. The subscriber station moves to the assigned voice channel and monitors the Supervisory Audio Tone (SAT). If the SAT is correct, the subscriber station enters conversation mode. The AVC checks the transponded SAT from the subscriber station, and if it matches the transmitted SAT, the voice channel enters conversation mode. The audio link is now established between the BTS and the subscriber. The audio path continues from the E1/T1 interface to the DMUX to the telephone network.

When a *digital* subscriber station originates a call, the subscriber station locks onto the DCCH to obtain the system parameters. If the subscriber passes the authentication process, the WAC assigns an unused digital time slot as the DTC, and indicates to the subscriber station which channel to use. The subscriber station moves to the DTC, decodes the received digital message, and sends the message back to the WAC. The subscriber station synchronizes itself with the DTC, enables the vocoder, and enters conversation state. The BTS checks the received message from the station. If it matches the original message, the DTC routes the received voice through the vocoder, processes the voice, and establishes the audio path between the BTS and the subscriber station.

When *paging*, the WAC can send messages to subscriber stations using either a DCCH or ACC, depending on the mode of the subscriber station. If it receives a response from the station, the WAC configures an unused transceiver to either a DTC or AVC, and tells the station which channel to use. Once the subscriber station appears on the channel, the WAC sends an alert command and alerts the user with a ring tone. When the user answers the call, the audio link is established.

When a call is terminated, the WAC frees up the channel by deactivating it. The DTC or AVC is then ready for a new call. Channels are rotated by last used, next idle to maximize equipment life.

2.9 External Links

Two kinds of digital (PCM) trunks can be used to connect the WIN*RoLL 136* to the telephone network: E1 2.048 Mbps (CEPT), or T1 1.544 Mbps. E1 trunks have 30 voice circuits, and T1 trunks have 24 voice circuits. E1 trunks can be used in 120 ohm (50-pin, D connector) or 75 ohm (BNC) configurations.

Digital trunks can be configured in several ways, depending on the number of channels, level of call blocking, and type of trunk.

Up to 96 wired phone subscribers can connect directly to the WIN*RoLL 136*. The total number of wired phone subscribers depends on the equipment configuration.

3 Hardware

This section describes the main hardware components of the WIN*RoLL 136*, as shown in Figure 1–8 (the ROC is not shown, but is one of the main components). A block diagram of a basic WIN*RoLL 136* system is provided in Figure 1–9.

Figure 1–8 WIN*RoLL 136* Components

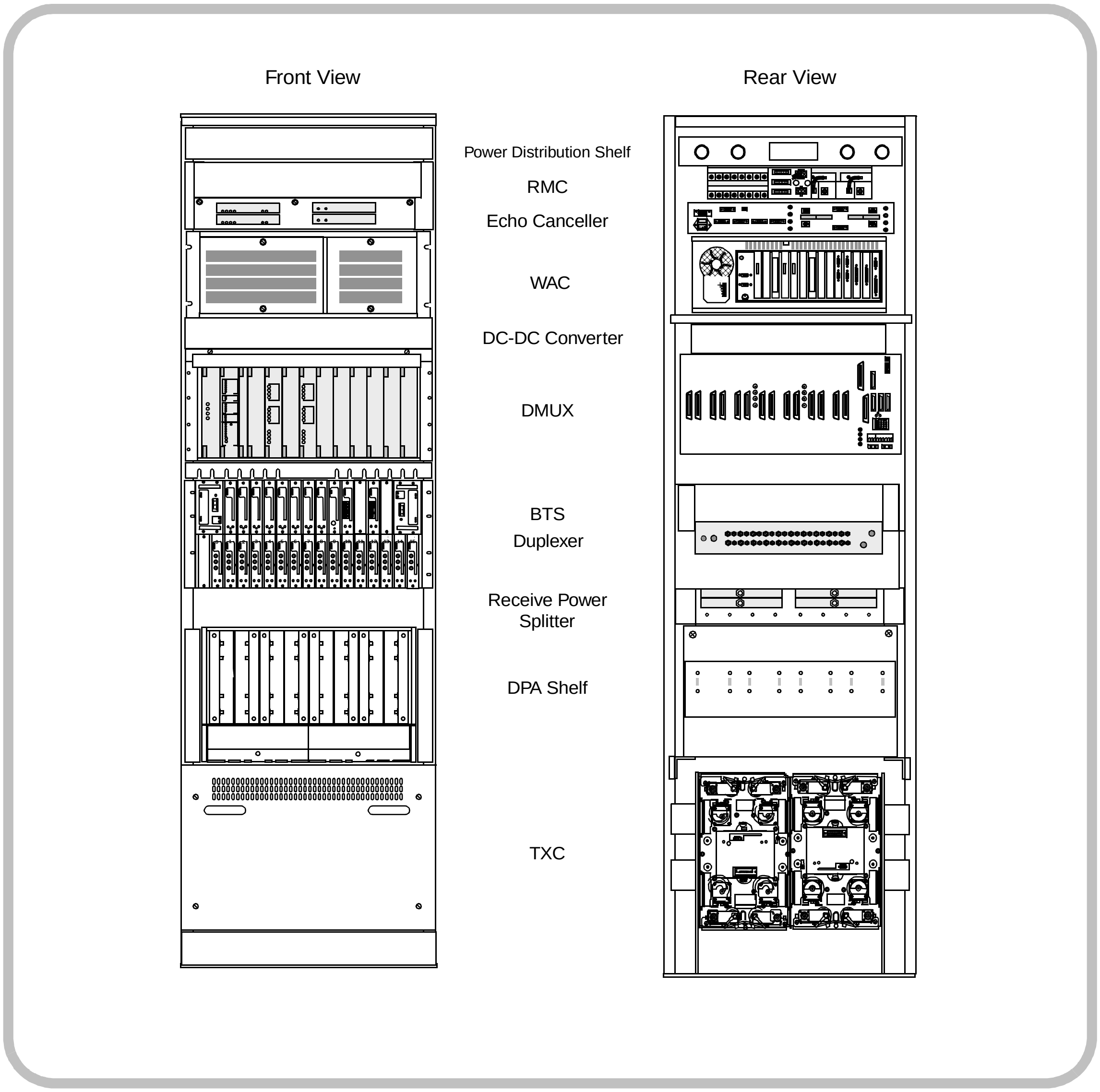
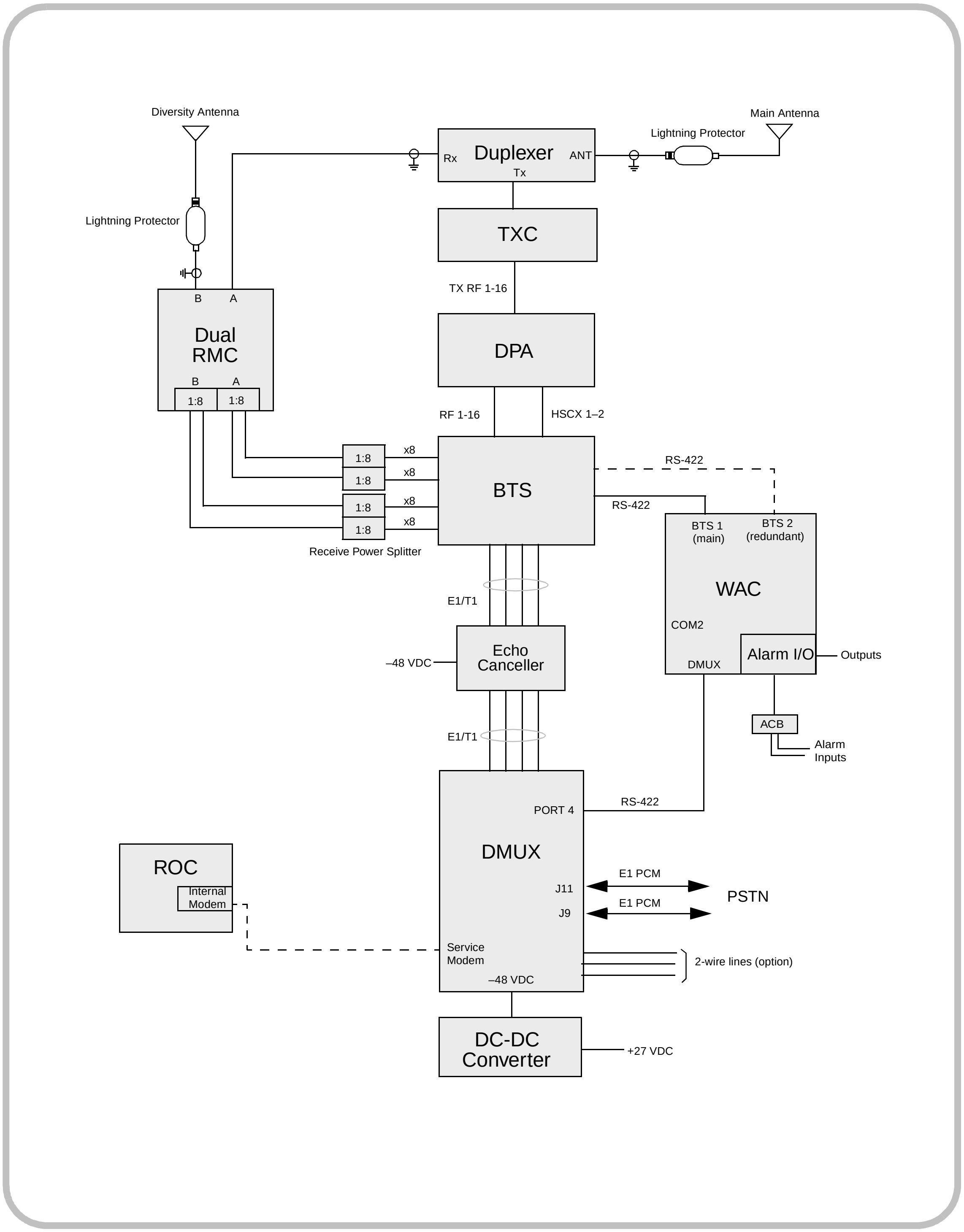


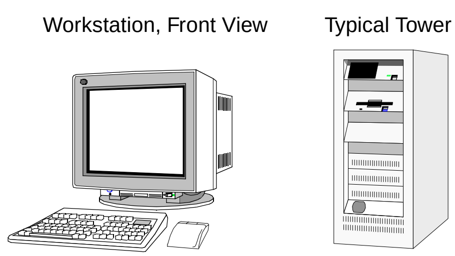
Figure 1–9 WIN*RoLL 136* Basic Block Diagram



3.1 RoLL Operations Centre (ROC)

The ROC provides the user interface to operate and manage the WIN*RoLL 136*. The ROC is a standalone graphics workstation with ROC*Pilot* application software—see Figure 1–10. The software features an intuitive Windows™-based graphical user interface. The ROC connects to the DMUX via a modem and telephone facilities.

Figure 1–10 ROC Hardware



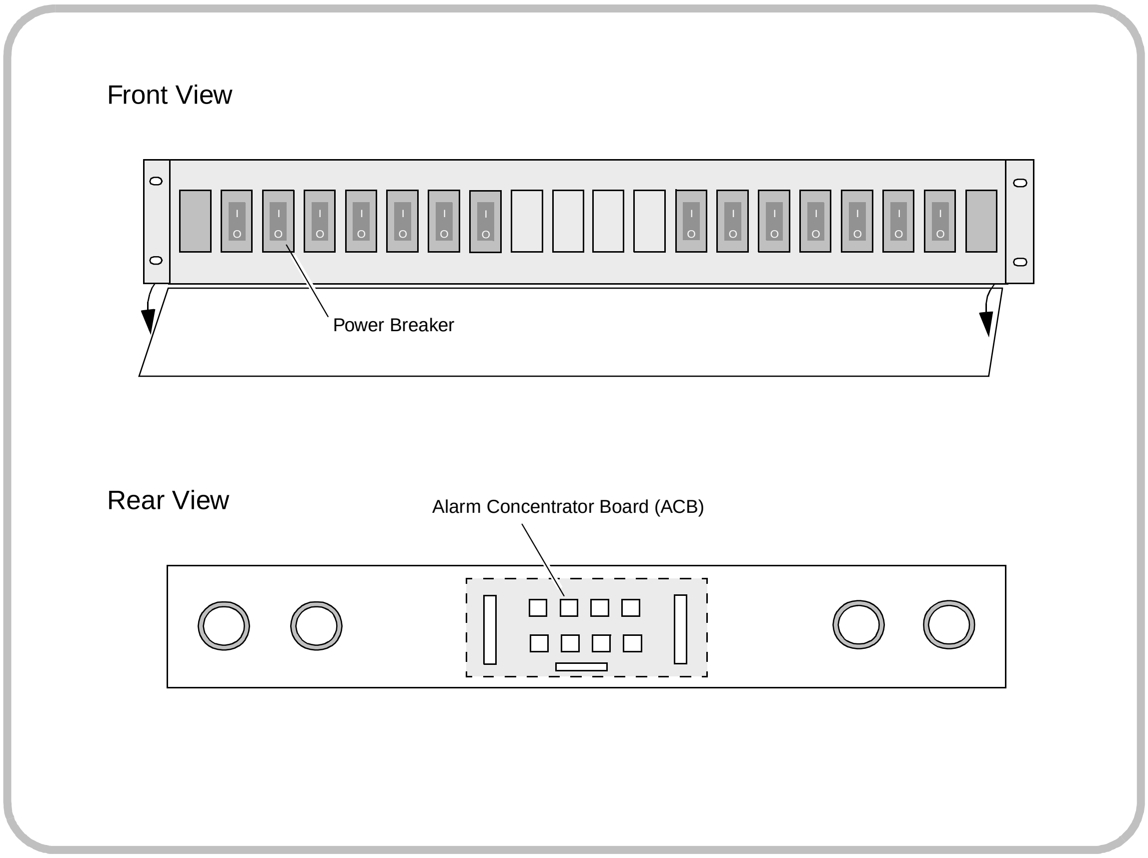
The ROC can support four site sessions simultaneously, if equipped with four internal modems. It can support up to 32 sessions by polling (based on no greater than 20 minutes between polling periods for alarm and operations measurement collection, and no greater than two minutes for each poll's servicing time). Other functions of the ROC include:

- alarm, log, trace, and maintenance information
- performance analysis and status reports
- DMUX, WAC, and BTS configuration
- subscriber administration and feature activation/deactivation
- software upgrades.

3.2 Power Distribution Shelf

The power distribution shelf (PDS) distributes DC power from the power plant to components in the frame—see Figure 1–11. The alarm concentrator board acts as a connection point for alarm cables. Alarm status signals go to the alarm control modules located in the WAC. The WAC records alarms in a log file and sends alarm messages to the ROC.

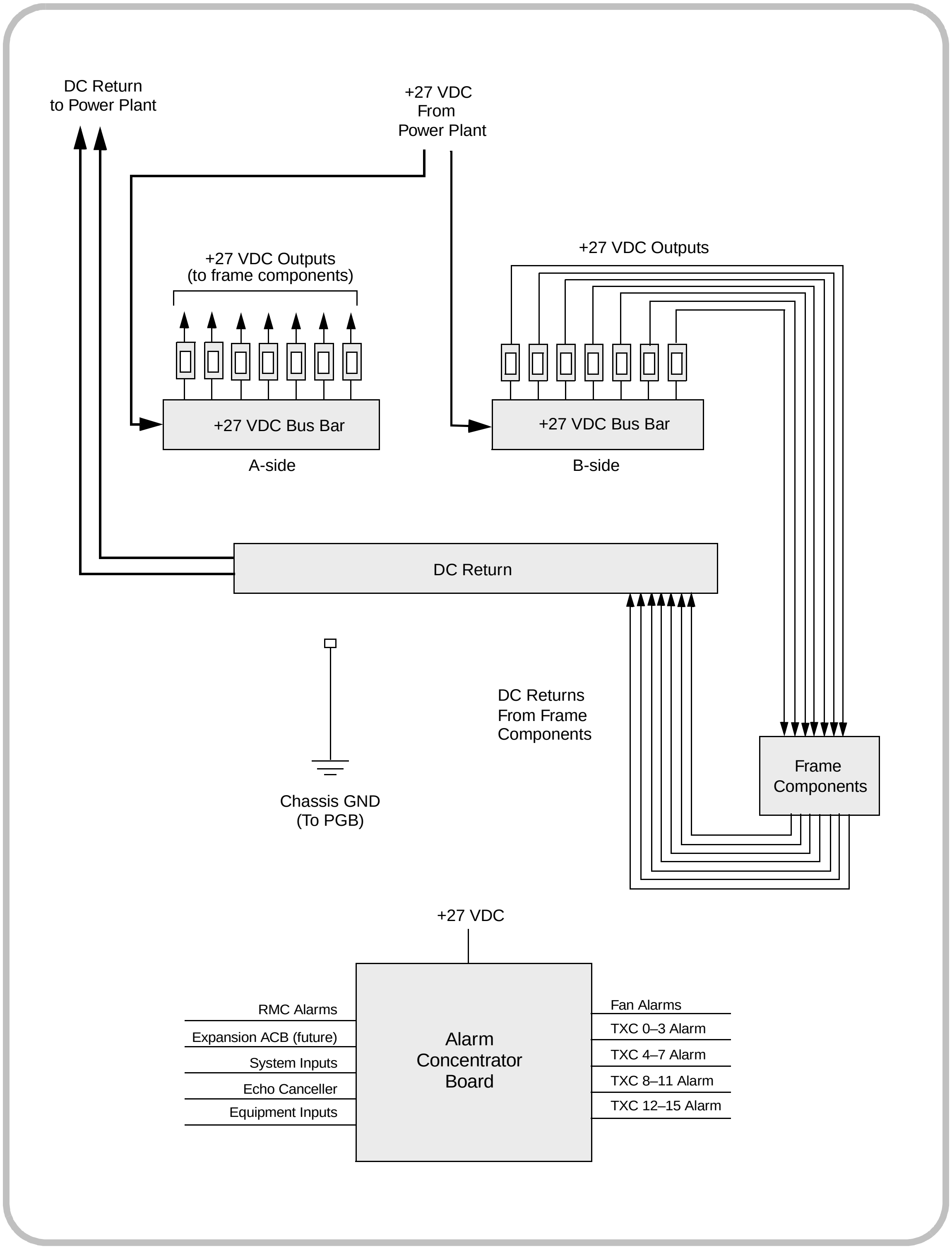
Figure 1–11 Power Distribution Shelf



Operation

The power distribution shelf receives +27 Vdc from the local power plant. (Note that the current from the power plant is carried over two power cables, which attach to the A-side bus bar, and B-side bus bar). The PDS distributes power through individual circuit breakers to components in the frame—see Figure 1–12. The circuit breakers provide circuit protection, and can be used to turn individual components on or off.

Figure 1–12 Power Distribution Shelf, Block Diagram

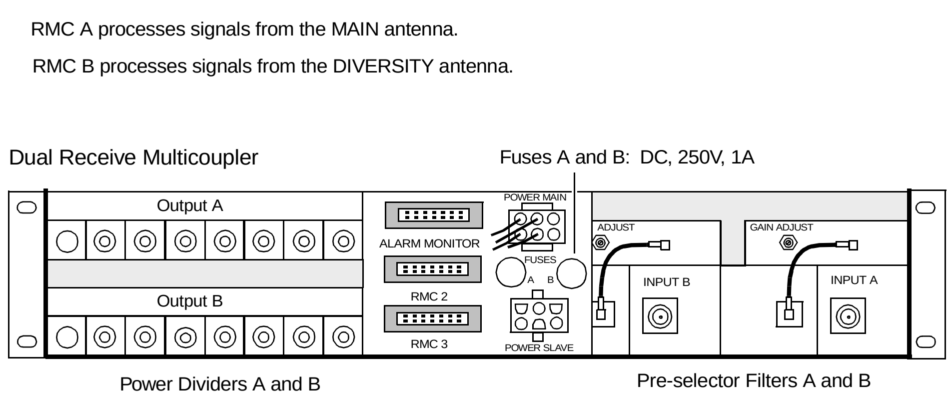


3.3 Receiver Multicoupler (RMC)

The RMC filters, amplifies, and distributes incoming radio signals from the antenna(s)—see Figure 1–13. The dual RMC has two sides—one for the main antenna (A, upper) and one for the diversity receive antenna (B, lower).

- *Filtering* is performed by a pre-selector filter, tuned to the receive frequency band of the transceivers.
- *Amplification* is performed by a Low Noise Amplifier (LNA), which increases the signal strength; the alarm concentrator module (located in the WAC) monitors LNA operation.
- *Distribution* is performed by an 8-way divider, which distributes the received RF signal to the BTS via the Receive Power Splitter (RPS). Each transceiver module in the BTS shelf has a receive input. Figure 1–14, page 1–21 shows how the signal is distributed.

Figure 1–13 RMC, Rear View



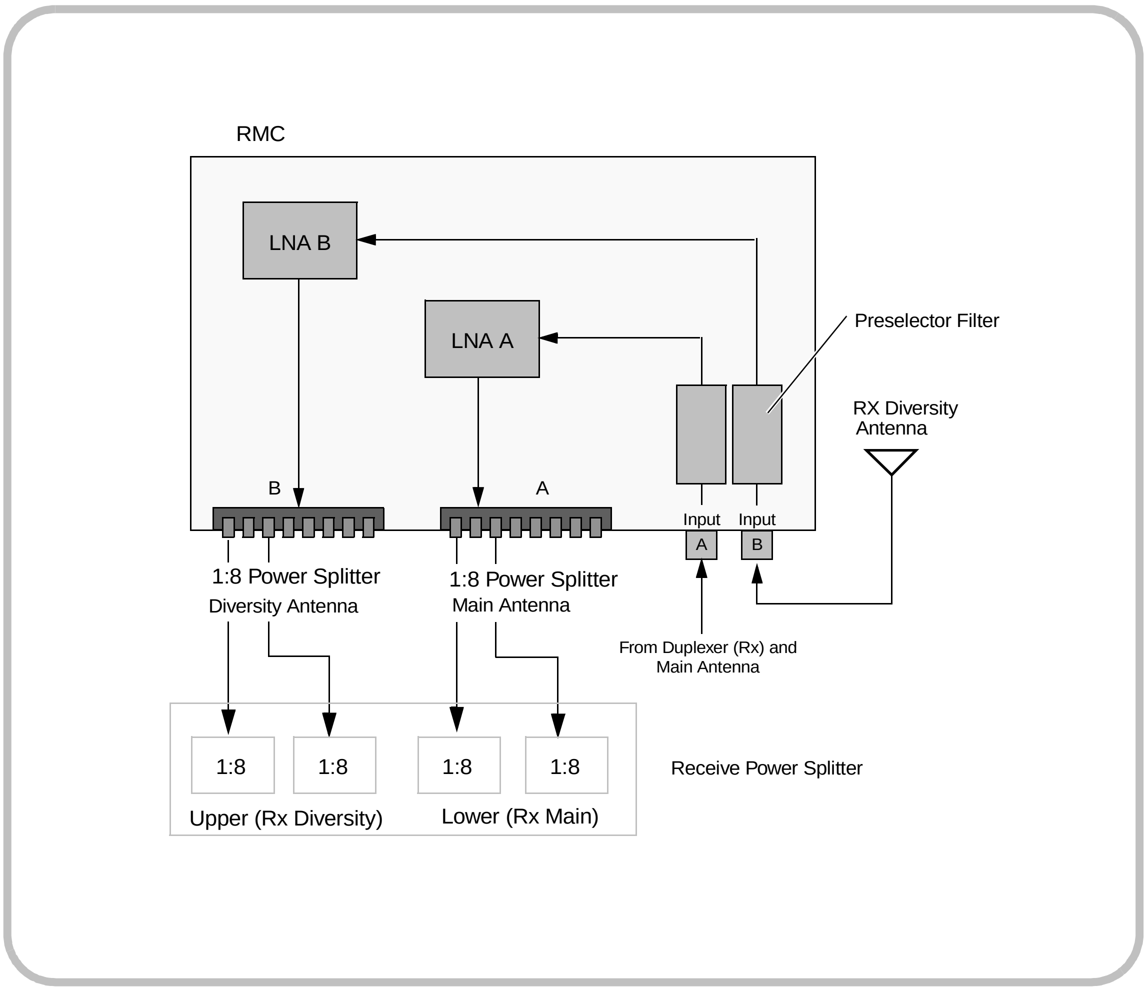
Operation

The *pre-selector filter* isolates the RF signal from the transmit frequencies outside the 869–894 MHz (EAMPS) frequency band. The duplexer output is fed into the RMC’s pre-selector filter.

The LNA amplifies the RF signals from the pre-selector filter, and has a low noise figure and sufficient gain to compensate for signal loss in the 1:8 power splitters and coaxial cables. The LNA generates an alarm if the current draw of the shelf exceeds its limit. A variable calibrated locking attenuator compensates for the gain adjustment. Each 1-to-2 split of the signal equals a nominal 3 dB loss, but the LNA gain offsets this loss.

The 1:8 splitter divides the signal from the LNA into eight equal outputs. Two of the "A" outputs are routed to the RPS—see Figure 1–14. Two of the "B" outputs are also routed to the RPS.

Figure 1–14 RMC Block Diagram



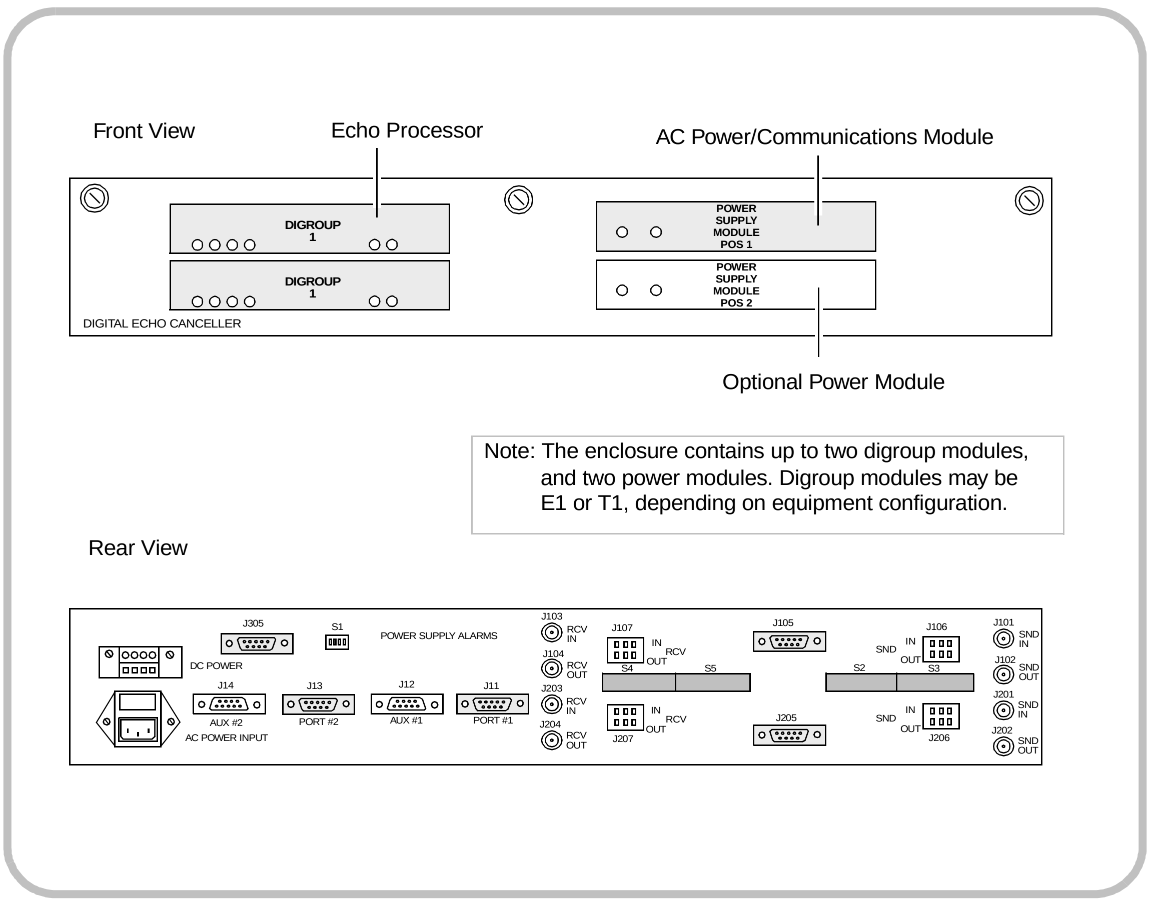
3.4 Echo Canceller

The echo canceller is shown in Figure 1–15. It minimizes undesirable audio echo due to:

- end-to-end propagation delays
- signal-processing delays
- imperfect (hybrid) impedance mismatch at 2-wire to 4-wire conversion points.

Propagation delay is a result of the time required for a voice signal to travel over long distances. Signal processing delays can result from the speech and wireless channel coding necessary for digital radio transmission. Impedance mismatch occurs in networks with both 2-wire and 4-wire transmission sections—some of the incoming speech energy reflects back to the talker as a distorted, delayed copy. End-user equipment can introduce acoustic echo and cross-talk.

Figure 1–15 Echo Canceller

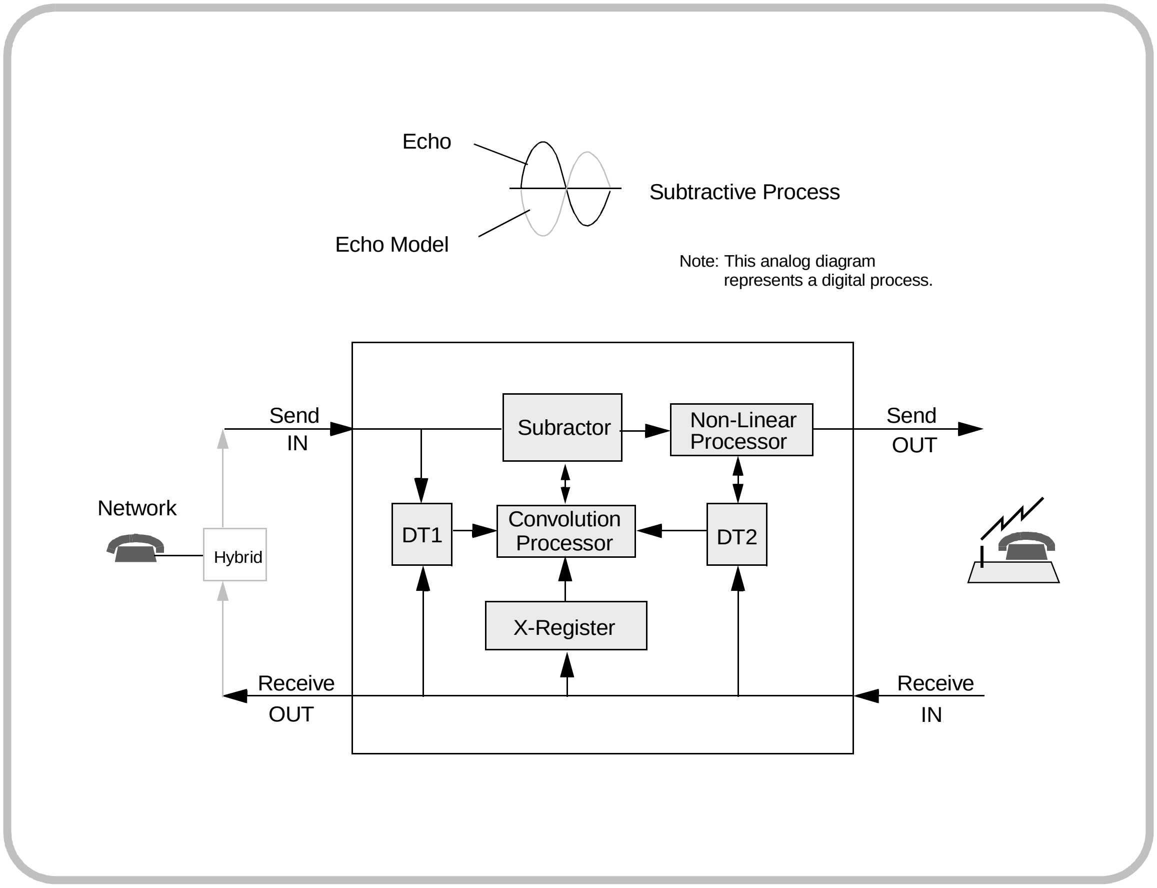


Operation

Echo is an acoustic problem that occurs during phone conversations, and is characterized by the talker hearing a distorted, low-volume copy of their own voice. The longer the round trip time, and the greater the amount of signal coding and processing, the worse the echo is. An echo canceller reduces the echo signal without reducing the level of the original speech.

Echo cancellers synthesize a copy of the echo, then subtract the copy from the original echo. The process is shown in Figure 1–16. The signal in the receive path (Receive IN) is sampled, stored in an X-register, and compared with the signal in the echo return path (Send OUT). The echo canceller mixes the echo model with the return signal at the appropriate time. This subtractive process removes most of the echo.

Figure 1–16 Echo Canceller Block Diagram

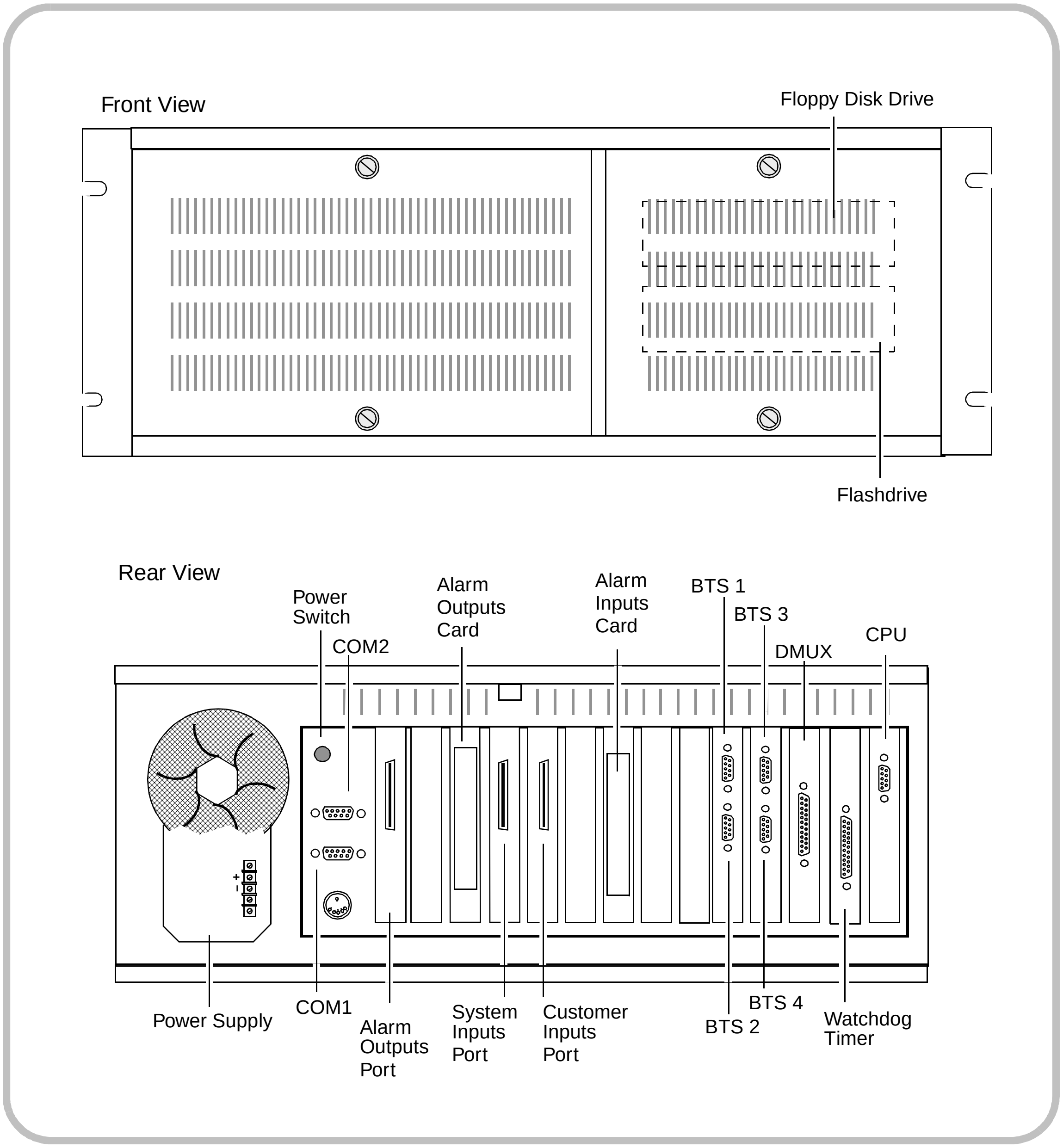


The echo canceller consists of a metal chassis with backplane, an echo processor (called a “digroup” card), and a power and communication card. A dual card configuration is available (two processor cards and two power and communication cards) that can increase capacity and add redundancy.

3.5 Wireless Access Controller (WAC)

The WAC, shown in Figure 1–17, is the main system controller and is responsible for call processing and real-time control of the BTS. The operating system, call processing software, and subscriber database are all contained in the WAC.

Figure 1–17 WAC—Front and Rear Views



Operation

The WAC is an industrial-grade computer customized to perform call processing. Some of its functions include:

- Call management
  - call setup and tear down
  - call monitoring
  - data services
  - priority and emergency calls
  - group alerting and station-terminated SMS
  - fraud detection and IS-136 authentication
- Radio channel allocation and management
- Control of the DMUX (cross-connect matrix)
- Subscriber management
- Alarm control management
- Software downloads and upgrades.

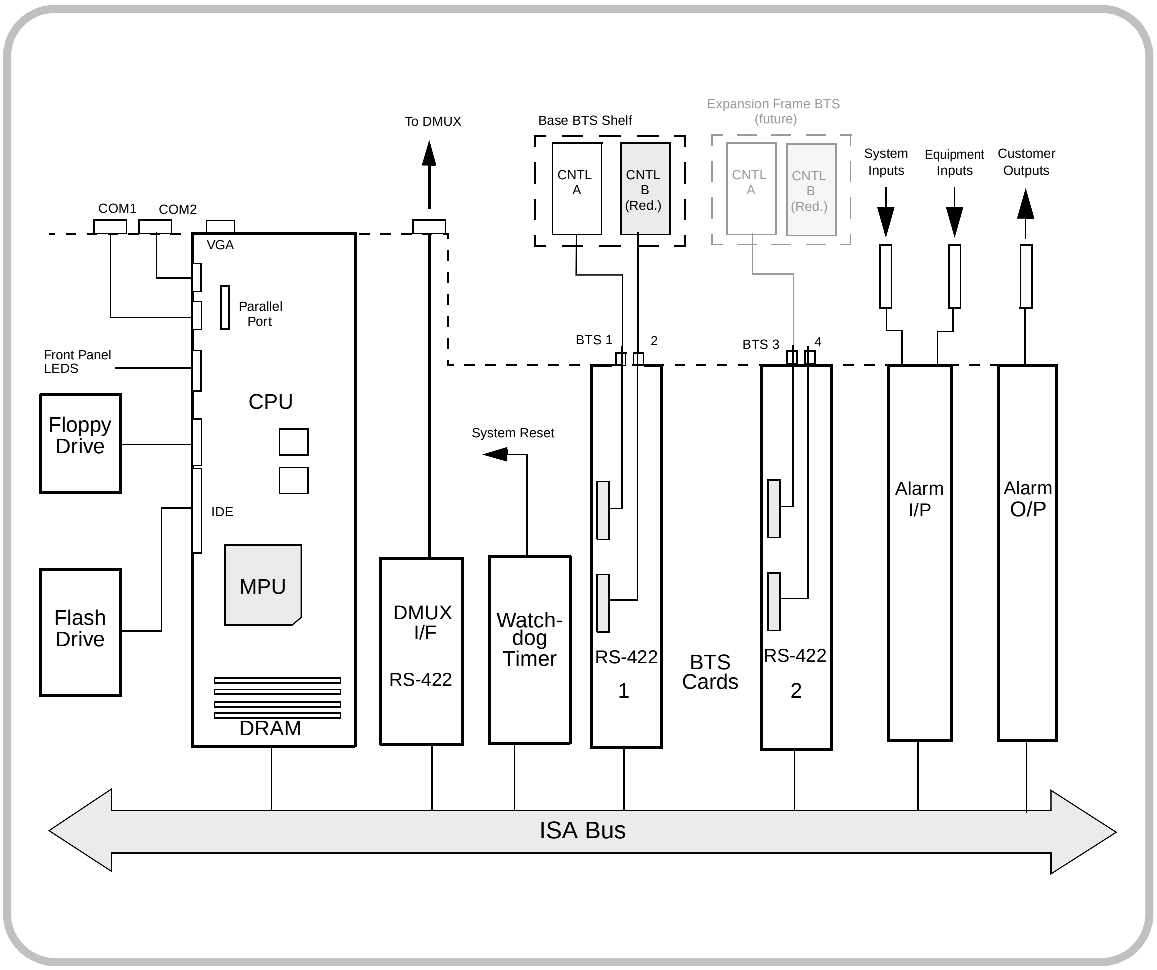
A flash EPROM stores the Vx Works® operating system, which is loaded (decompressed) to a solid-state hard disk. Data and software can be downloaded to the WAC through the RS-422 serial communication port, or via the floppy disk drive.

The WAC enclosure contains a +24 Vdc power supply, 14-slot ISA backplane, and various cards that plug into the backplane. The WAC cards are listed below.

WAC Components	
CPU	Provides system control and operation of the WAC. 120 to 200 MHz Pentium processor with 16 MB of DRAM, 2 MB flash EPROM, 2 MB flash ROM with embedded MS DOS, 8.3 MHz ISA bus interface, two serial communication ports, and one parallel I/O port. Contains IDE interface supporting 2 or 4 IDE drives, and a floppy disk interface.
DMUX Interface	Has one RS-422 serial port using a 16550 UART to handle WAC-to-DMUX communications.
BTS Interface	Two multiport asynchronous controllers with two DB9 RS-422 ports on each card (the lower port is redundant) provide digital links to the BTS. The ports support a simultaneous data rate of 115 kbit/sec.
Flashdisk	A flash disk drive, with up to 20 MB secondary storage space, mounts on an interface card located in the peripheral mounting space below the floppy disk. It appears as disk drive D: to the CPU card. Like all flash devices, it has a limited number of write cycles (100,000).

Floppy Disk Drive	A 3.5 inch floppy disk drive is provided for on-site software updates. (Normally, updates are provided via the serial port and PC or modem link).
Alarm Control Modules and Connectors	Two boards provide 8 output contacts and 48 isolated inputs through three 50-pin connectors. The outputs allow for Normally Open (NO) or Normally Closed (NC) contacts. The inputs support up to 30 Vdc and are split into two groups: customer inputs and equipment inputs.
Watchdog Timer	Senses system activity. If it senses no activity within a selectable period of time (between 0.5 and 550 seconds), the system is considered to be “locked up”, and the card initiates a system reset (equivalent to pressing the reset button).

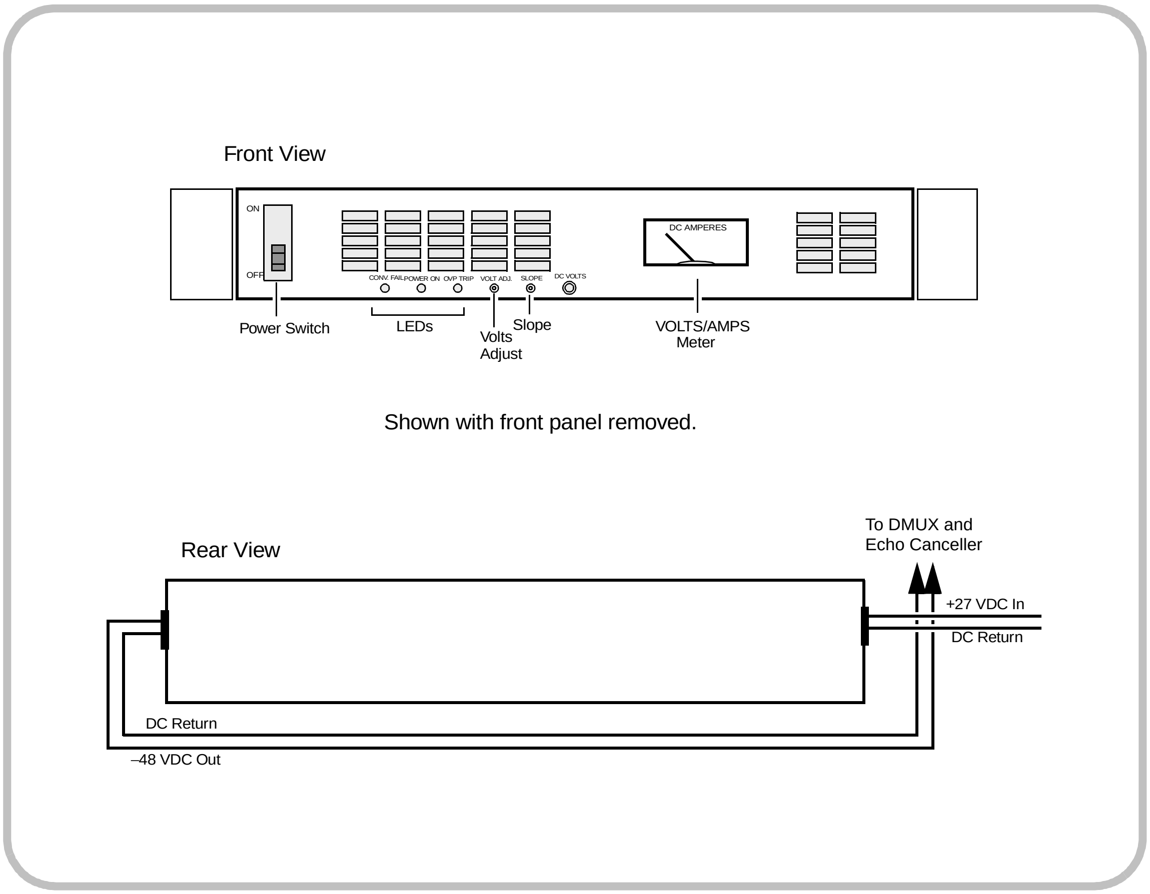
Figure 1–18 WAC Block Diagram



3.6 DC–DC Converter

The DC-DC converter, shown in Figure 1–19, supplies –48 Vdc to the DMUX and echo canceller. The input voltage to the converter comes from the DC distribution shelf (+27 Vdc).

Figure 1–19 DC-DC Converter



3.7 Digital Multiplexer (DMUX)

The DMUX has several important functions:

- Links the WIN*RoLL 136* to the telephone network (via 1st order E1/T1 digital trunks)
- Links up to 96 local wired-subscribers directly to WIN*RoLL 136*
- Performs local call completion
- Cross-connects PCM digital trunks to BTS wireless channels
- Performs trunk signalling (R1/R2)
- Supports common channel signalling
- Supports vertical features (flash hook) with common channel signalling
- Generates call process tones to the land party
- Supports local call routing
- Detects and reports meter pulses for public call offices
- Collects Call Detail Records (CDRs)
- Provides a remote terminal link to the WAC
- Connects to the ROC via an internal modem (contained on the MCU card) operating at 14.44 Kbps
- Supports data server (future).

The high-level data and voice processing in the DMUX is controlled by the WAC.

Figure 1–20 Direct Connection to the ROC

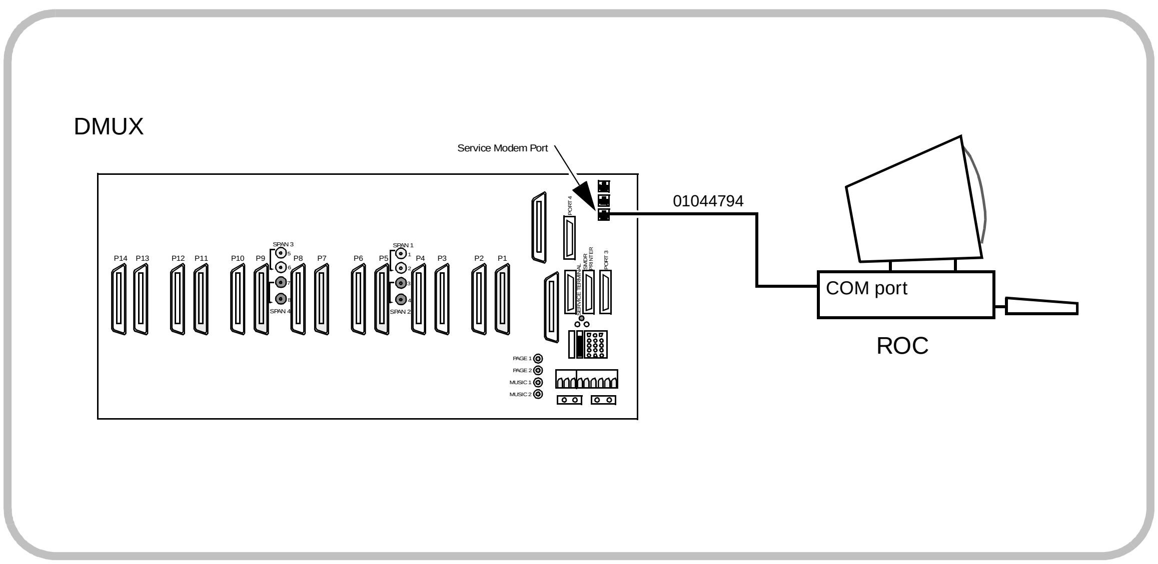


Figure 1–21 shows a DMUX E1 card configuration.

Figure 1–21 DMUX (Dual Digital Span)

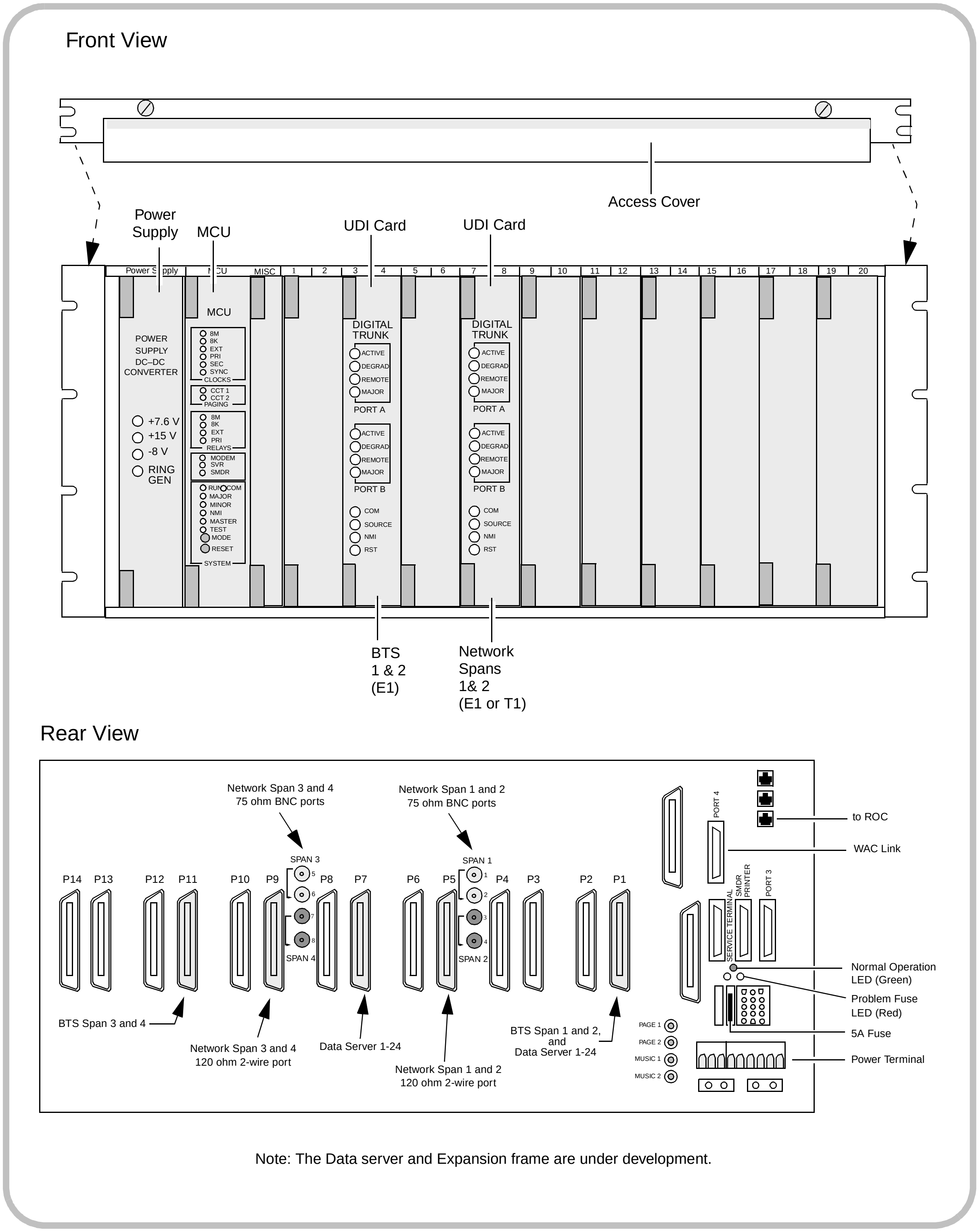
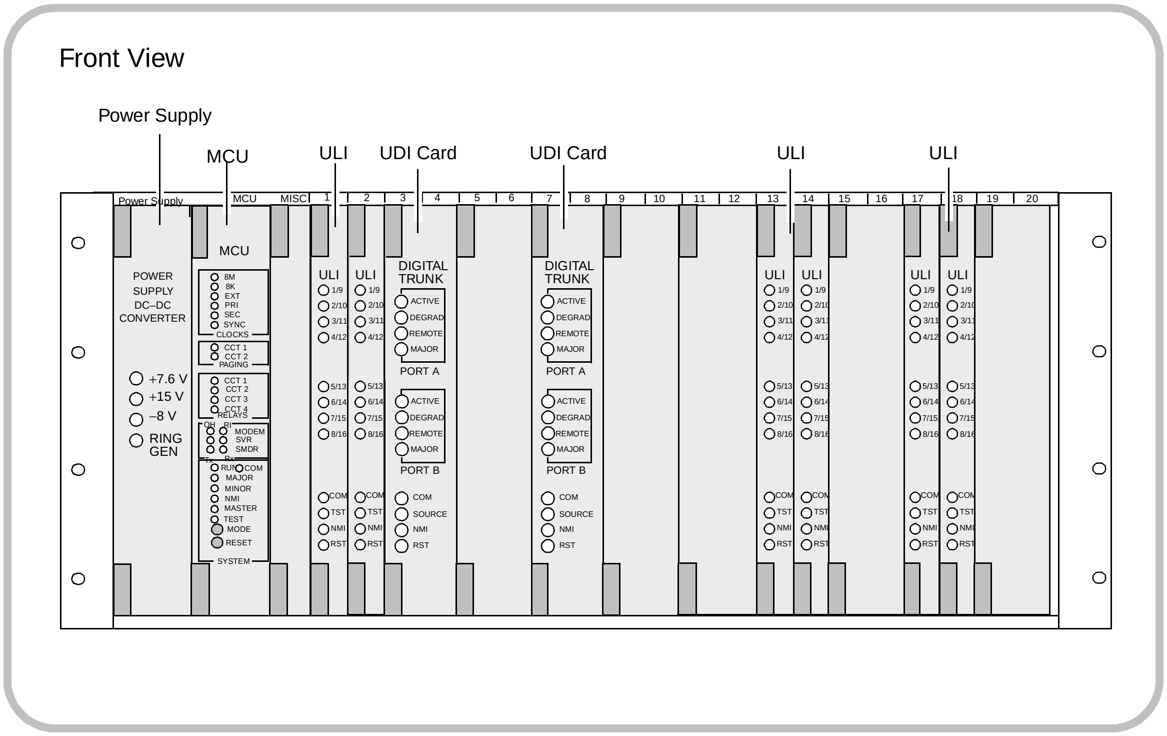


Figure 1–22 shows the DMUX card configuration for 16 RF channels and 96 subscriber lines.

Figure 1–22 DMUX Shelf: 60 trunks (E1) with 96 Subscriber Lines



The DMUX is contained in a single shelf. The cards and modules in the DMUX include:

- Power supply.
- Main Control Unit (MCU).
- Universal Digital Interface (UDI) cards with modules, including E1/T1 module(s), and R1/R2 Signal Processing Modules (SPMs).
- Universal Line Interface (ULI) cards with link modules.

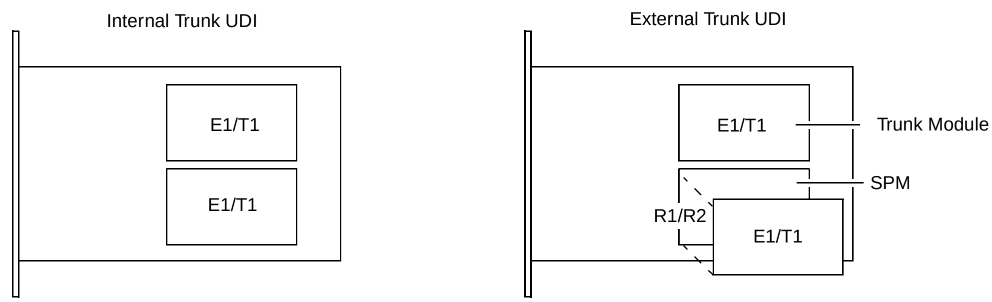
The DMUX requires –48 Vdc, which is supplied by the DC–DC converter. The power supply/ring generator supplies and regulates the shelf's DC voltages.

Operation

The DMUX cross-connects network trunks to BTS radio channels—it is the voice and signalling interface to the PSTN, and it is the voice interface to the BTS.

The MCU controls low-level operation of the shelf. It contains the CPU, firmware, cross-connect matrix, tone generators, and service port (internal modem). The cross-connect matrix on the MCU multiplexes signals from the network trunk to the BTS trunk. One MCU is required per system, located in the slot directly to the right of the power supply card.

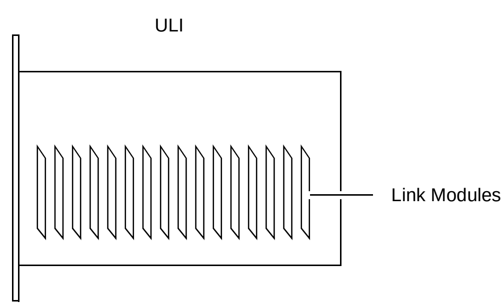
UDI cards are *digital* interface cards that link the DMUX to the PSTN (via external trunk UDI) or the BTS (via internal trunk UDI). The type of trunk and signalling scheme of a UDI card depends on the kinds of modules that are plugged into the card. E1 and T1 trunk modules, and R1 and R2 SPMs are available.



Notes: E1 modules are used with E1 trunks.
T1 modules are used with T1 trunks.
R1 signal processing modules are used with T1 trunks.
R2 signal processing modules are used with E1 trunks.
Internal trunk UDI cards do not have a signalling module.

The slot locations of UDI cards in the DMUX depend on the number and type of trunks (E1 or T1), and the number of subscriber lines.

ULI cards are *analog* interface cards that connect to phone subscribers. Each ULI supports up to 16 link modules. A DMUX can support up to 96 wired subscribers (with six ULI cards).



Various DMUX combinations of trunks and subscriber lines are available, however, PCM mapping must be verified to ensure that the 240 available timeslots are not exceeded. To prevent call blocking and to spread the load across all PCM highways, ULI cards must be placed in certain slot locations. Wired and wireless subscribers “compete” for trunks, so overall system performance is affected by the configuration. Figure 1–23 illustrates the maximum configuration with *no subscriber lines*. Figure 1–24 shows a configuration with the *maximum number of subscriber lines (96)*.

Figure 1–23 96-channel DMUX

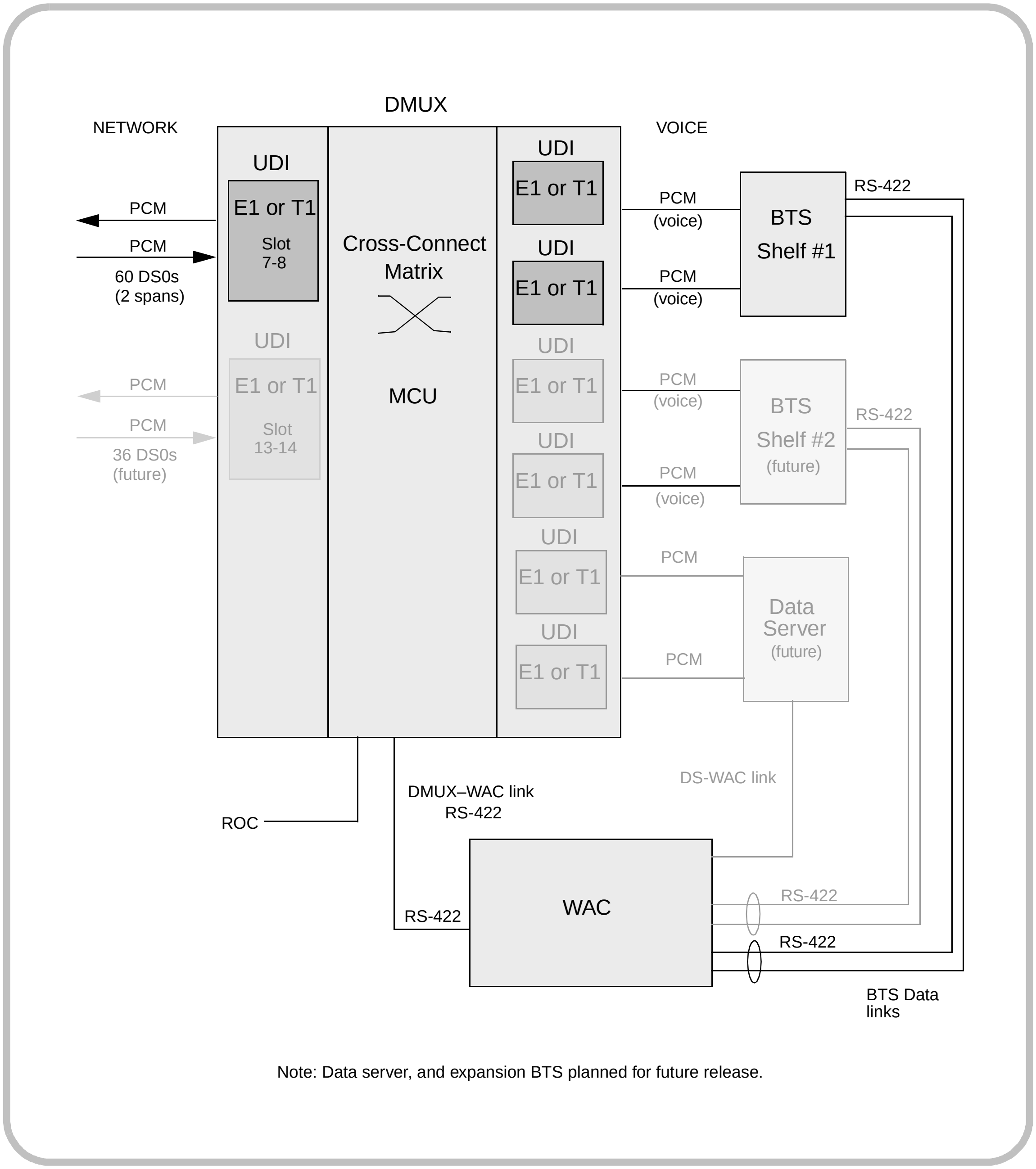
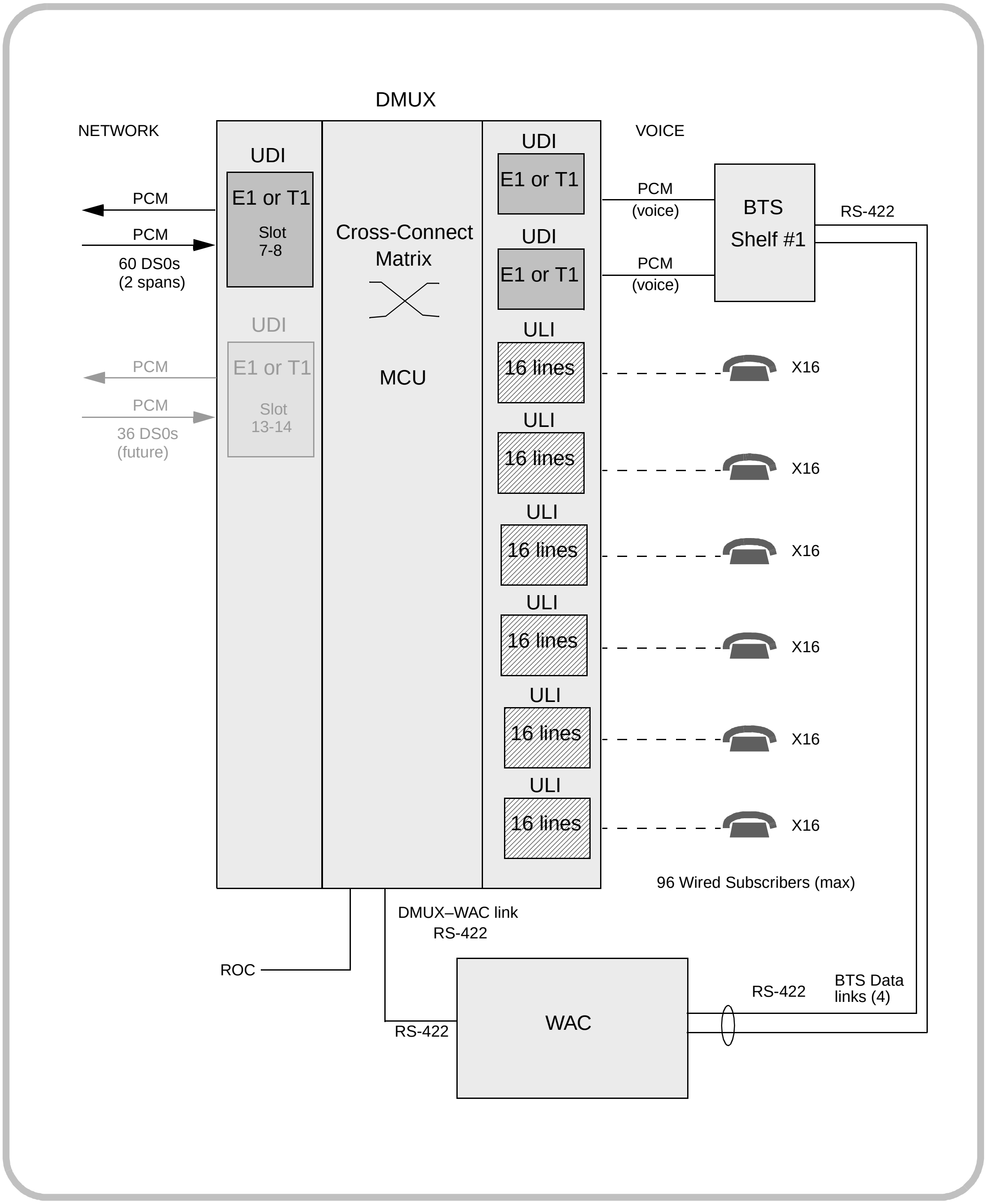


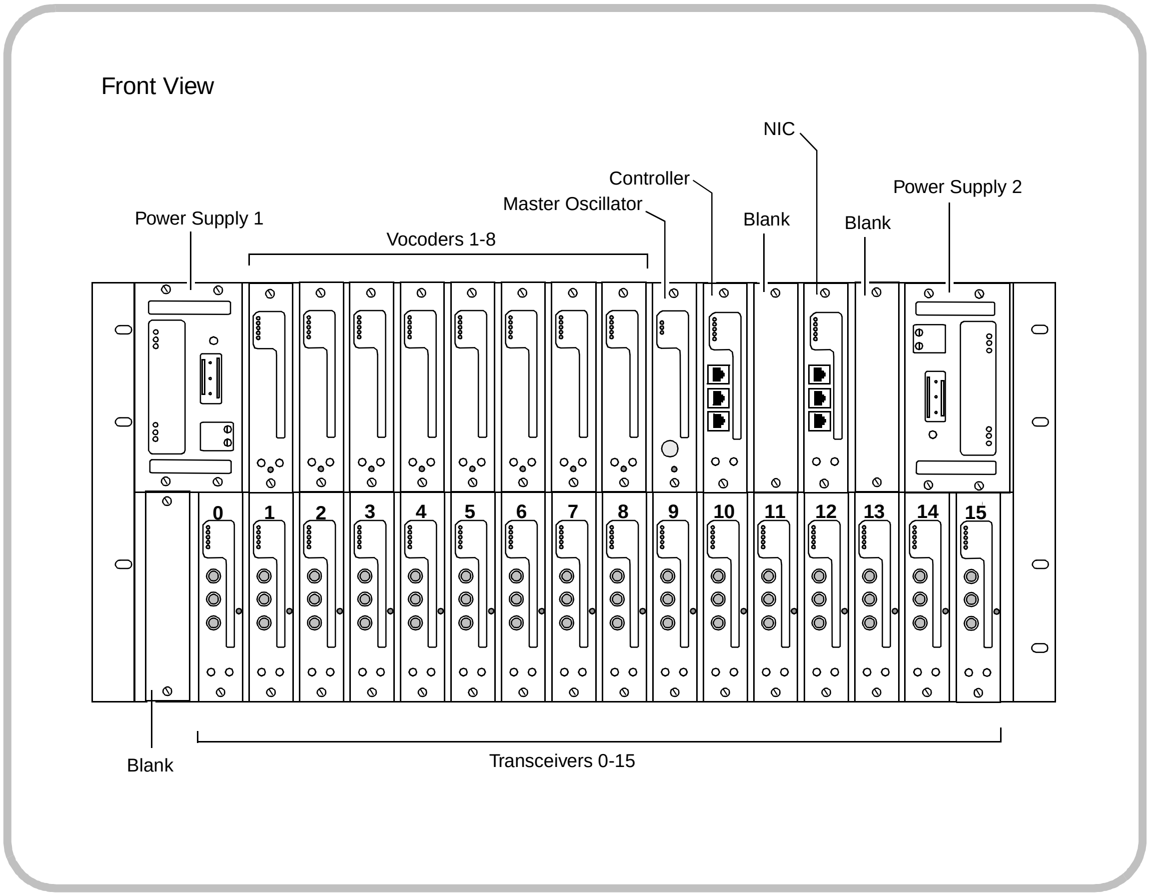
Figure 1–24 48-channel DMUX with 96 Subscriber Lines



3.8 Base Transceiver System (BTS)

The BTS is the radio signal processing center of the WIN*RoLL 136*. The BTS converts voice and data information to and from RF signals, under direction of the WAC. Figure 1–25 shows the BTS components, and Figure 1–27 shows the BTS block diagram.

Figure 1–25 BTS Shelf



Operation

To transmit, the BTS accepts PCM data from the DMUX, and converts the data to RF signals. To receive, the BTS receives RF signals and converts them to PCM data. A significant amount of processing takes place in the BTS including: channel encoding and decoding, modulation and demodulation, data compression and decompression, rate adaptation, equalization, and error recovery.

BTS Components	
Transceivers 0-15 (Radios)	Each transceiver consists of an RF card and a modem Digital Signal Processing (DSP) card. The transceiver handles radio transmit and receive, and frequency synthesizing. The modem DSP card handles digital signal conversion and coding/decoding. When receiving, radios convert the radio analog signals to digital baseband and decode the signal. When transmitting, they convert the digital signal to an FSK (analog mode) or pi/4DQPSK (digital mode) signal that is modulated into RF signals. Operates in analog or digital mode. In analog mode, each transceiver supports a single wireless channel. In digital mode, each transceiver supports 3 full-rate TDMA channels. A block diagram of the transceiver is shown in Figure 1–27. Each transceiver: • performs modulation and demodulation • supports voice encoding and decoding • filters out interference from adjacent radios • performs diversity algorithm on receive path • controls the transmit signal power level • measures the quality of the incoming receive signal • establishes dynamic channel mode assignment to DCCH, DTC, ACC, and AVC.
Master oscillator	Provides a 9.6 MHz reference frequency for the transceivers.
Vocoder(s)	• Performs voice coding and decoding using VSELP or ACELP codec for voice, and communication protocol for data services. • Converts 13 kbps raw bit stream to and from 64 kbps PCM voice information. • Channel coding, interleaving, framing during transmit, de-framing, de-interleaving, and channel decoding during receive. • Required for digital mode—each vocoder supports two digital transceivers (six conversations). The vocoder is *not* required for analog mode.
Controller	• Controls all the transceivers and vocoders in the BTS shelf via the ST-Bus in the backplane. • Provides an RS-232 port for diagnostics, field support. • HDLC high-speed serial port monitors Digital Power Amplifiers (DPAs). • Handles message translation and IS-136 protocol. • Redundant controller (optional) takes over operations if main controller card fails .
Network Interface Card (NIC)	• Provides physical E1 connection between the BTS and the DMUX. • Provides physical RS-422 connection to the WAC (the WAC controls the BTS). • Redundant NIC (optional) takes over operations if main NIC fails.
Power supplies	• Provides and regulates power to the BTS shelf (+6 Vdc analog and +6 Vdc digital). • When the BTS is fully populated, the two power supply modules share the load to supply voltage; if the BTS is less than half populated only one power supply provides current to the modules. • Second power supply card takes over if the other power supply fails.
Backplane	• Contains connectors, ST-Buses, serial buses, and parallel communication buses that tie the whole BTS together.

Figure 1–26 BTS Block Diagram

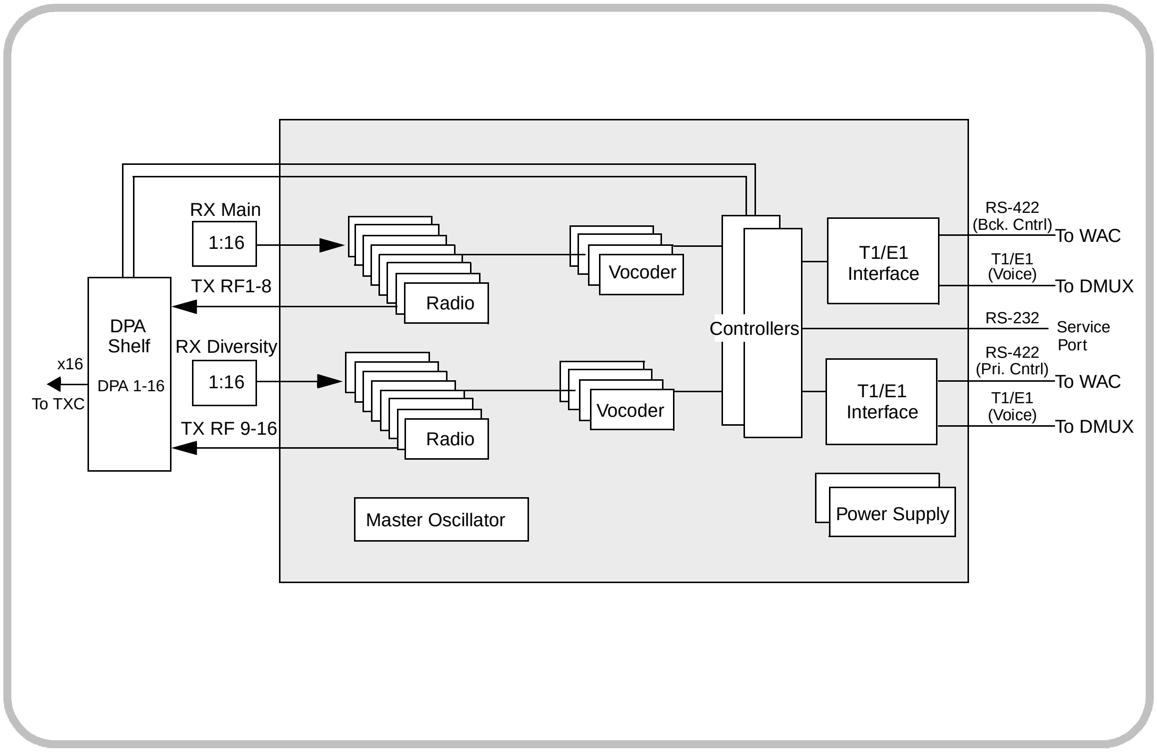
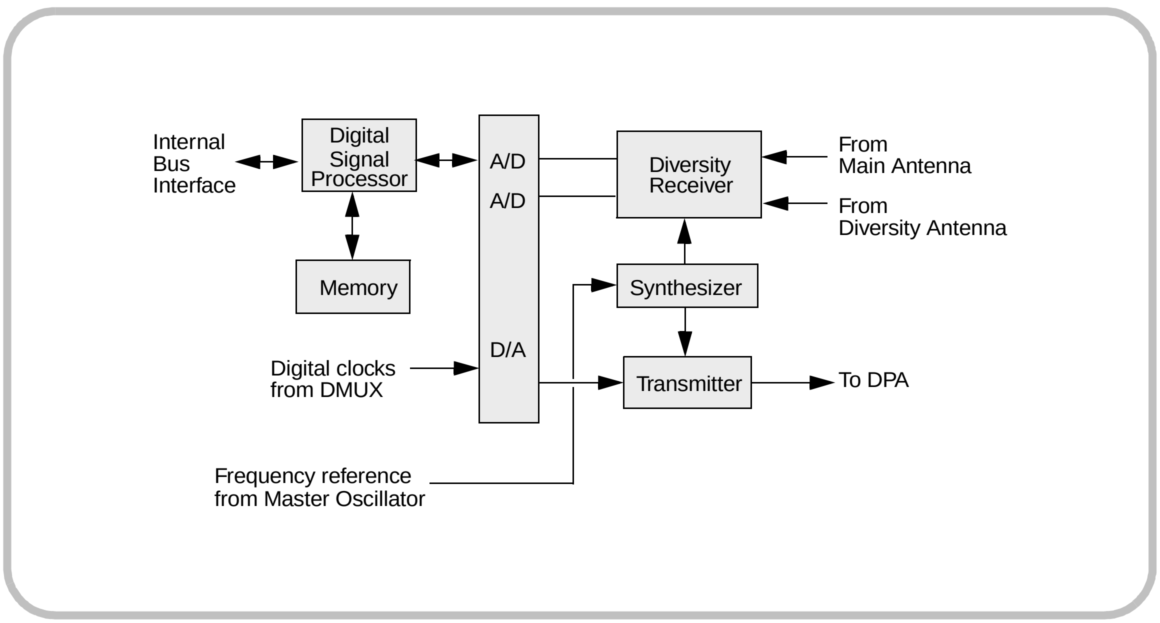


Figure 1–27 Transceiver Block Diagram



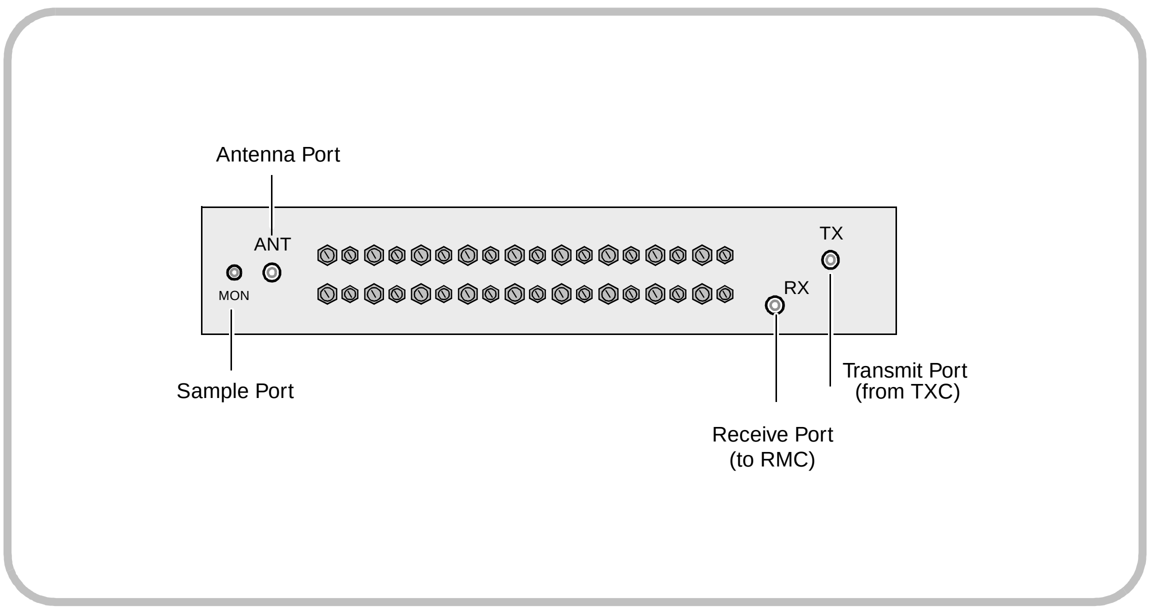
Backup Control Channel Operation

Under normal conditions, transceivers function as either primary control channels (DCCH or ACC), or traffic channels (DTC or AVC). If a primary control channel fails, a designated traffic channel automatically takes over the control function (after which it's called a backup traffic channel or BTC) . When the change occurs, two transceivers—the BTC, and the primary control channel—both drive the combiner at the same time and frequency. This situation causes a low power output and may damage the PAs. The solution to this problem is enabling each combiner group to operate with one of its ports tuned off-band (TOB) when there is no RF signal applied to it (The DCCH, ACC and designated BTC should be assigned to a combiner port that is enabled for TOB operation). You enable this feature by setting the rotary switch on the control module of the combiner. See Figure 4–84, page 4–165 for information about combiner switch settings.

3.9 Duplexer

The duplexer enables the WIN*RoLL 136* to simultaneously transmit and receive RF signals through a single antenna—see Figure 1–28. The duplexer is located behind the BTS.

Figure 1–28 Duplexer, Rear View

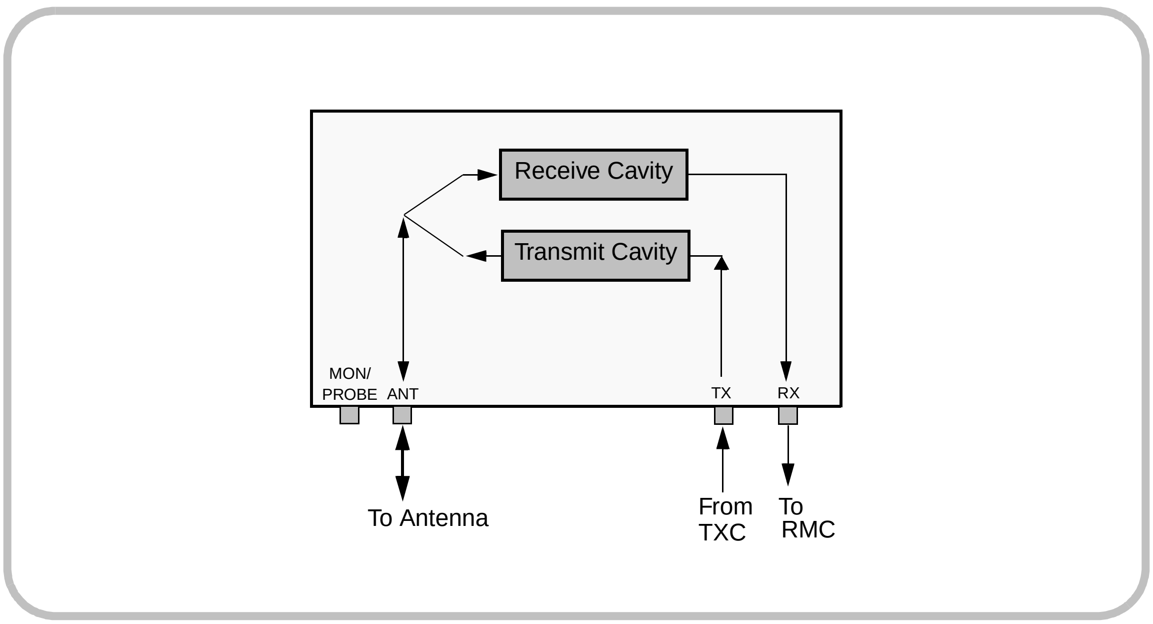


Operation

The duplexer consists of two resonant cavities (bandpass filters), one tuned to pass the transmit band and reject the receive band, and the other tuned to pass the receive band and reject the transmit band. Separation between the two bands is normally 45 MHz—strict isolation is required because of the proximity of the high-power transmit band to the low-power receive band. Without the duplexer, two physically separate antennas would be required—one for transmitting and one for receiving.

When transmitting, RF signals from the TXC go through the duplexer to the antenna. When receiving, the RF signals from the antenna go to the duplexer, and from the duplexer to the RMC. The main antenna connects to the ANT port of the duplexer, and the RMC shelf connects to the RX port. The duplexer also has a sample port (MON/PROBE port), which can be used for test purposes—see Figure 1–29.

Figure 1–29 Duplexer Block Diagram



3.10 Receive Power Splitter

The receive power splitter divides the A and B radio signals from the RMC into eight separate signals, and distributes the signals to the BTS transceivers. Each transceiver requires two RX signal inputs: one from the main receive antenna (B), and one from the diversity receive antenna (A). See Figure 1–30 and Figure 1–31.

Figure 1–30 Receive Power Splitter

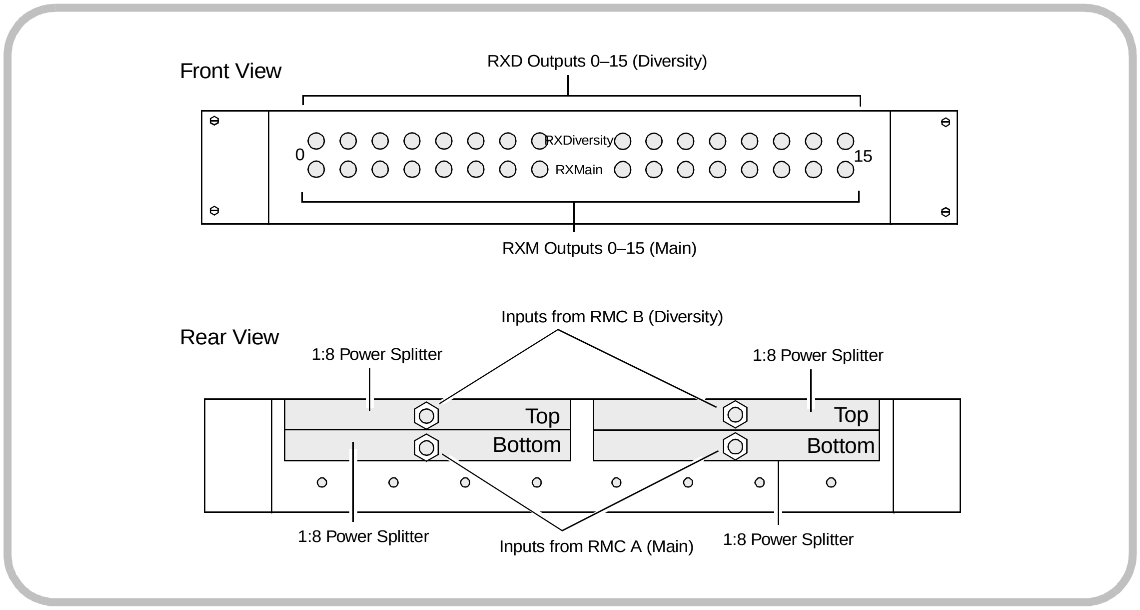
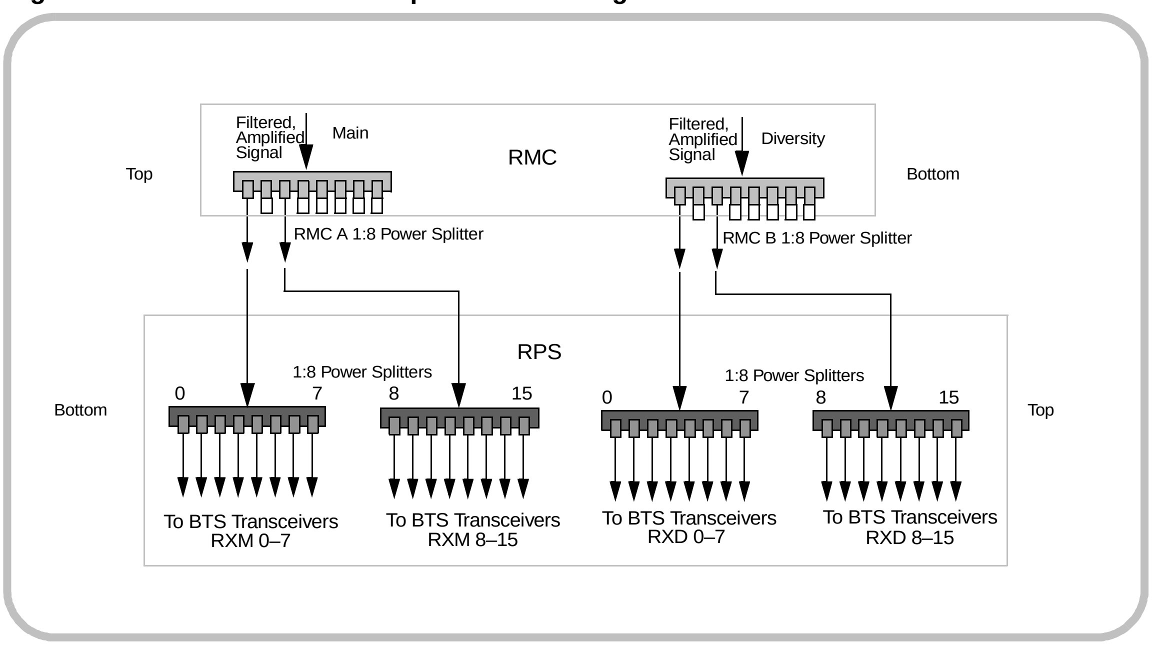


Figure 1–31 Receive Power Splitter Block Diagram



3.11 Digital Power Amplifier (DPA) Shelf

The 800 MHz DPA increases the RF power output of the BTS transceivers from a nominal +24 dBm (250 mW) to +44 dBm (25 W). The DPA inputs come from the BTS transceivers; the DPA outputs go to the TXC. Each DPA module contains two amplifiers. See Figure 1–32 and Figure 1–33.

Figure 1–32 DPA Shelf

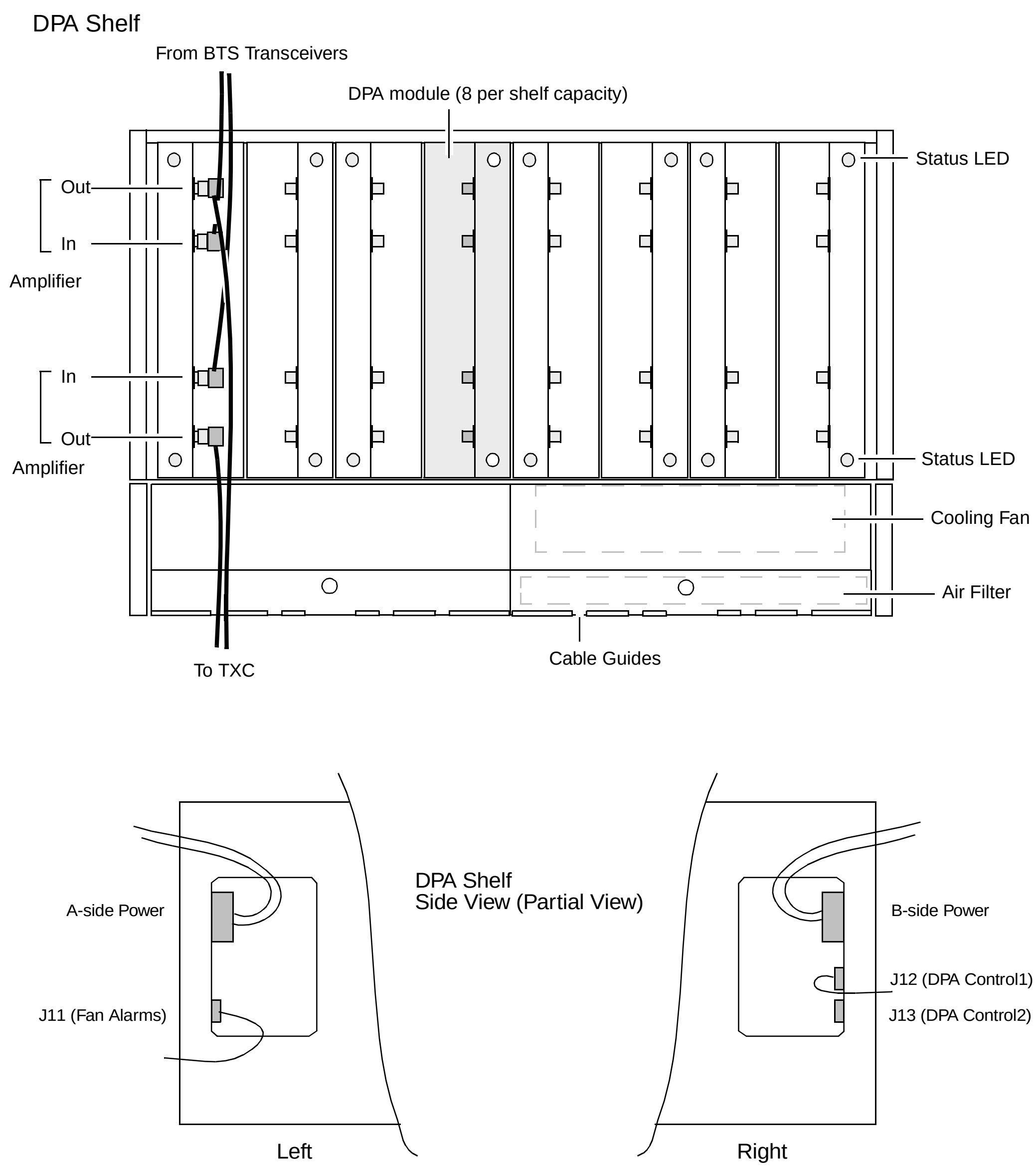
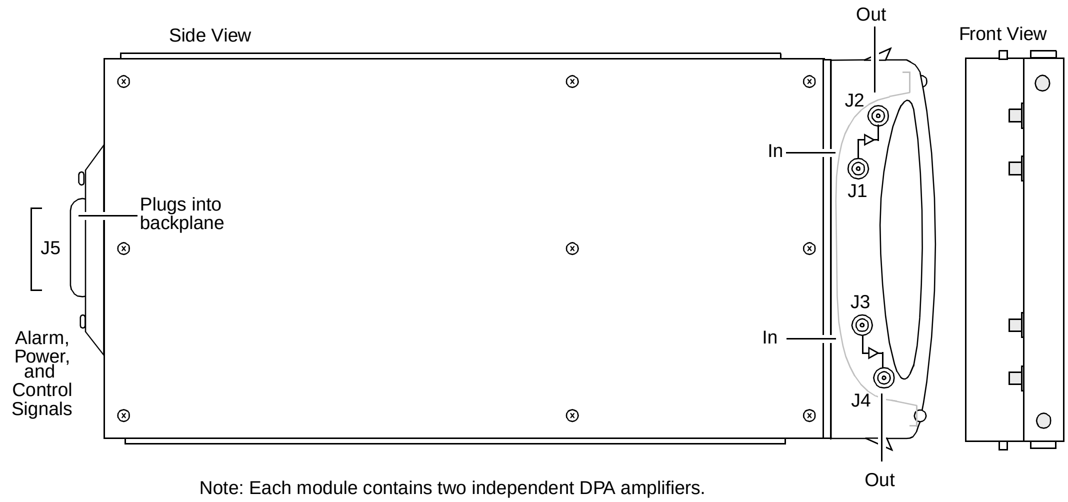


Figure 1–33 DPA Module



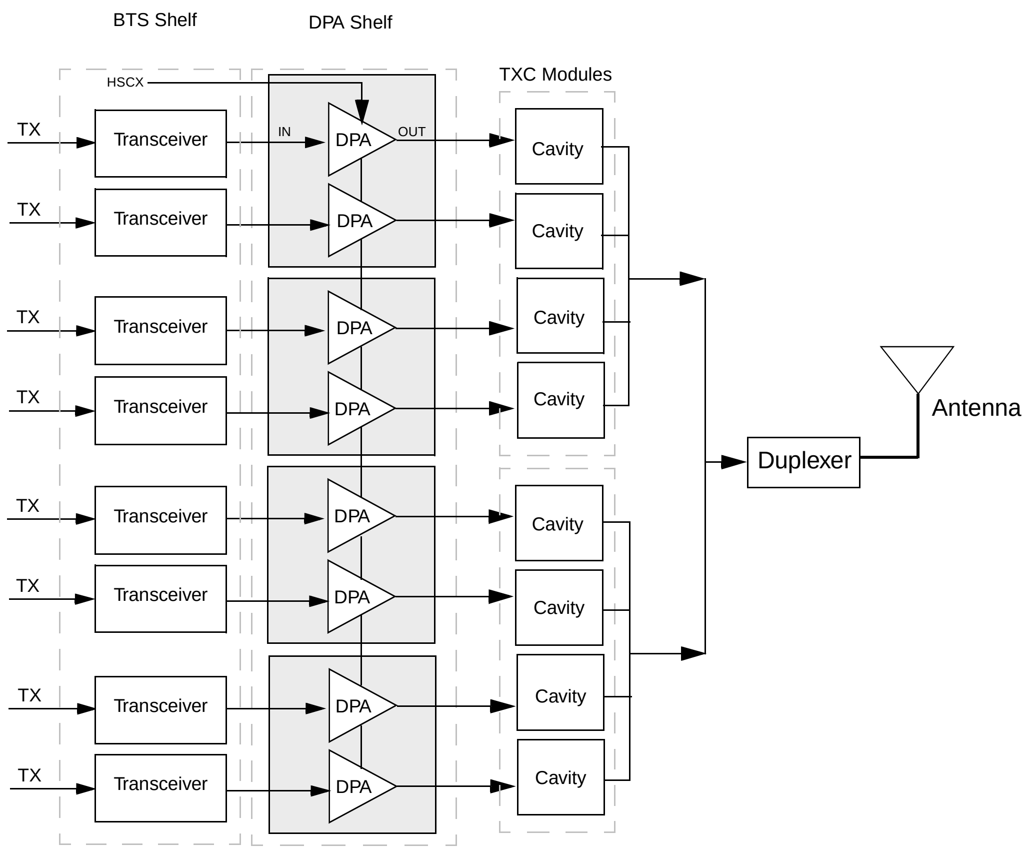
Operation

The DPA is a linear, fixed-gain amplifier that amplifies the modulated signal from the transceiver. Temperature and other status messages from the DPAs are monitored by the BTS over a serial communication link. DPAs are capable of operating in analog or digital mode.

Two separate DPAs are located in each DPA module (circuitry is not shared between amplifiers). RF input and output connectors are located on the front of the module. Variable speed fans underneath the DPAs provide cooling air, and the rate of air flow automatically increases or decreases to keep the DPAs at a stable operating temperature. Cooling air is cleaned by replaceable air filters. Each amplifier has a bi-color LED that displays the amplifier status: Green = normal, Red = Alarm.

Figure 1–34 is a block diagram that shows how the DPA shelf connects to the BTS and TXC (eight channels are shown). Connections are made with flexible, double-shielded RF cables to minimize insertion loss and maximize performance.

Figure 1–34 DPA Shelf Block Diagram

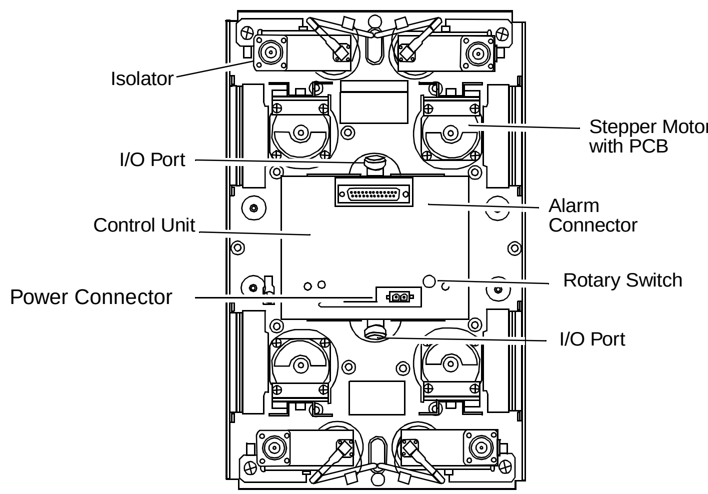


Note: Each DPA module contains two separate DPAs.
TX = Transmit

3.12 Transmit Combiner (TXC)

The TXC combines the DPA outputs into a single RF output, which goes to the duplexer. A primary frame supports up to 16 RF channels (two 8-channel TXC units installed back to back). The WIN*RoLL 136* uses auto-tune TXCs, so manual adjustment is unnecessary.

Figure 1–35 4-Channel TXC Module



Auto-tune TXC (Stepper motor-type)

Operation

The TXC receives DPA outputs, isolates and filters them, and routes the combined output to the duplexer—see Figure 1–36. Bandpass resonant cavities are tuned to pass the transmit frequency at maximum forward power, and to provide high resistance and minimum reverse power for any other signals. Each cavity is tuned to the frequency of the transceiver that feeds it by moving a “plunger” in and out of the cavity—see Figure 1–36 and Figure 1–37. RF energy outside the transceiver frequency shunts to ground and produces heat.

Auto-tune TXCs are equipped with a dual-port isolator tuned to the 869–894 MHz frequency band. At initial power-up, a microprocessor-based controller tunes all cavities automatically to the desired transmitting frequency, once the RF carrier is applied to the TXC. A stepper motor moves the inner conductor in and out of the cavity. During normal operation, the TXC compensates for frequency drifts caused by temperature variations, mechanical influences, and aging. If no activity occurs within a 24 hour period, a cavity is automatically tuned out-of-band. (The rotary switch must be set to enable out-of-band tuning).

Figure 1–36 TXC Block Diagram

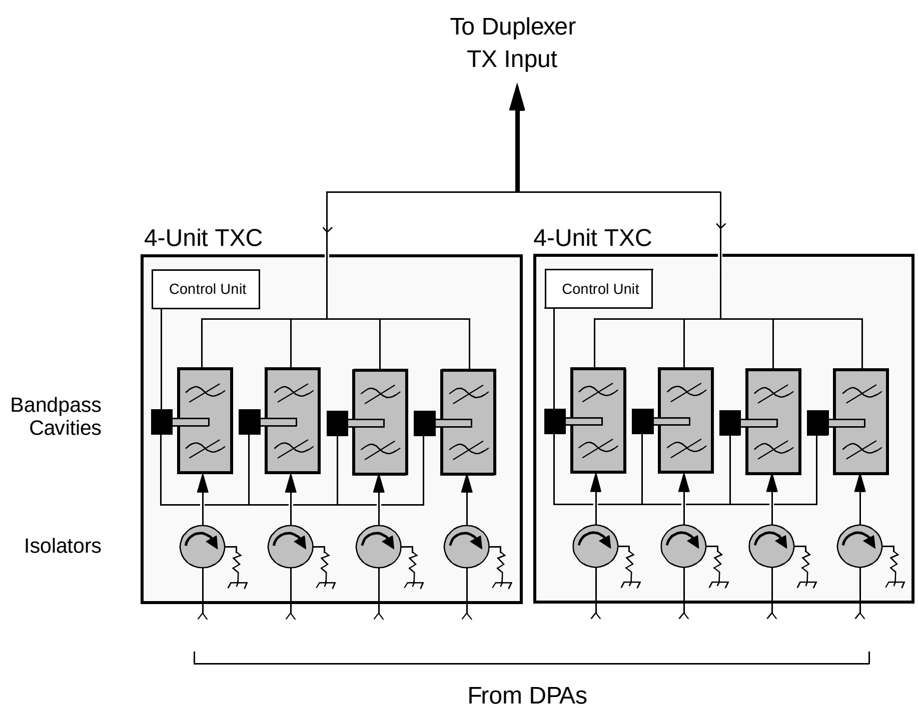
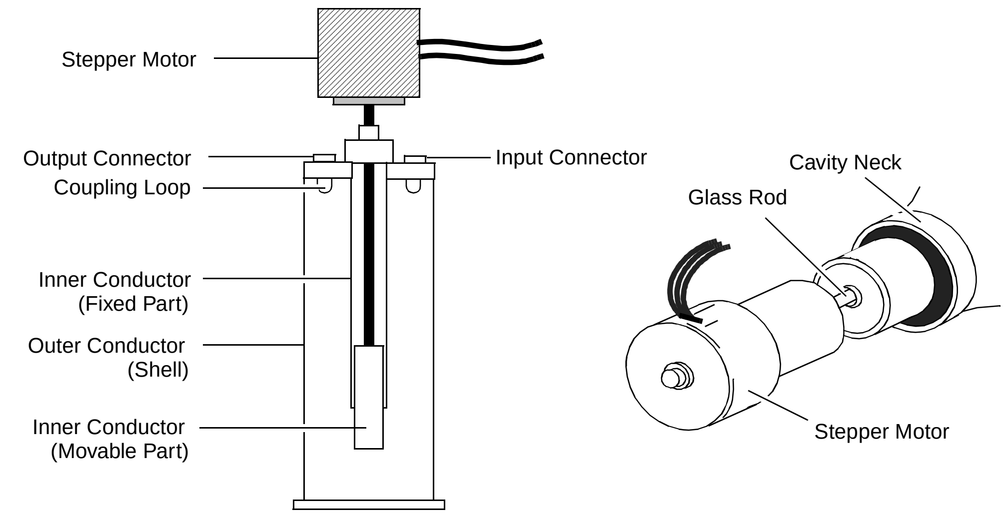


Figure 1–37 Tuning Mechanism



Auto-Tune Mechanism

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4 Optional Equipment

This section describes optional equipment for the WIN*RoLL 136*.

4.1 DMUX Options

ULI and UDI cards, OPX modules, and a CDR SIMM are available as options—see Figure 1–38.

Universal Line Interface (ULI) Cards

Up to six ULI cards can be installed in the DMUX, providing up to 96 subscribers with 2-wire lines. Each 2-wire line requires an OPX module on the ULI. Up to sixteen OPX link modules can be inserted into each ULI card.

Universal Digital Interface (UDI) Cards

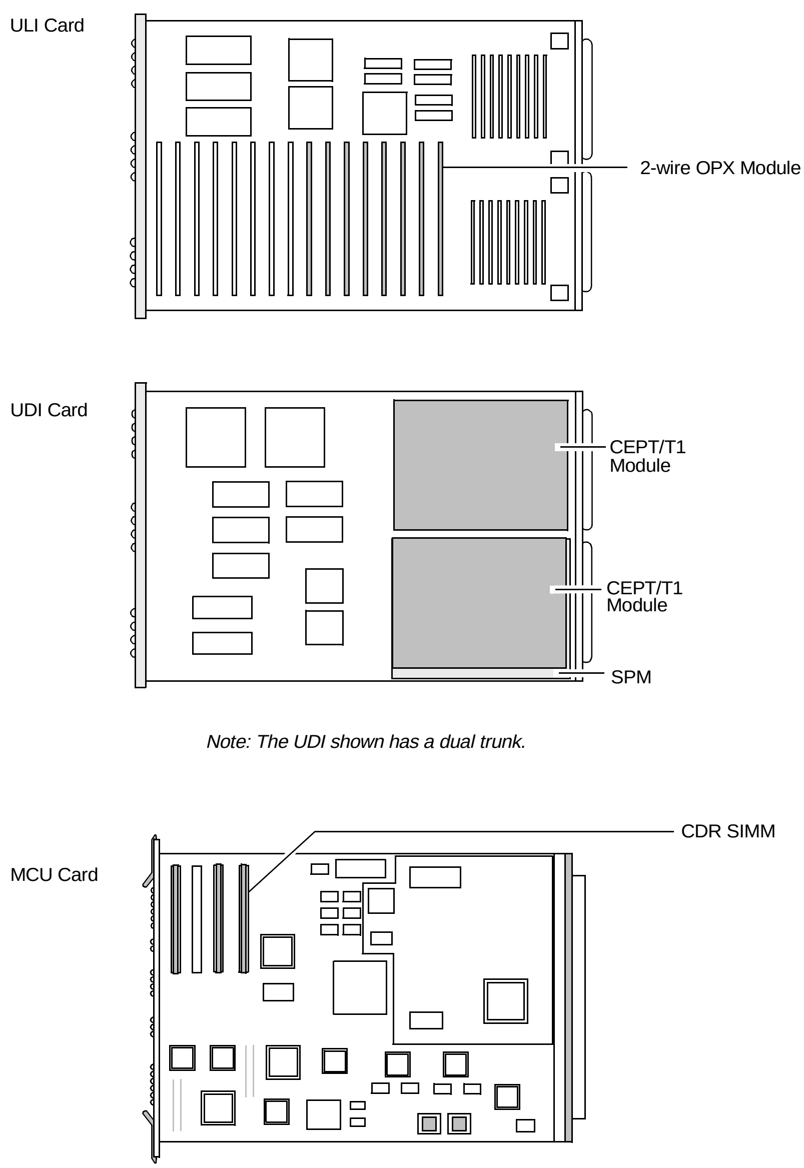
The UDI card supports E1 (CEPT) and T1 digital interfaces. Daughter cards (one per digital trunk) plug into each UDI to determine the specific type of interface. A Signal Processing Module (SPM) plugs into the UDI card to enable R1/R2 signalling. The DMUX supports up to two external trunk cards, and two internal trunk cards.

Since wired subscribers “compete” with wireless subscribers, the system performance for wireless subscribers should be adjusted if a large number of wired subscribers is supported.

Call Detail Records (CDR) SIMM

The optional CDR SIMM plugs into the DMUX's MCU card, and enables convenient bill processing. The DMUX produces and stores CDRs in its NVRAM circular file, which has the capacity to hold at least 12000 CDRs. Call records are stored on flash memory for printing and saving at your convenience.

Figure 1–38   DMUX Card Options

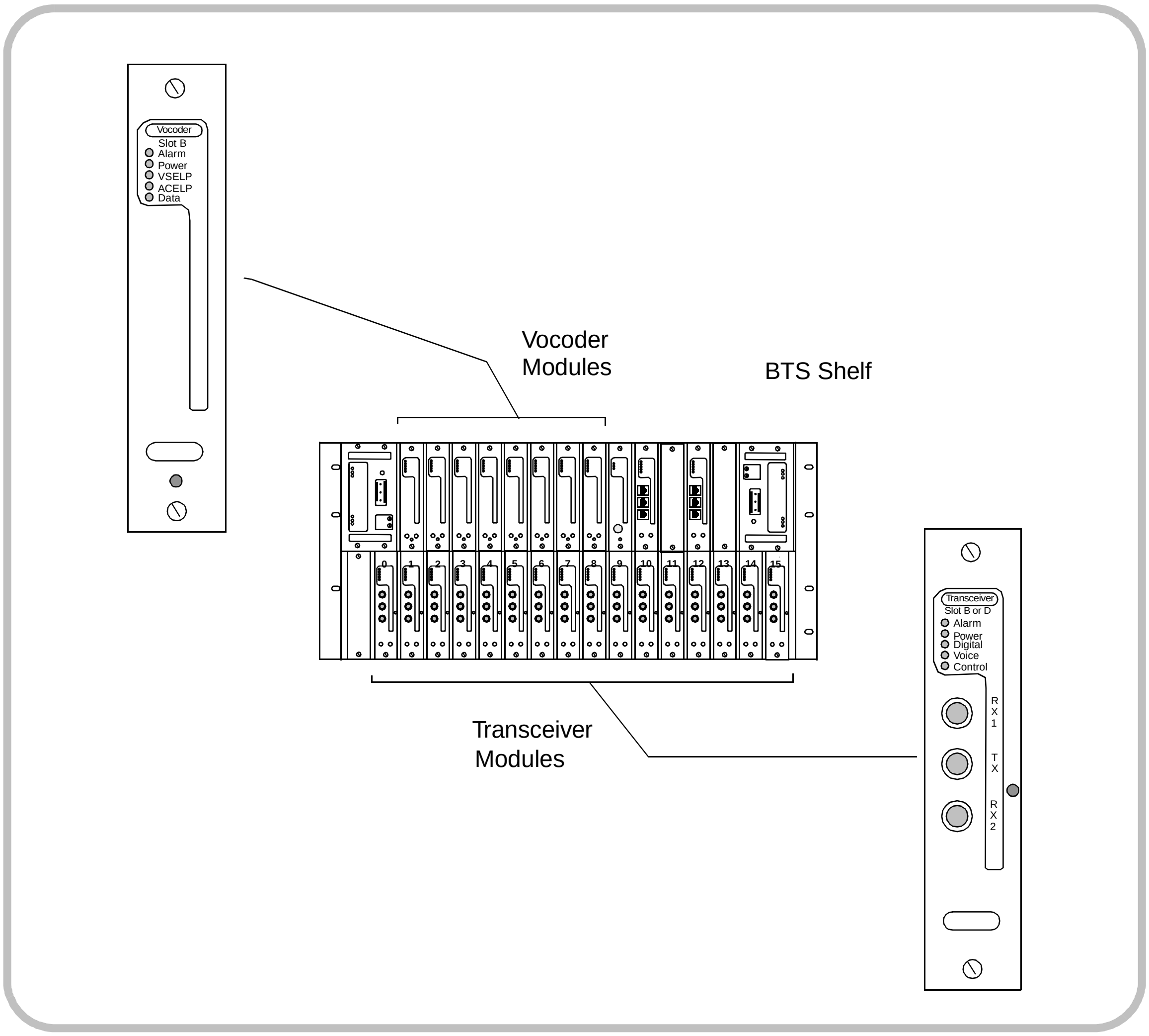


4.2 BTS Transceivers and Vocoders

Transceiver modules and vocoders can be added to the WIN*RoLL 136* to increase its capacity—see Figure 1–39.

- Each additional transceiver module adds three digital channels, or one analog wireless channel.
- If you add a transceiver for *digital* operation, you usually need to add a vocoder. Each vocoder supports two digital transceivers. (Vocoders are not required if the transceiver is operated in analog mode only.)
- Transceivers are added from left to right in the BTS shelf.

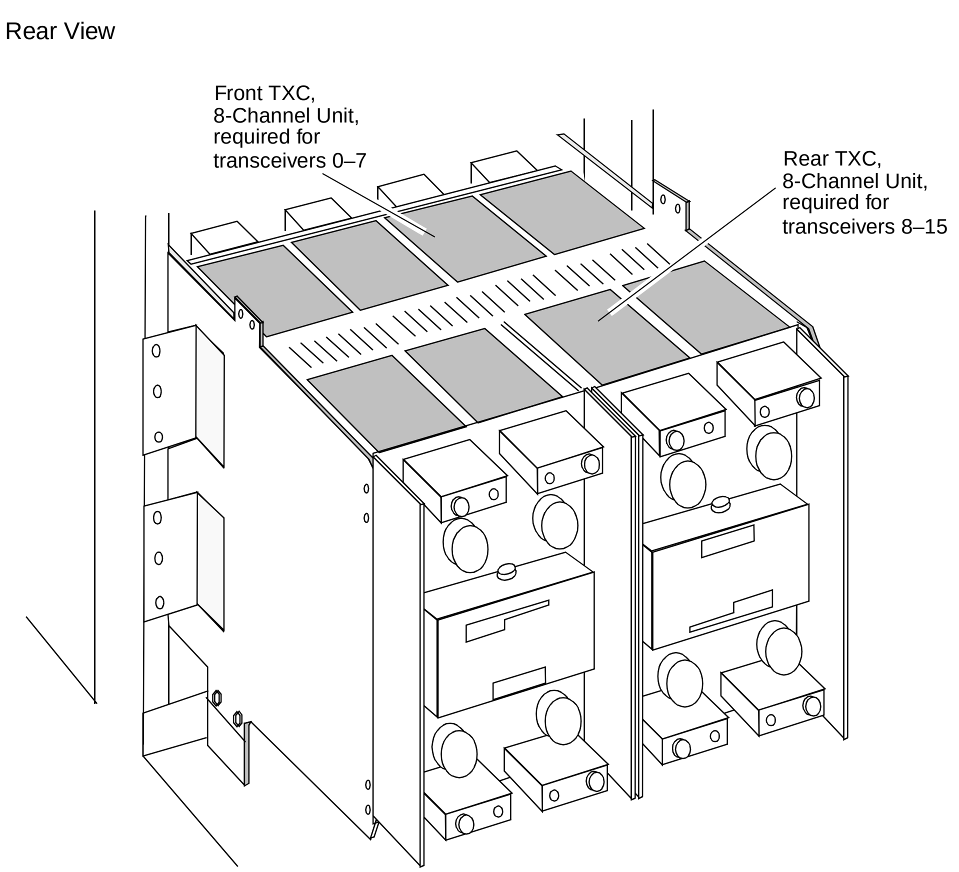
Figure 1–39 Optional BTS Transceiver and Vocoder Modules



4.3 TXC Expansion

A primary frame comes equipped with an eight-channel TXC. If you increase the number of transceivers to more than eight, you need to add a second eight-channel TXC, as shown in Figure 1–40. The additional (rear) TXC is installed behind the front TXC.

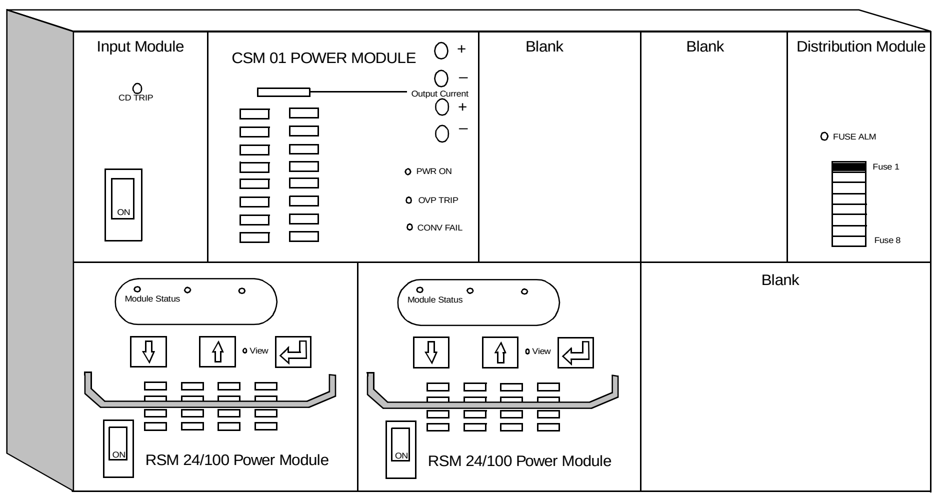
Figure 1–40   TXC Expansion



4.4 Power Plant

A compact power plant unit that provides +27 Vdc and –48 Vdc is available from Harris.

Figure 1–41 Power Supply Unit, Front View



Equipment may not appear exactly as illustrated.

5 Specifications

System Capacity	Subscribers	4800 mixed (digital or analog) 96 lines (2-wire)
	Busy Hour Call Attempts	12,000
	Erlangs	41.5 at 5% GOS
	Range of RF coverage	Up to 50 km—see Note.
	RF Channels	up to 16
	Maximum Digital Traffic Channels	47
	Maximum Analog Voice Channels	15
Physical	Depth	610 mm (24 in.)
	Height	2134 mm (84 in.)
	Width	610 mm (24 in.)
	Gross Weight (max)	295 kg (650 lb.)
Electrical	DC Power Requirements:	
	Supply Voltage	+27 Vdc ±10% Vdc
	Primary Frame Current Draw	150A @ +27 Vdc (Max.)
	Expansion Frame Current Draw	135A @ +27 Vdc (Max.)
	Ripple	400 mV
	Spurious (0.005 to 10 MHz)	<–55 dBm @ 0.3 to 3.4 kHz
	Noise	<32 dBrnC (600-ohms bridged)
	Voltage Stability	±1% of preset voltage @ 0 to 100% load
	Voltage Response	<600 msec for a step of 10 to 70%
	Voltage Over/Undershoot	<20% of preset voltage for a step of 10 to 70% load
	Additional Power Requirements:	
	Regulation	–1%, ± 0.1% load (static) <2% deviation for 50 - 100% load step
	Noise	<22 dBrnC (Voice Band) <10 mV RMS to 10 MHz (Wide Band) <50 mV p-p to 100 MHz
	Grounding	ANSI T1.313-1991 and MIL-HDBK-419 standards are used as guidelines
Radio Frequency (RF)	Air Interface	EIA/TIA IS-136 (digital and analog)
	Cell Site Receive Frequency Band	869–894 MHz
	Cell Site Transmit Frequency Band	824–849 MHz
	DPA Power Output	25 W
	RF Power Output at Antenna Port	7.9 W
	Channel Spacing	30 kHz

Network Interface	E1 (CEPT) T1 Synchronization and Clock Stability (Standard Configuration)	R2 Digital Line (AB)/R2MFC (MF-Compelled) signalling, China Signalling #1 D4/ESF (AMI or B8ZS)/ R1 MF signalling BTS recovers from E1/T1 span
Environmental	Acoustic Noise Level Relative Humidity (non-condensing) Ambient Operating Temperature Air Pressure Health and Safety Regulations (Compliance)	<75 dBA 10 to 80% 0 to +50°C 86 kPa to 106 kPa CSA 22.2
Regulatory (pending)	EMI/EMC Network Interface	FCC part 22 (with applicable FCC Part 15 rules) IC RSS–118 FCC part 68 IC CS-03

Note: The BTS and RSS provide sufficient transmitter output power and receiver sensitivity to support reliable communications (i.e., 3% BER or 12 dB SINAD) for a typical installation. Typical RF coverage is dependent on several factors including: terrain, clutter, climate, and Rayleigh multipath fading, height of the antenna, subscriber station power rating etc.

End of Chapter

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