HARRIS

WINRoLL™ Wireless Solutions

RURALNET WINRoLL

METRONET WINRoLL

System Descriptions for 800 MHz Products

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1 System Description

Contents

1 Introduction

This chapter provides an overview of the **RURALNET 800™** and **METRONET 800™** products, members of the WINRoLL™ wireless local loop product family.

RURALNET 800 offers affordable high quality digital voice telephone service to unserved or poorly served rural areas worldwide. It provides a coverage radius of 50 km and is deployed quickly and economically.

METRONET 800 offers a high capacity digital wireless local loop system for higher density suburban and urban applications. A full set of features is available, including advanced network management, data and fax, and advanced fraud protection.

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

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

Advanced Feature Sets, page 47, describes the software feature sets.

Optional Hardware, page 53, describes some optional hardware for the RURALNET 800 and METRONET 800.

Specifications, page 61, lists technical specifications.

2 System Overview

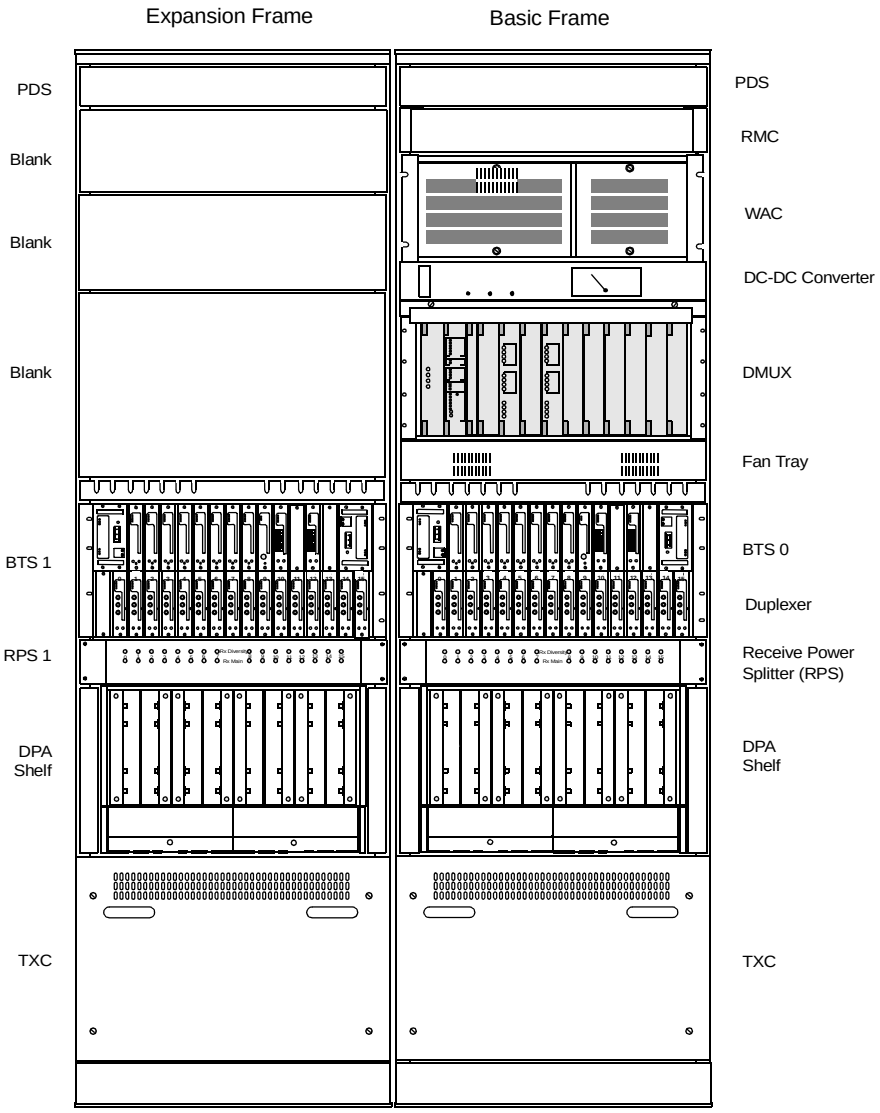
The RURALNET 800 and METRONET 800 are members of the WinRoLL family of full-featured digital wireless local loop (WLL) communications systems. WLL technology is an efficient way to provide basic telephone service without the expense of installing and maintaining kilometers of copper wire. In developed countries, WLL opens up competition by enabling new service providers to bypass existing wireline networks to deliver voice and data services. Available features include:

- Economical Public Telephone Service—A low-cost way to provide high-quality basic telephone service, replace existing facilities, or expand telephone services especially in low-density, rural areas. The RURALNET 800 and METRONET 800 can service up to 6000 phone or fax numbers, and connects to the existing PSTN with T1/E1 digital trunks.
- Digital Air Interface—Industry-proven IS-136 TDMA (time division multiple access) air interface significantly increases the voice capacity of each RF channel compared to a conventional analog channel. Up to 16 RF channels with a capacity of three digital traffic channels per RF channel are currently available (47 digital traffic channels and 1 digital control channel).
- Wireless Intelligent Network—Multiple, enhanced services are available, which are distributed across a network. Services are flexible and quick to deploy.
- Low Cost Subscriber Unit—An economical fixed radio terminal is available from Harris. Subscribers plug standard telephone sets into compact radio transceivers.
- Fast rollout time—The system and subscriber units are installed and made operational in a very short time.
- Local Call Completion—Calls originating and terminating within the same wireless service area can be routed locally within the RURALNET 800 and METRONET 800, instead of being routed through the PSTN. As a result, more calls can be processed more efficiently.
- Wired-line Service—Up to 96 local subscribers can obtain conventional wired service by connecting directly to the RURALNET 800 and METRONET 800. This feature enables service companies to provide limited wired telephone service to local subscribers.
- Centralized Operation and Administration—Able to control multiple RURALNET 800 and METRONET 800 sites from a single workstation called the RoLL Operations Centre (ROC).
- Enhanced system monitoring and subscriber maintenance support.
- Pulse metering for Public Call Office (PCO) operation and billing is supported.

RURALNET 800 and METRONET 800 offer a high degree of flexibility, low cost per subscriber, low cost of maintenance, and fast installation.

A RURALNET 48-channel digital system is contained in a single frame. Adding a METRONET expansion frame increases the capacity to 95 digital voice channels. Figure 1 shows a METRONET system.

Figure 1 METRONET 95 Voice Channel System



Note: ROC is not shown.

A fan tray provides additional cooling to the DMUX.
An echo canceller function is implemented within the BTS shelf.

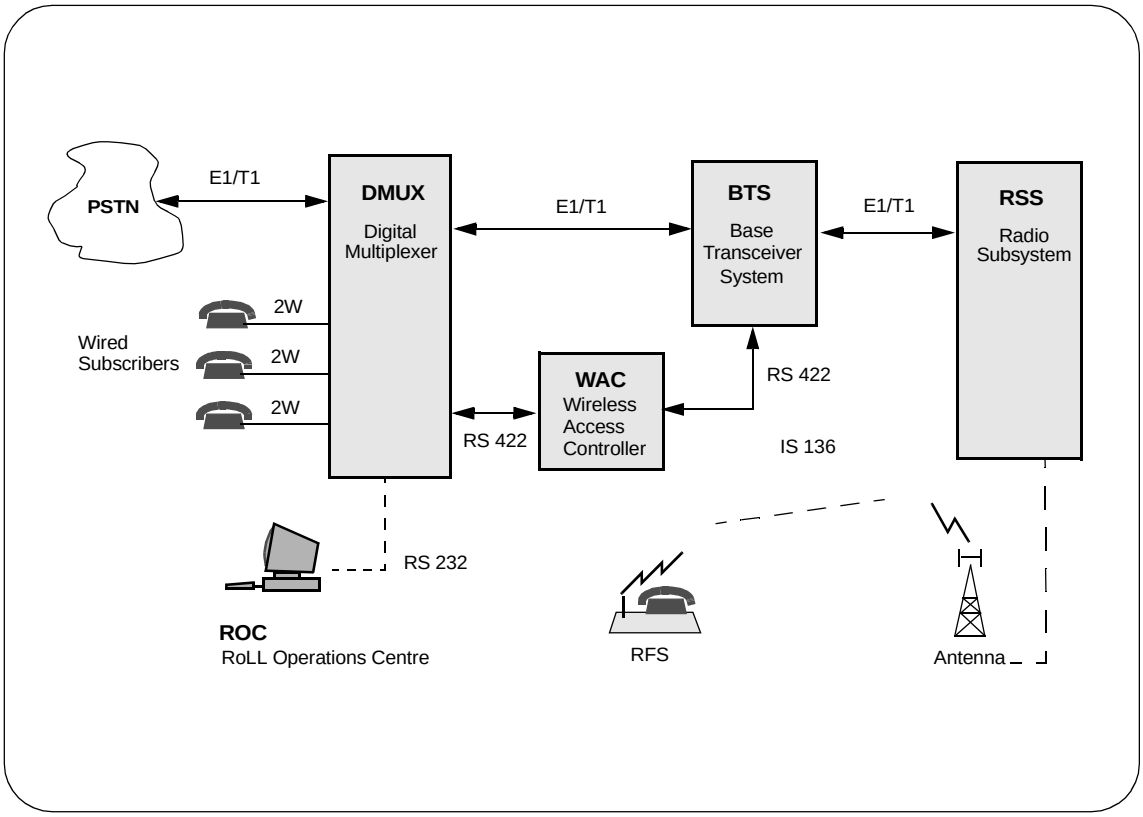
2.1 Hardware Subsystems

The RURALNET 800 and METRONET 800 consist of five hardware subsystems and other equipment:

- RoLL Operations Centre (ROC)
- Wireless Access Controller (WAC)
- Digital Multiplexer (DMUX)
- Base Transceiver System (BTS)
- Radio SubSystem (RSS)
- Other Equipment

Figure 2 shows a block diagram of the subsystems. *Hardware*, page 15 describes each subsystem in detail.

Figure 2 Subsystems



RoLL Operations Centre (ROC)

The ROC is the system's operation and administration centre. It is a Pentium™ based graphics workstation with ROC*Pilot*™ application software. ROC*Pilot*™

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

Figure 3 ROC and Operator

Wireless Access Controller (WAC)

The WAC is the *system control* centre of the RURALNET 800 and METRONET 800. 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), WAC self-monitoring, and alarm processing.

Digital Multiplexer (DMUX)

The DMUX directs communication between the local telephone network and the RURALNET 800 or METRONET 800. It links the system to the external communications network via digital E1/T1 (PCM) trunks, and cross-connects (multiplexes) information between trunks and radio transceivers. An internal PCM 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, echo cancelling, and DPA control. BTS operation is controlled by the WAC. A 32-channel system has two BTSs: BTS0 and BTS1.

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 BTS transceivers to a level suitable for on-air transmission
- Transmitter Combiner (TXC)—filters and combines outputs from DPAs into a single transmit output that goes to antenna
- Duplexer—isolates transmit signal from receive signal, making it possible to use single antenna for both receiving and transmitting

Other Subsystems and Equipment

Other susbsystems and equipment include:

- Echo Canceller—A software function in the BTS minimizes echo on transmission lines caused by end-to-end propagation delays, signal processing delays, and impedance mismatches in telephone circuits.
- Power Distribution Shelf—distributes +27 Vdc (from the power plant) to the components in a frame, and provides circuit breaker protection for the components.

Optional

- Power Plant—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.

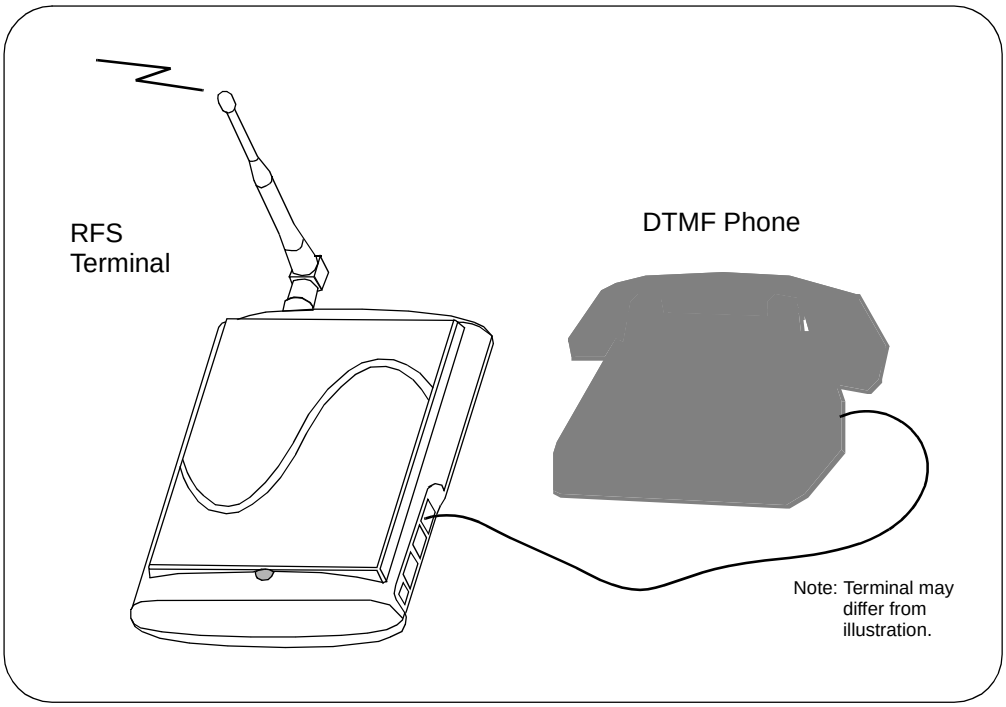
Alternate

- Fan Tray—cools the DMUX.
- Antennas—must meet Harris specifications. The primary frame requires a main (transmit/receive) antenna, and a diversity (receive) antenna.

Optional

- RFS (Radio Fixed Station)—is a fixed subscriber station. The RFS is a stand alone digital radio transceiver with a 2-wire interface port (RJ11) for connecting an analog phone, analog FAX port, and data port (RJ45) for digital FAX, PC, and data. It has a message display interface for short data messages, email and metering pulse rates.

Figure 4 RFS

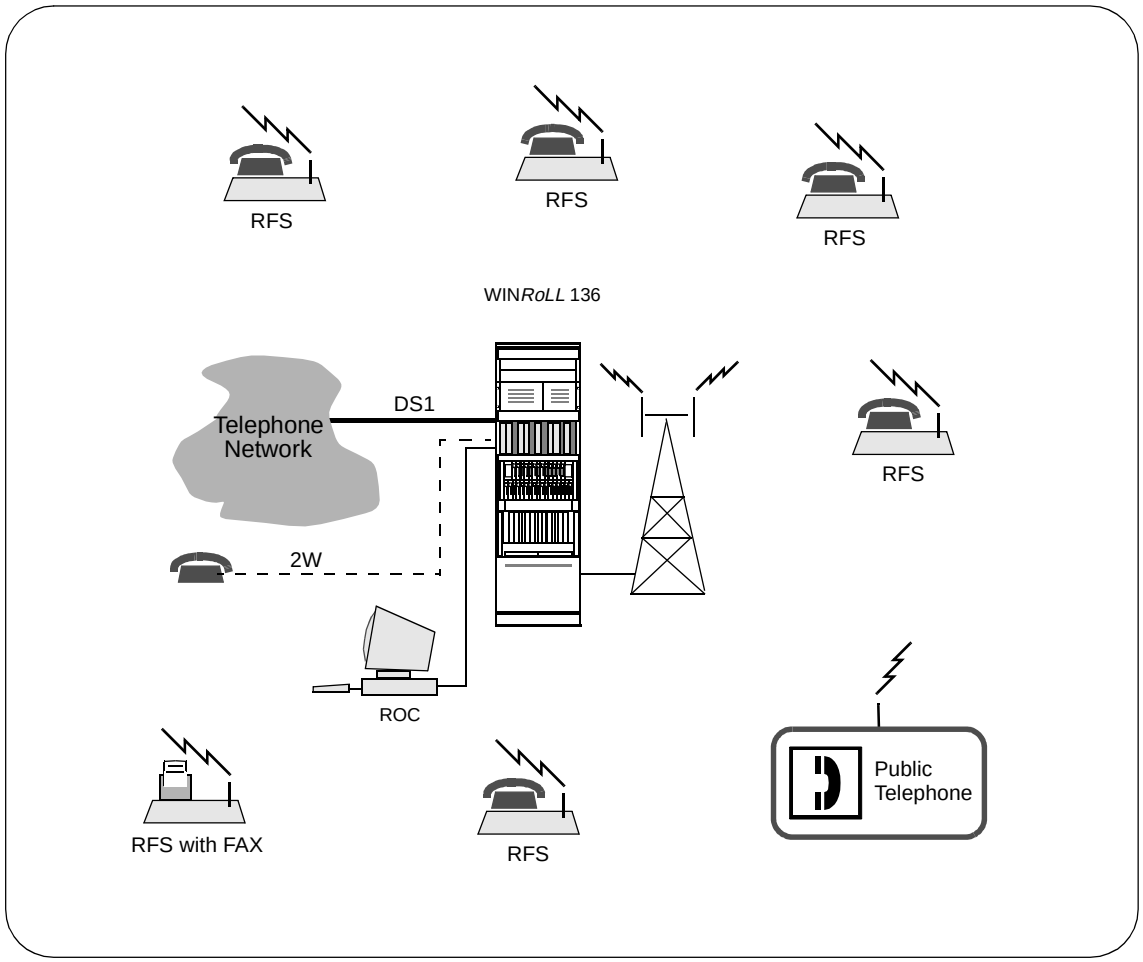


The RFS also has a Personal Indentification Number (PIN) or password that the user requires in order to make calls. The PIN is user selectable, and it can be enabled or disabled by the user at any time.

2.2 System Architecture

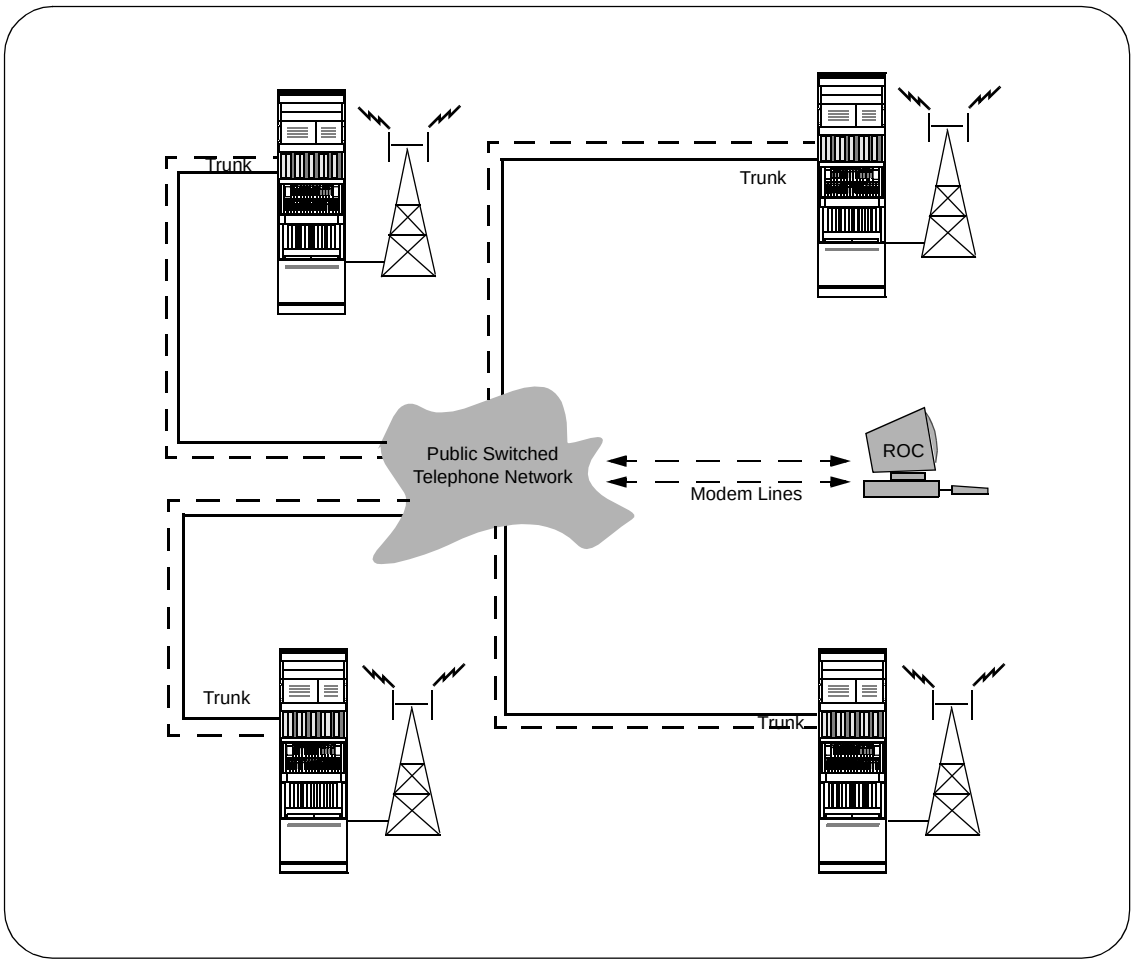
The RURALNET 800 and METRONET 800 connect to a telephone network via one or more digital trunks. Figure 5 shows a basic system, which supports a variety of subscriber stations. (If the system is private, it can simply be connected to another RURALNET 800 or METRONET 800 system).

Figure 5 System Architecture



The ROC controls single or multiple RURALNET 800 or METRONET 800 systems via modem(s)—see Figure 6. A standard ROC with four modems can support four sites simultaneously, or up to 32 RURALNET 800 and METRONET 800 sites with polled communication.

Figure 6 ROC Servicing Multiple Sites



2.3 Expansion

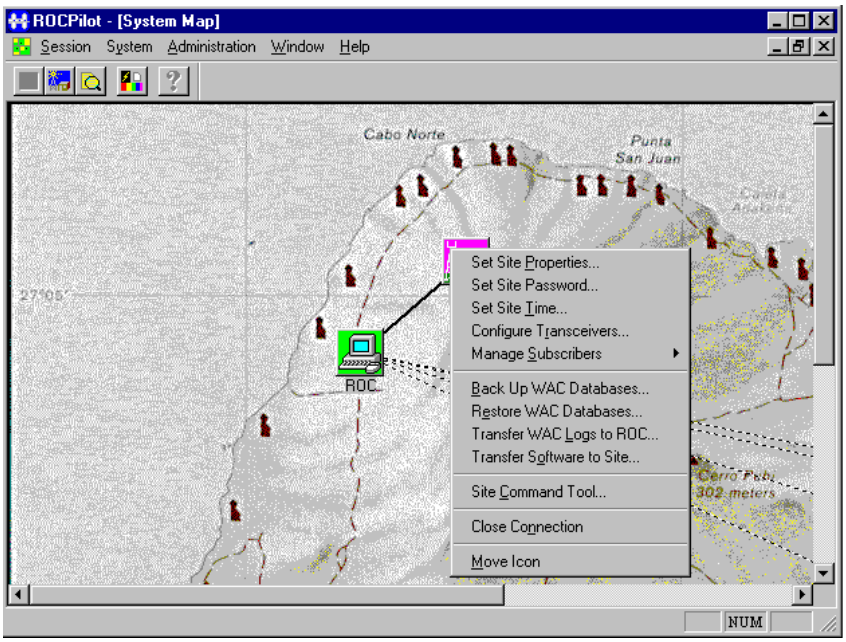
A RURALNET 800 consists of a basic frame with a capacity of up to 16 RF analog channels (48 digital channels). To add more channels within a frame, you add transceivers (each additional transceiver provides one more analog channel or three digital channels) and you add other components such as vocoders, DPAs, and TXCs.

By adding the METRONET 800 expansion frame, you can increase the capacity up to 95 digital traffic channels.

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 an icon, menu, or button. Figure 7 shows a sample screen.

Figure 7 ROC*Pilot* Sample Screen



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.

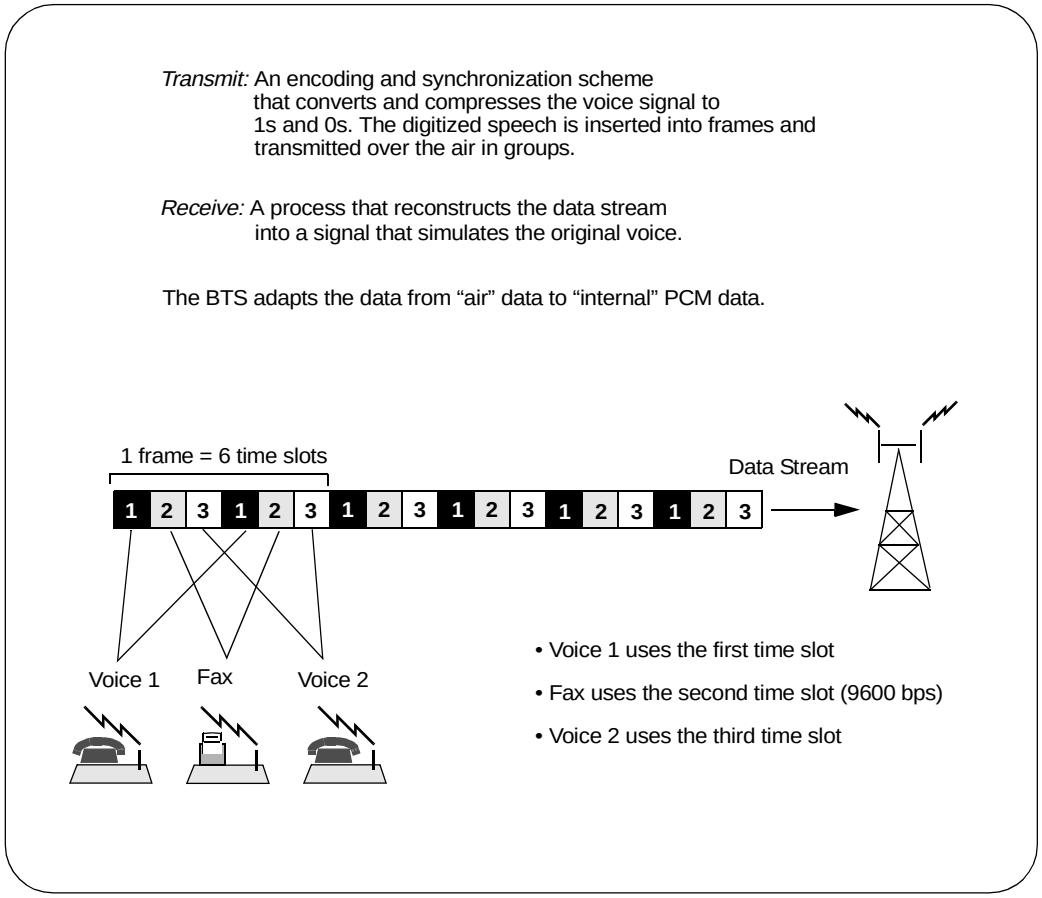
2.5 IS-136 Overview

Digital wireless communication is based on IS-136 communication standards. The following section is a brief overview of IS-136. For more information about IS-136, visit **www.uwcc.org**. For general information about TDMA, WLL and other wireless topics, visit **www.webproforum.com**.

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. When transmitting to the RURALNET 800 and METRONET 800, subscriber stations 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 8.

When transmitting to subscriber terminals, the BTS takes up to three conversations from the telephone network, encodes , and transmits them to subscriber stations over a single conventional RF wireless channel.

Figure 8 Time Division Concept



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 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.

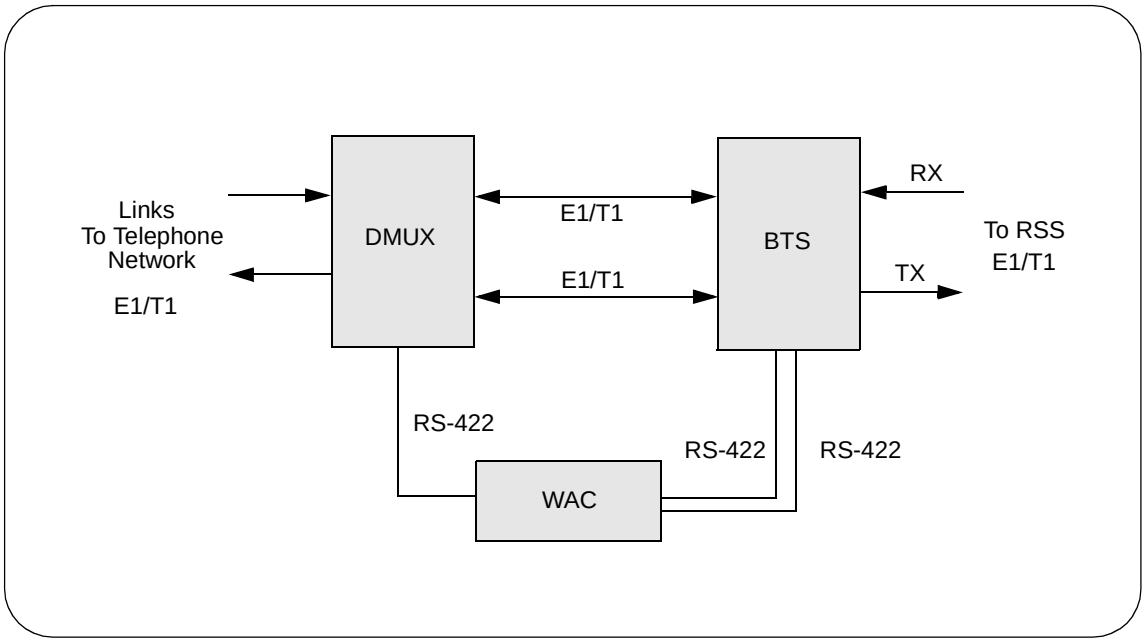
2.7 Internal Links

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 9.

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 9 Internal Links



2.8 Call Processing

Origination

The RFS monitors the DCCH. When a digital subscriber originates a call, the RFS 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 or WAC 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.

Termination

When paging, the WAC sends messages to subscriber stations using the DCCH. If it receives a response from the station, the WAC configures an unused transceiver to either a DTC or AVC (depends on the the number called), 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 on the apllicable FAX or voice port. 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 is then ready for a new call. Channels are rotated by last used, next idle to maximize equipment life.

Optional

Analog FAX Channel

The directory number determines if a network-originated call is processed as a FAX call or as a voice call. If a call originates from the FAX port of an RFS, the WAC assigns an analog voice channel (AVC) to the call. (One BTS transceiver is temporarily assigned to operate as an analog voice channel)..

2.9 External Links

Digital (PCM) trunks can be used to connect the RURALNET 800 and METRONET 800 to the telephone network. Two kinds of digital trunks are available: 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.

A limited number of wired phone subscribers can connect directly to the RURALNET 800 and METRONET 800. The total number of wired and wireless subscribers depends on the equipment configuration.

3 Hardware

This section describes the main hardware components of the RURALNET 800 and METRONET 800 basic frame, shown in Figure 10. (The ROC is not shown, but it is one of the main components.) A block diagram of a basic system is provided in Figure 11.

Figure 10 Main Components

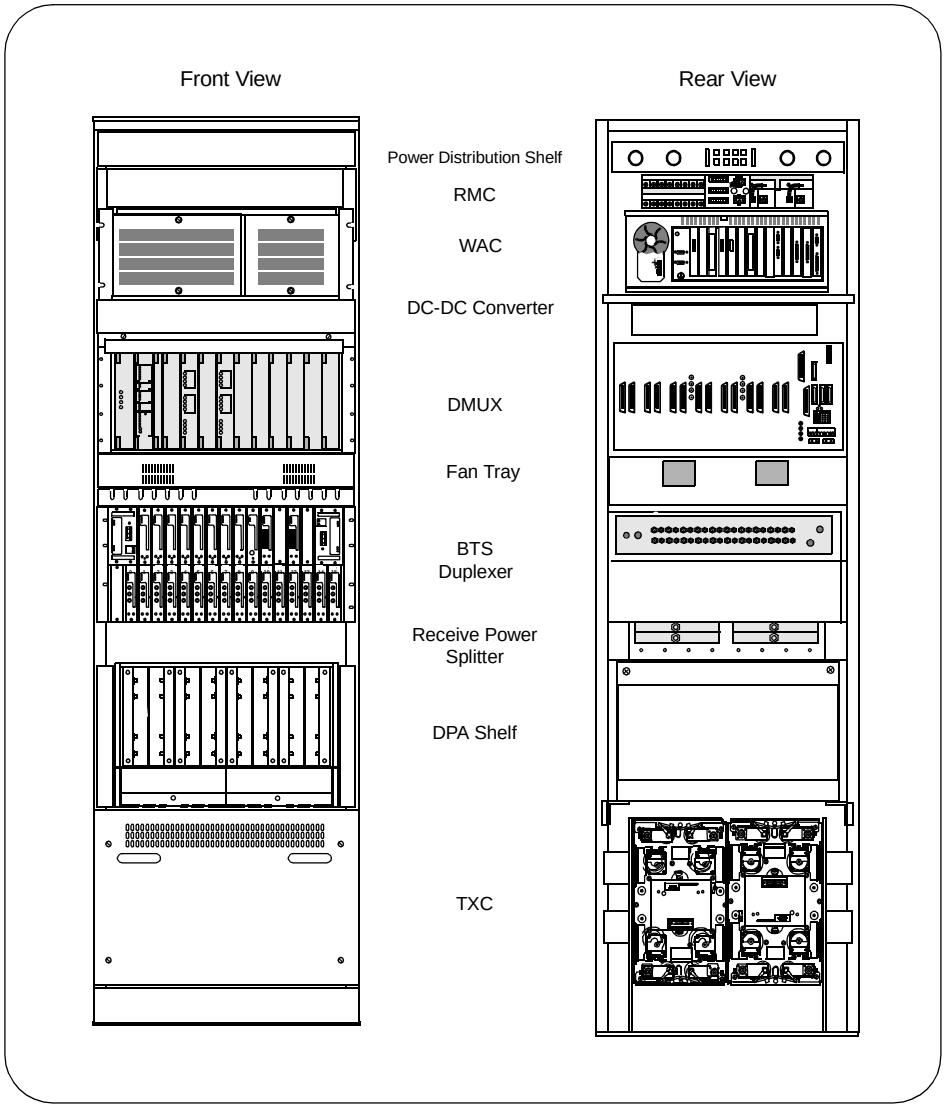
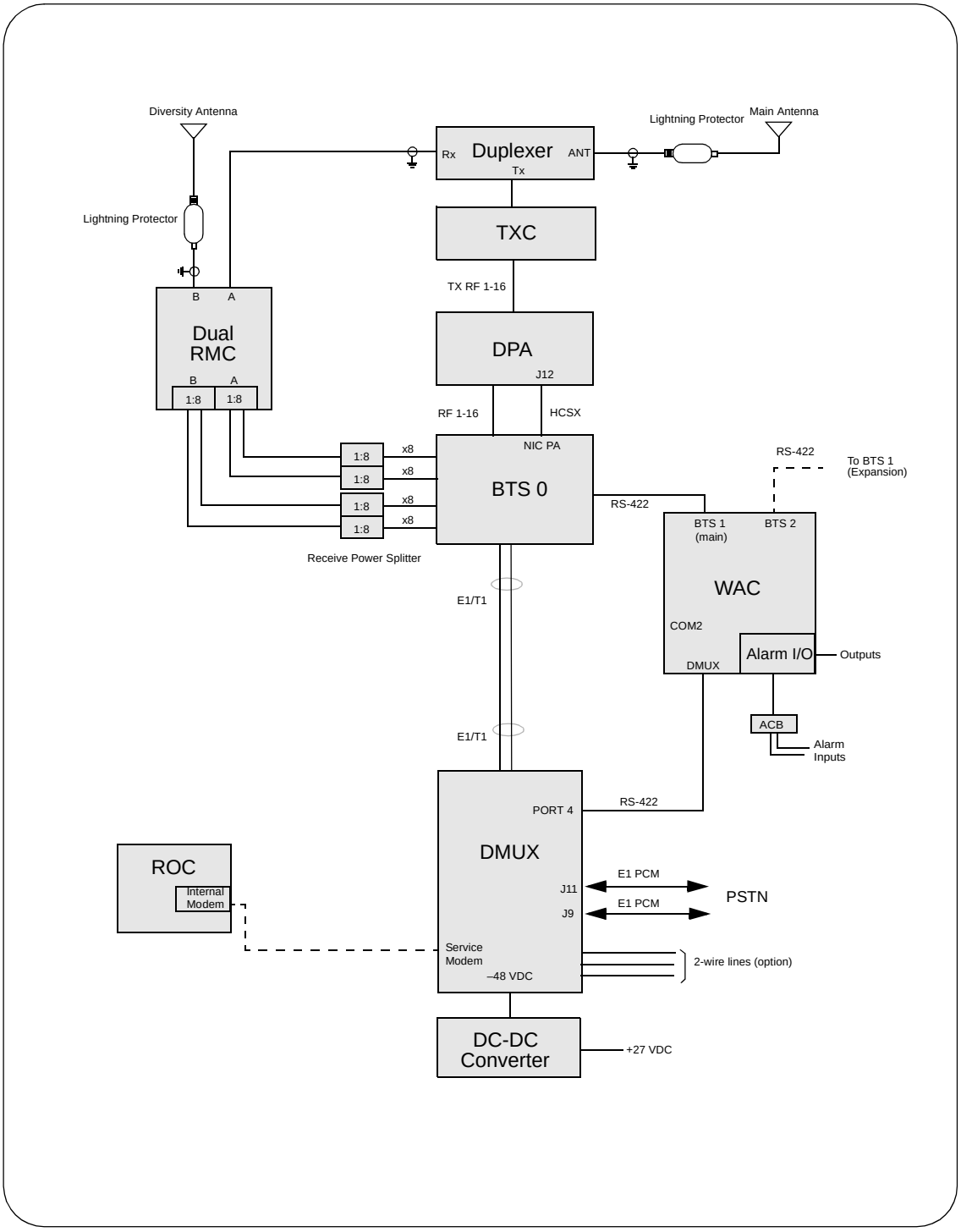


Figure 11 Basic Block Diagram



3.1 RoLL Operations Centre (ROC)

The ROC provides the user interface to operate and manage the RURALNET 800 and METRONET 800. The ROC is a standalone graphics workstation with ROC*Pilot* application software—see Figure 12. The software features an intuitive Windows™-based graphical user interface. The ROC connects to the DMUX via a modem and telephone facilities.

Figure 12 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. Some other functions of the ROC include:

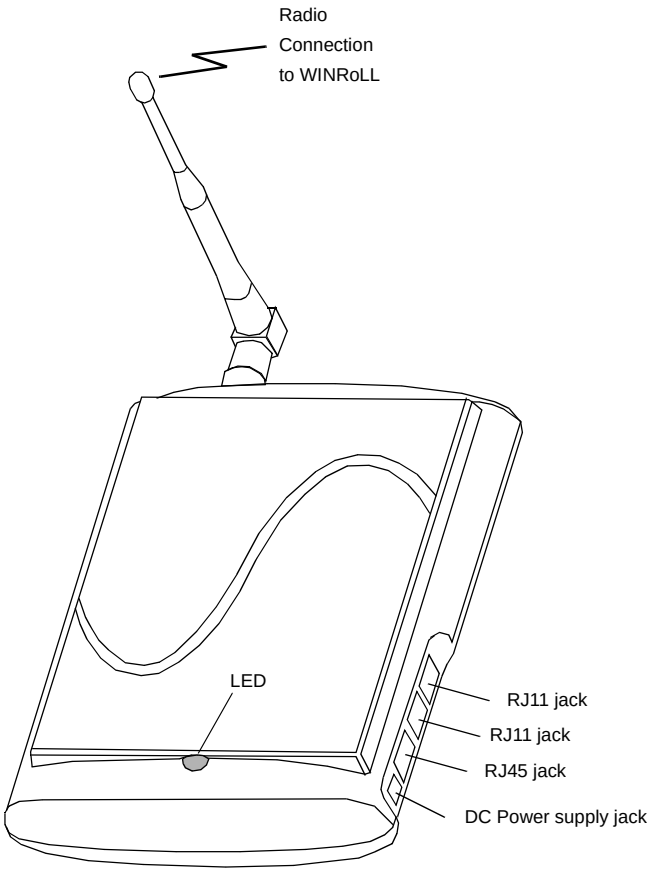
- alarm, log, trace, and maintenance information
- performance analysis and status reports
- DMUX, WAC, and BTS configuration
- subscriber administration and feature activation/deactivation
- software upgrades.

3.2 RFS Subscriber Terminal

Optional

The RFS (Radio Fixed Station) is a fixed subscriber terminal that is available from Harris. It is a stand-alone digital radio that consists of a 800 MHz band cellular transceiver and communication ports: a 2-wire (RJ11) jack for connecting an analog phone set, an RJ11 jack for analog fax, and an RJ45 interface for data, debug, digital fax, or PC. It operates with unregulated DC power adapter or optional battery back-up. It can be easily mounted on a wall, or placed on a table.

Figure 13 RFS Subscriber Terminal

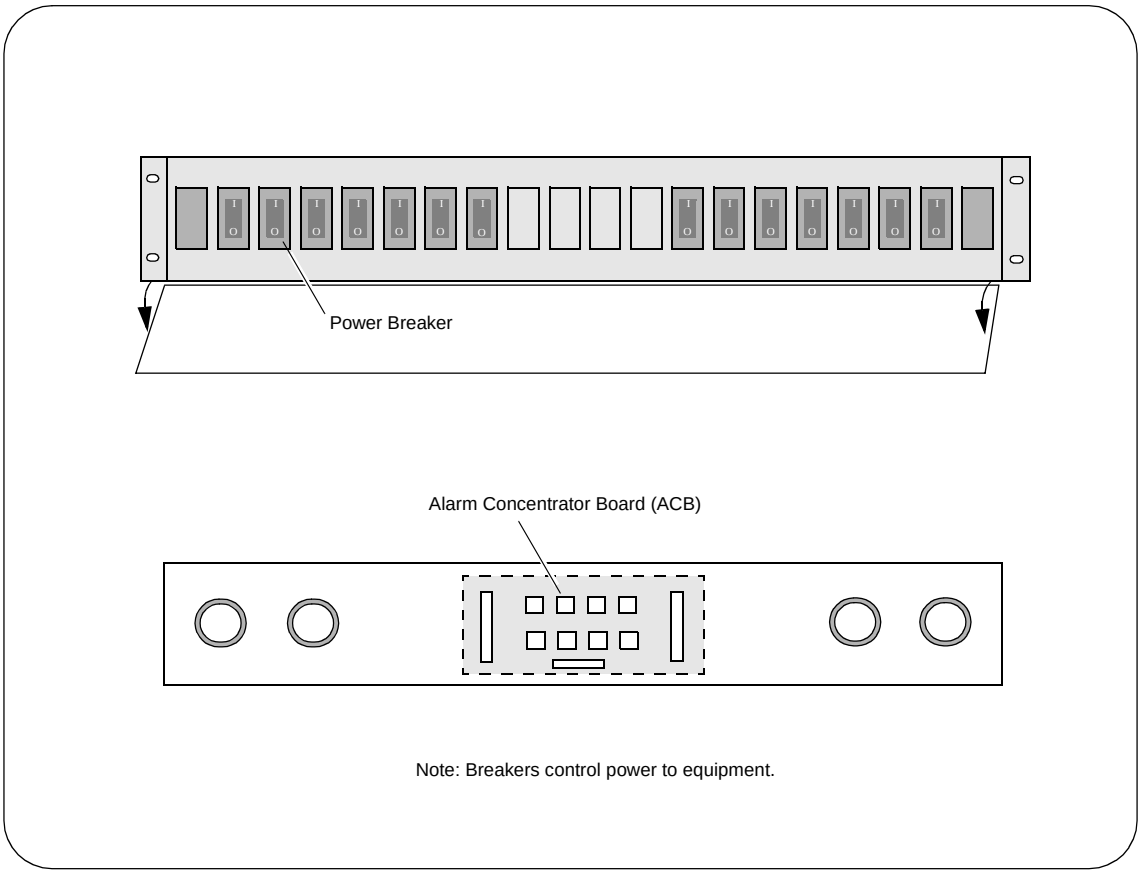


Note: RFS may differ from illustration.

3.3 Power Distribution Shelf

The Power Distribution Shelf (PDS) distributes DC power from the power plant to components in the frame—see Figure 14. 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.

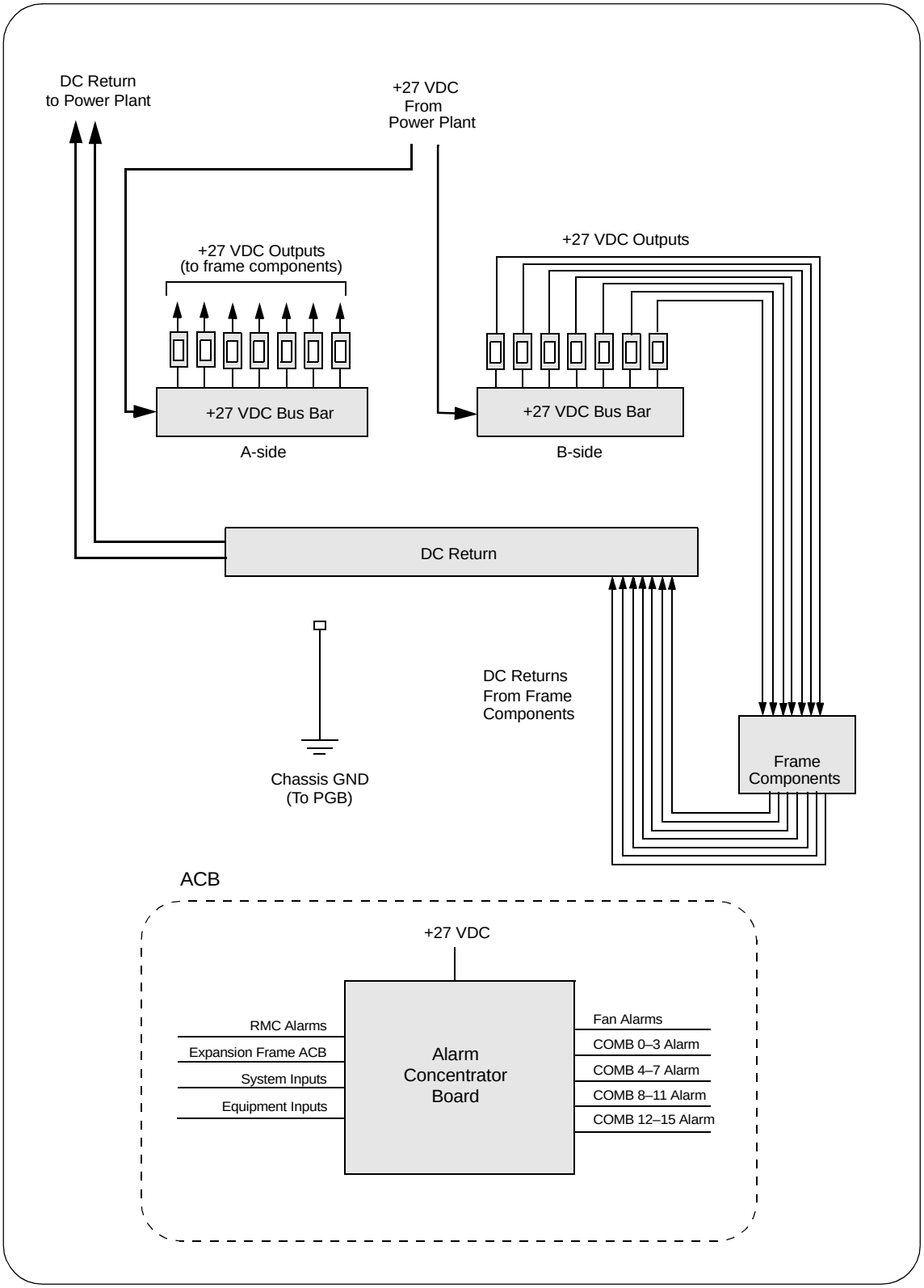
Figure 14 Power Distribution Shelf



Operation

The PDS 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 15. The circuit breakers provide circuit protection, and can be used to turn individual components on or off.

Figure 15 Power Distribution Shelf, Block Diagram

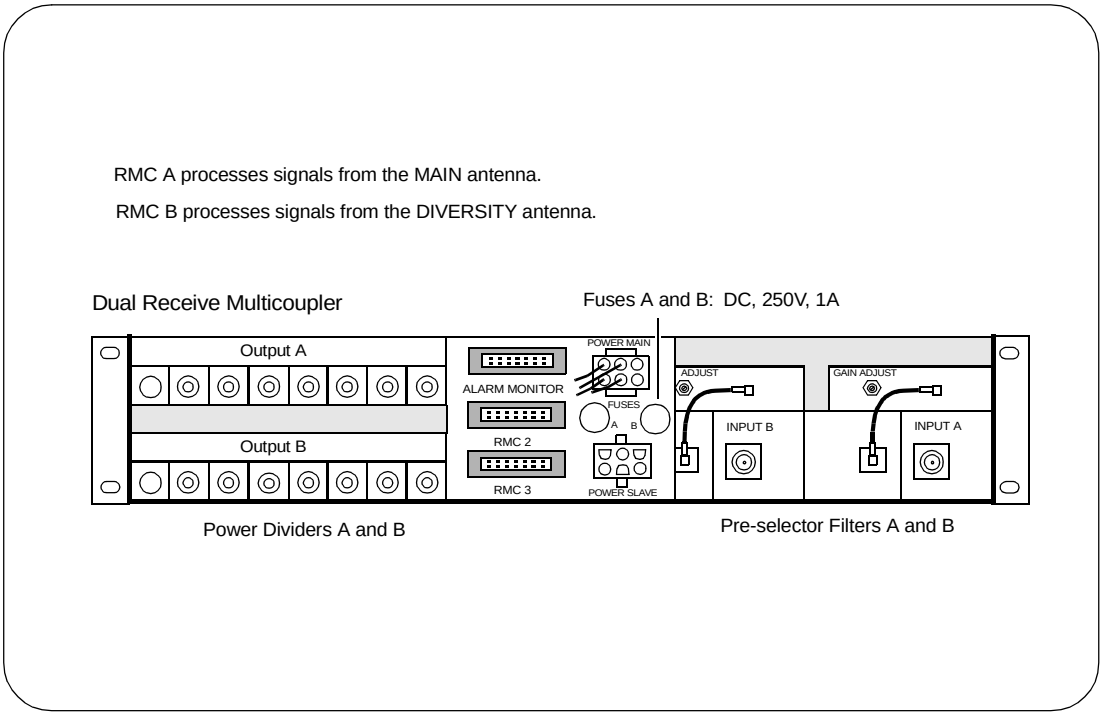


3.4 Receiver Multicoupler (RMC)

The RMC filters, amplifies, and distributes incoming radio signals from the antenna(s)—see Figure 16. 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 splitter, 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 17, page 22 shows how the signal is distributed.

Figure 16 RMC, Rear View



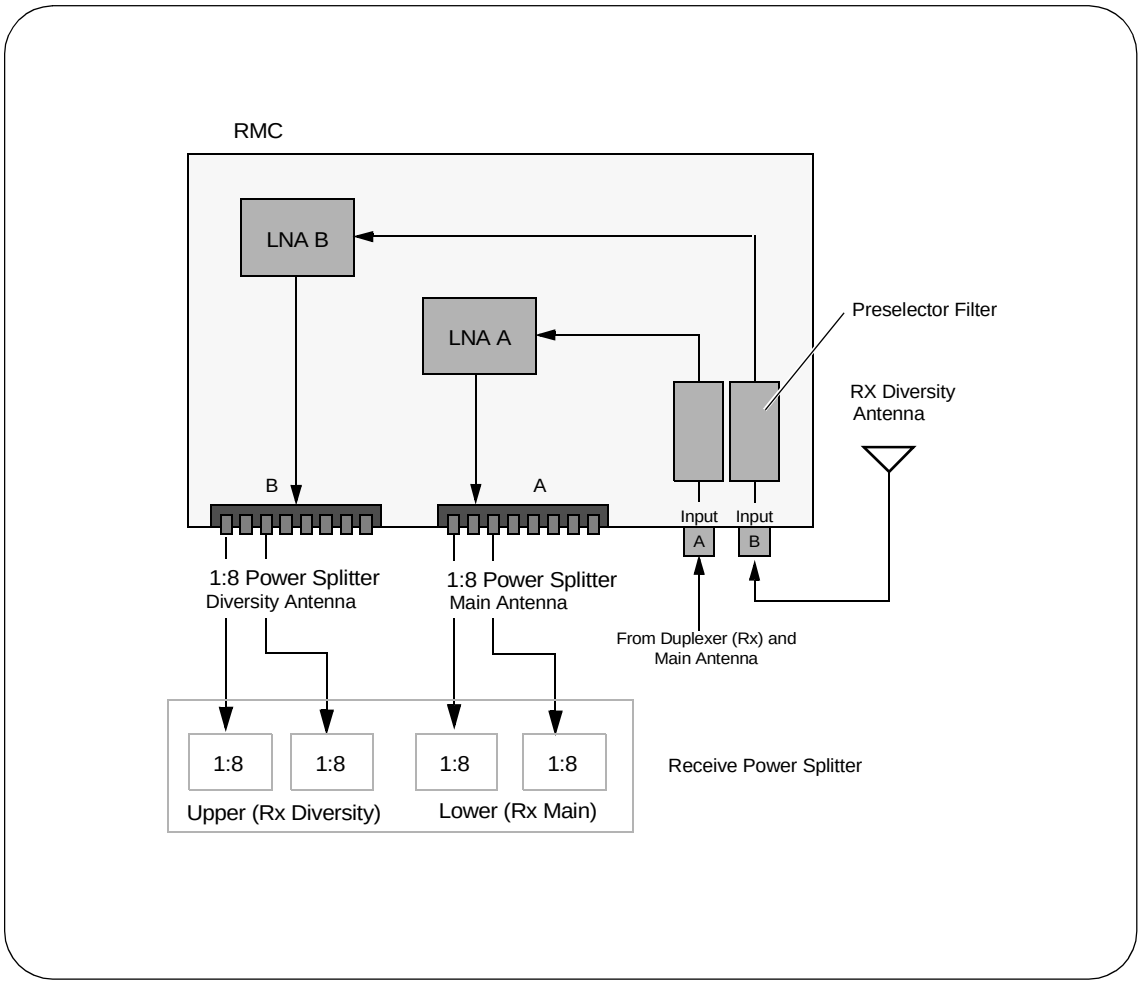
Operation

The pre-selector filter isolates the received RF signal from other transmit frequencies and further isolates 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, filters, 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 17. Two of the “B” outputs are also routed to the RPS. With an expansion frame in operation, an additional 2 outputs each from “A” and “B” are routed to a second RPS.

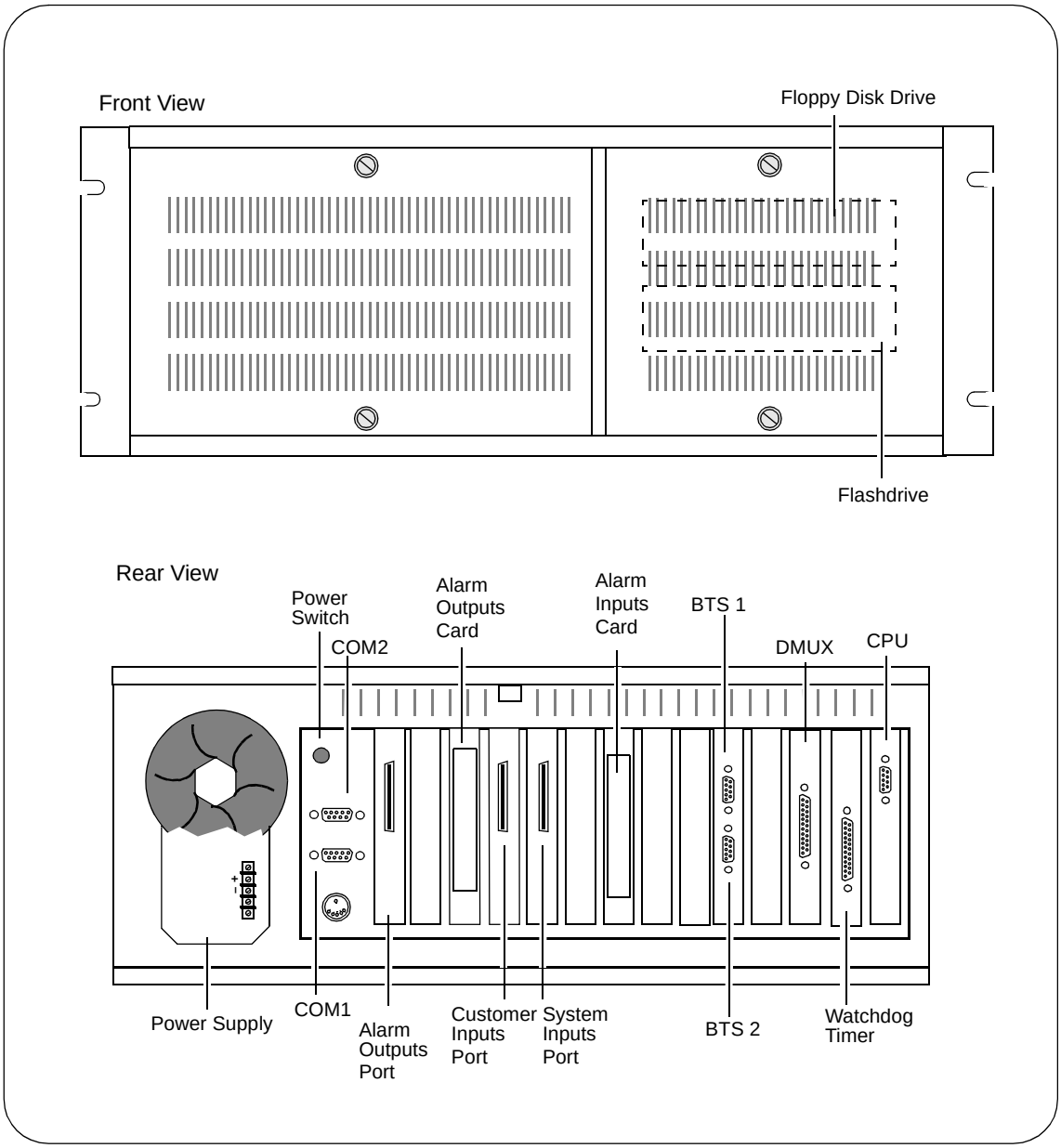
Figure 17 RMC Block Diagram



3.5 Wireless Access Controller (WAC)

The WAC, shown in Figure 18, 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. The WAC monitors its own operation and takes appropriate action if tasks fail.

Figure 18 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.
- Guardian task (self-monitoring function).
- PCO phone support

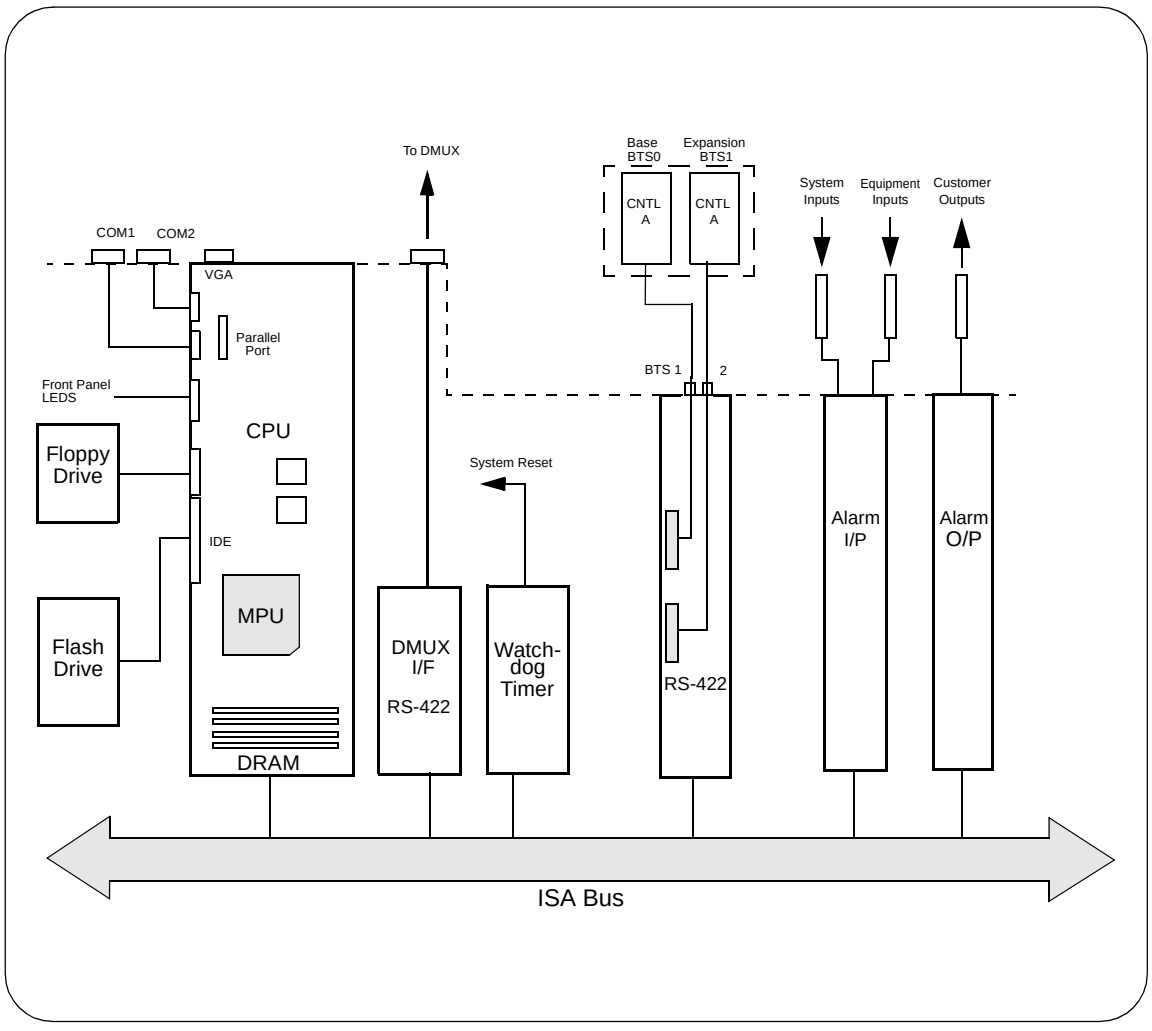
A flash EPROM stores the Vx Works® operating system, which is loaded (decompressed) to a solid-state hard disk. Data and software can be downloaded to the WAC through the RS-422 serial communication port, or via the floppy disk drive.

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. It contains the following: • 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. • IDE interface supporting two or four 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	A multiport asynchronous controller with two DB9 RS-422 ports provide digital links to the basic frame BTS and expansion frame 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).

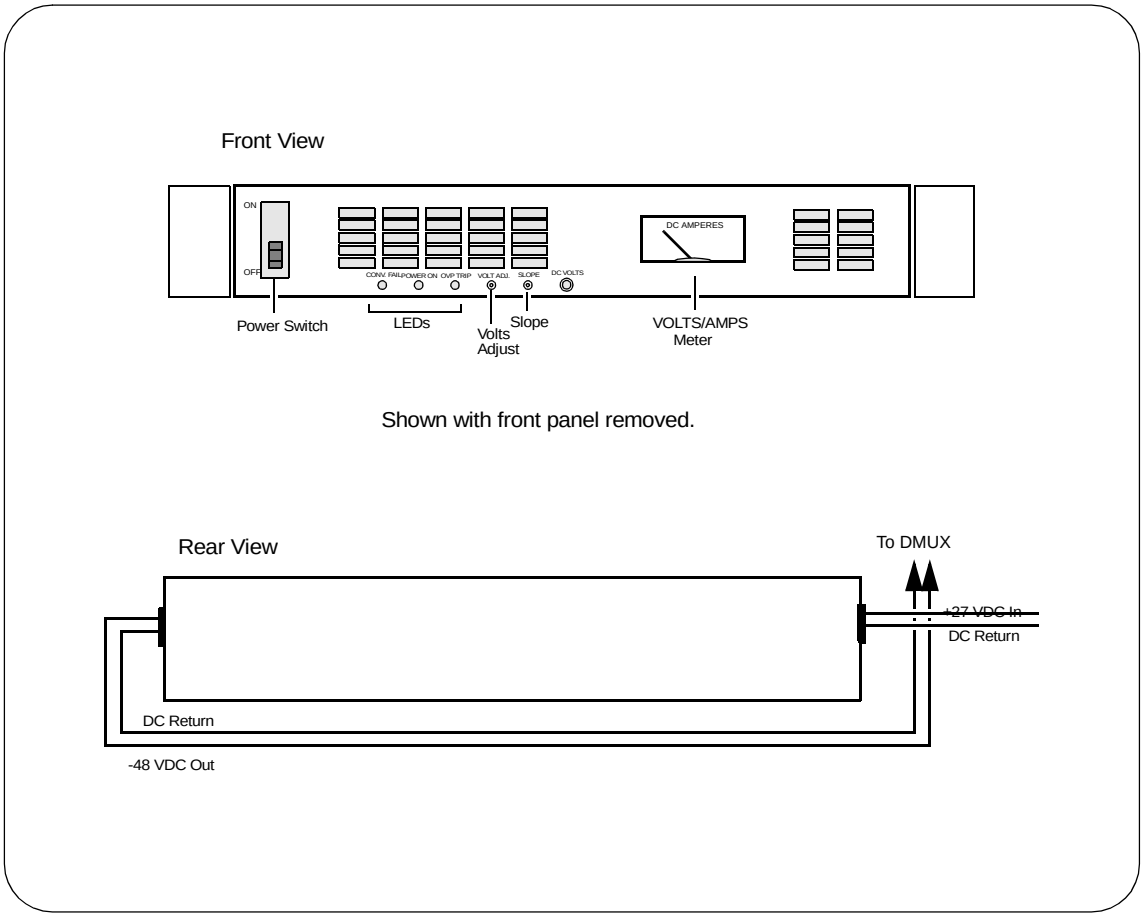
Figure 19 WAC Block Diagram



3.6 DC–DC Converter

The DC-DC converter, shown in Figure 20, supplies –48 Vdc to the DMUX .The input voltage to the converter comes from the DC distribution shelf (+27 Vdc).

Figure 20 DC-DC Converter



3.7 Digital Multiplexer (DMUX)

The DMUX can perform several important functions, depending on the feature sets you purchase:

- Links RURALNET 800 and METRONET 800 to telephone network (via 1st order E1/T1 digital trunks)
- Links up to 96 local wired-subscribers directly to RURALNET 800 and METRONET 800
- 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 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

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

Figure 21 Direct Connection to the ROC

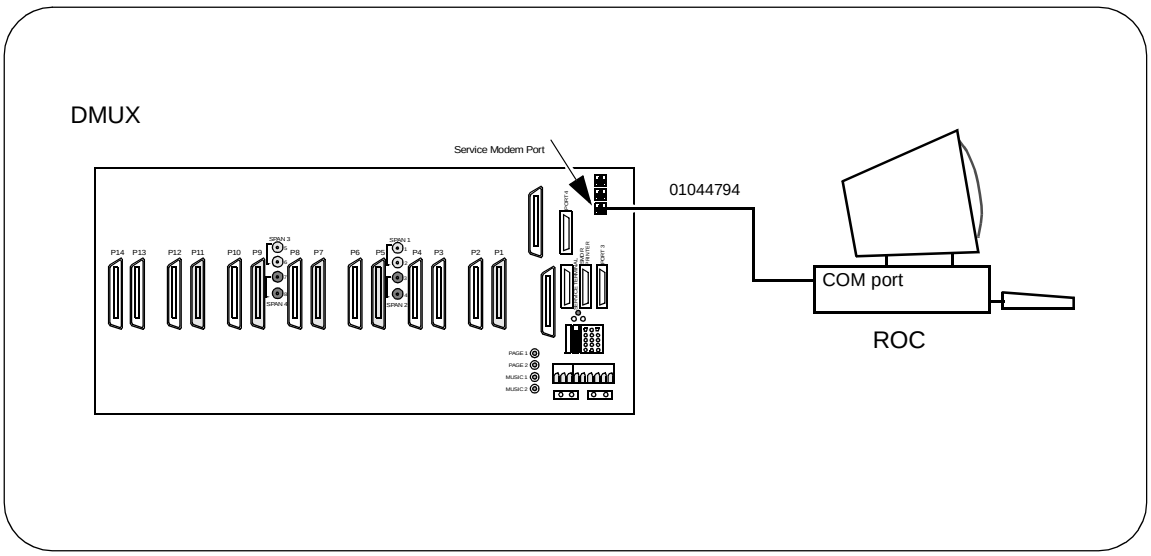
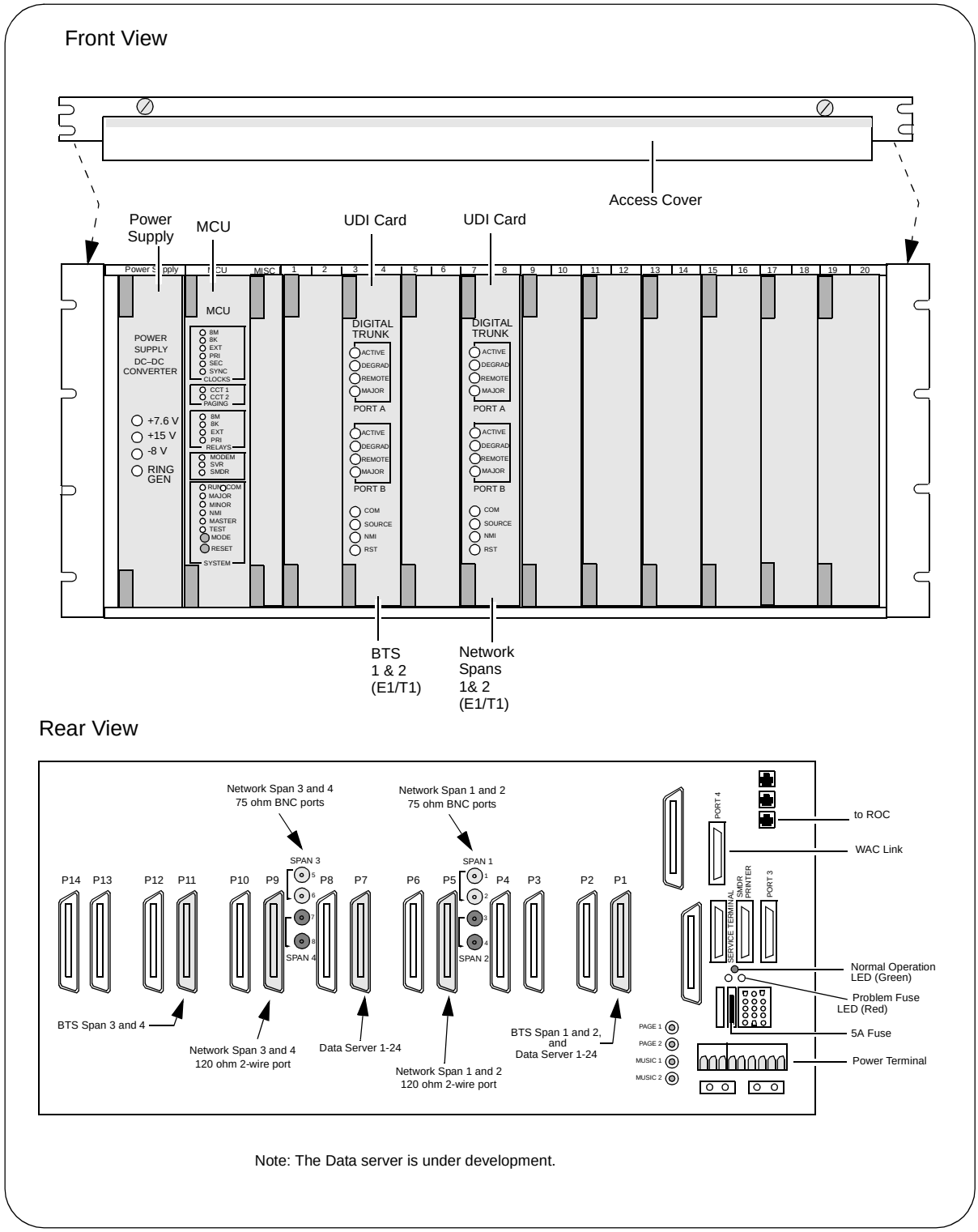


Figure 22 shows a basic DMUX card configuration for 16 RF channels.

Figure 22 16 Channel DMUX: Dual Digital Span



Note: The Data server is under development.

Figure 23 through Figure 29 show some basic DMUX configurations.

Figure 23 16 Channel DMUX: E1Configuration with 96 Subscriber Lines

Optional

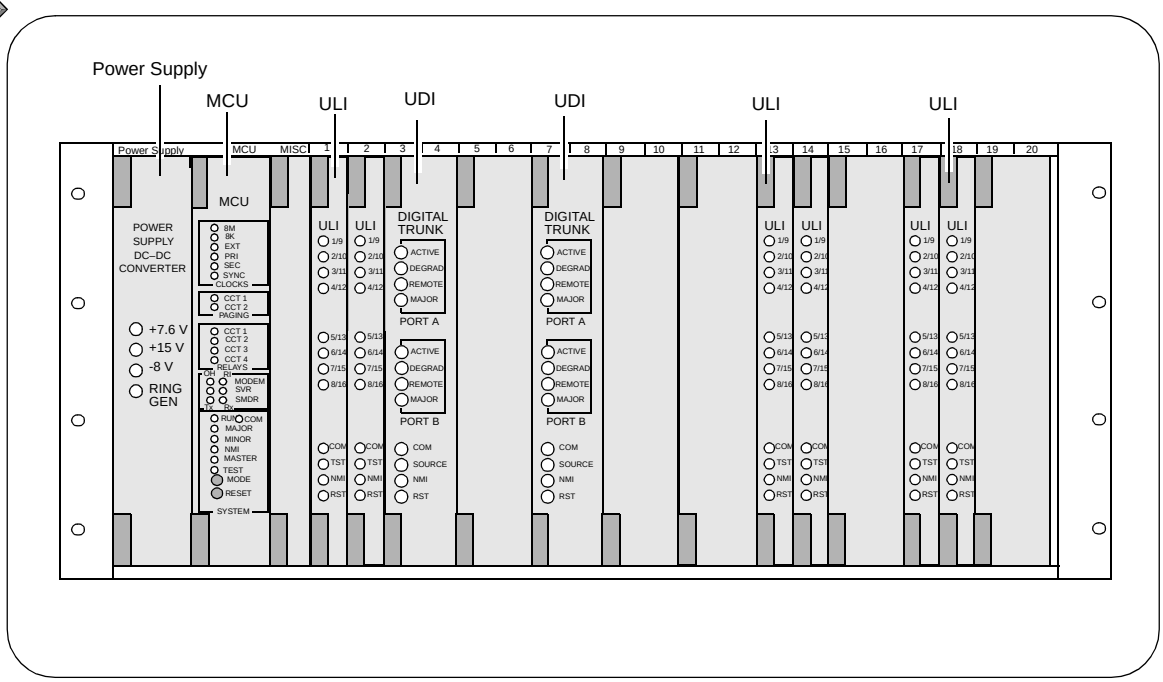


Figure 24 16 Channel DMUX: T1 Configuration with 88 Subscriber Lines

Optional

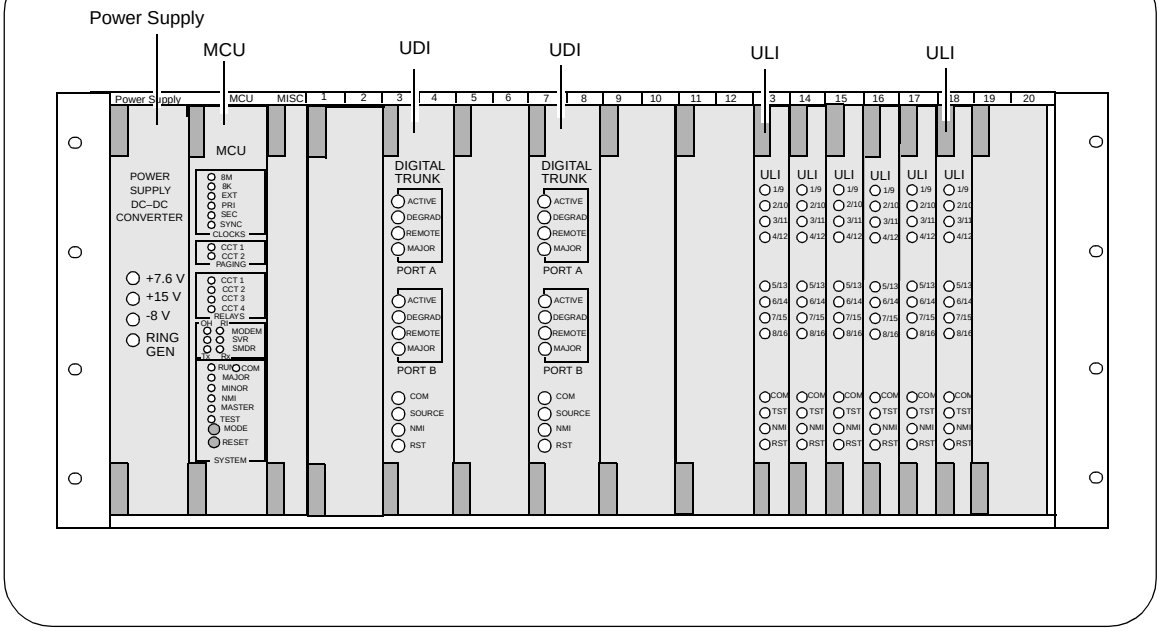
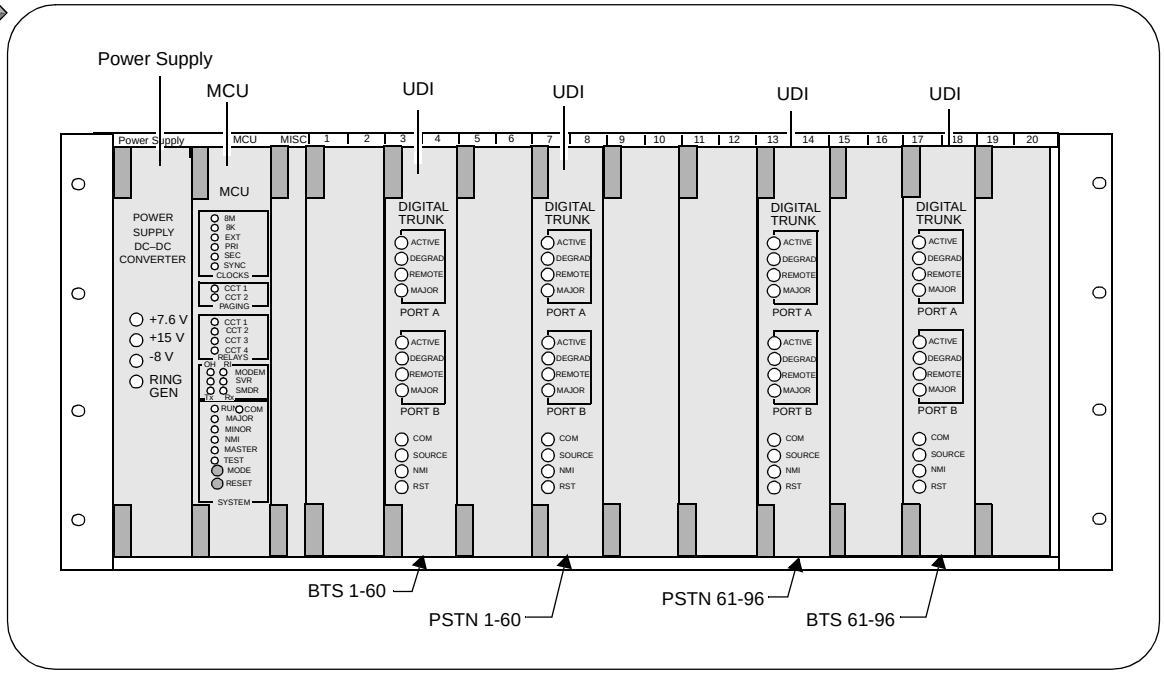


Figure 25 32 Channel DMUX : E1 Configuration

Optional



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.

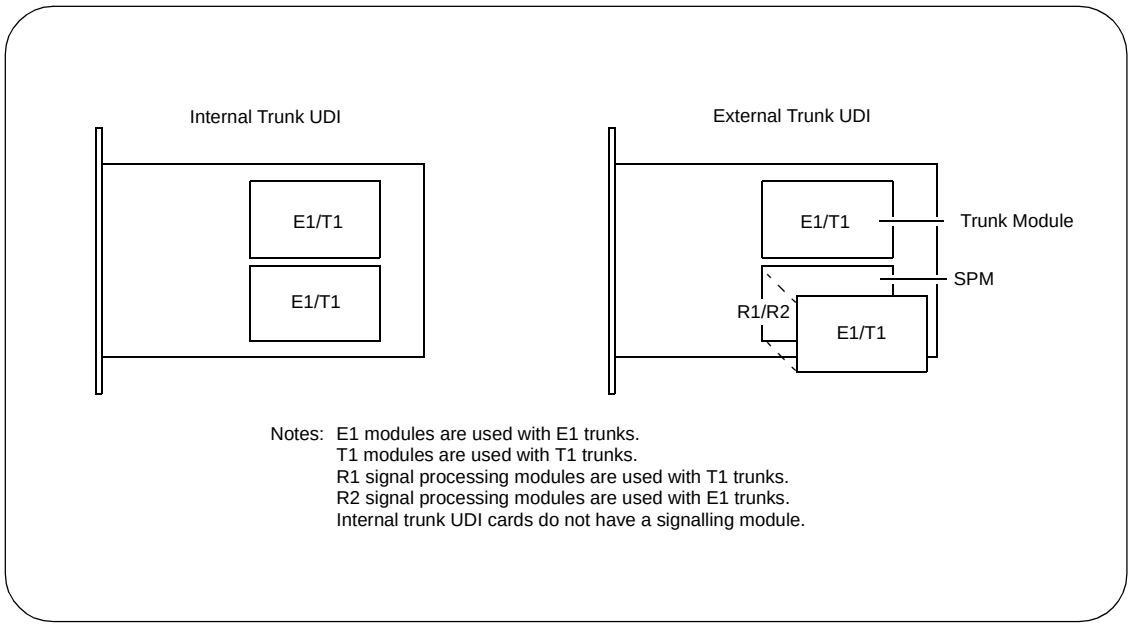
DMUX Operation

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.

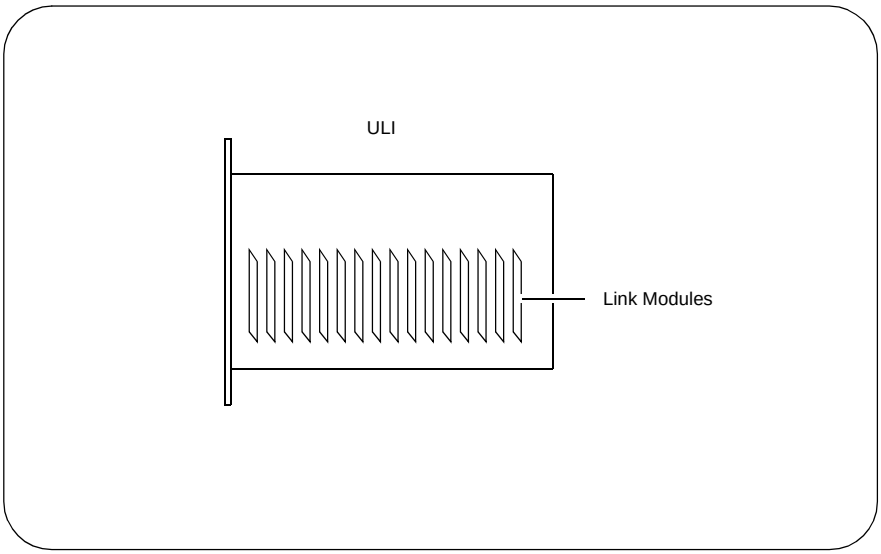
Figure 26 UDI Modules



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).

Figure 27 ULI Link Module Location



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 23 illustrates the maximum configuration with *no subscriber lines*. Figure 29 shows a configuration with the *maximum number of subscriber lines (96)*.

Figure 28 16 or 32 RF Channel DMUX

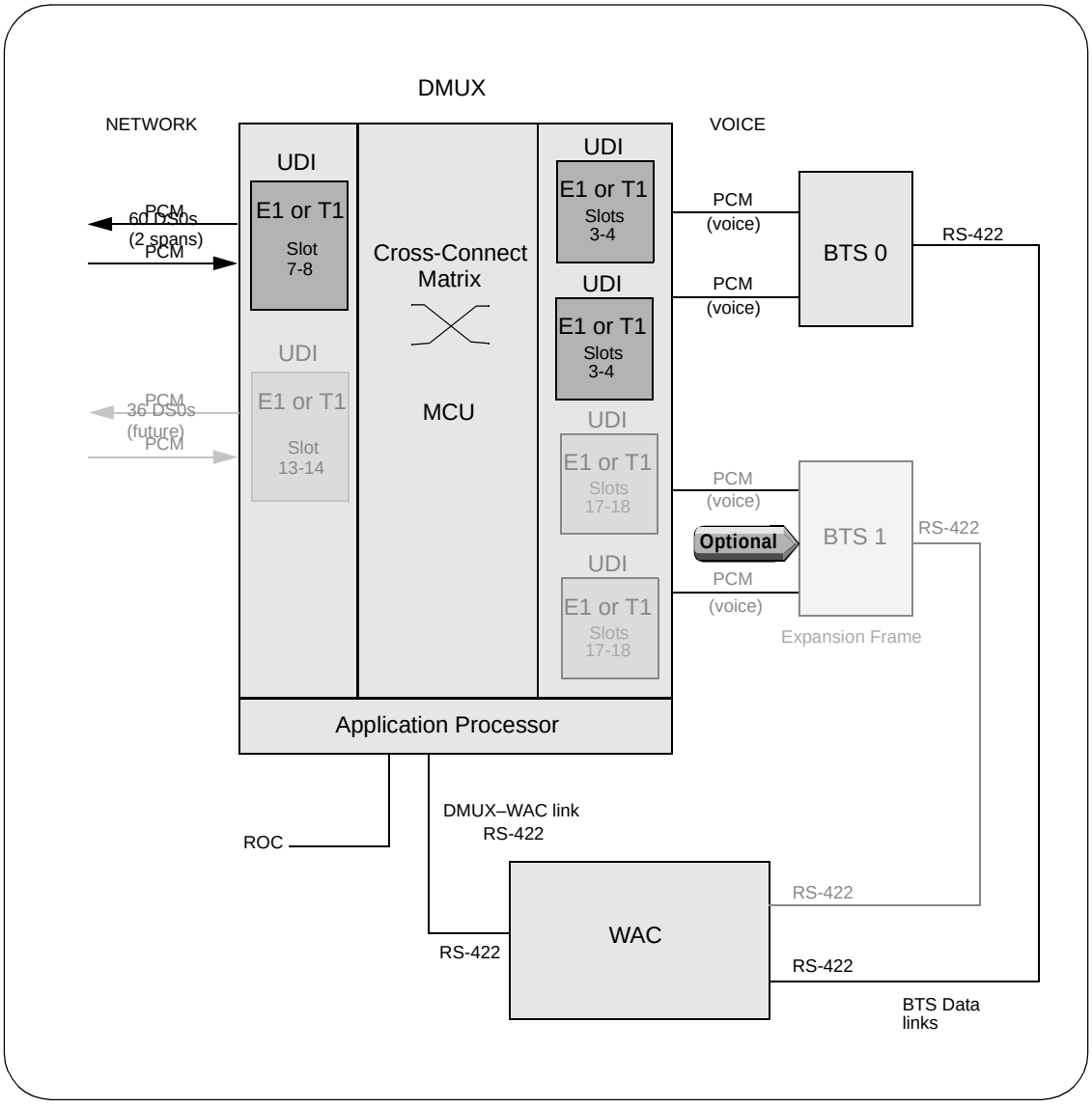
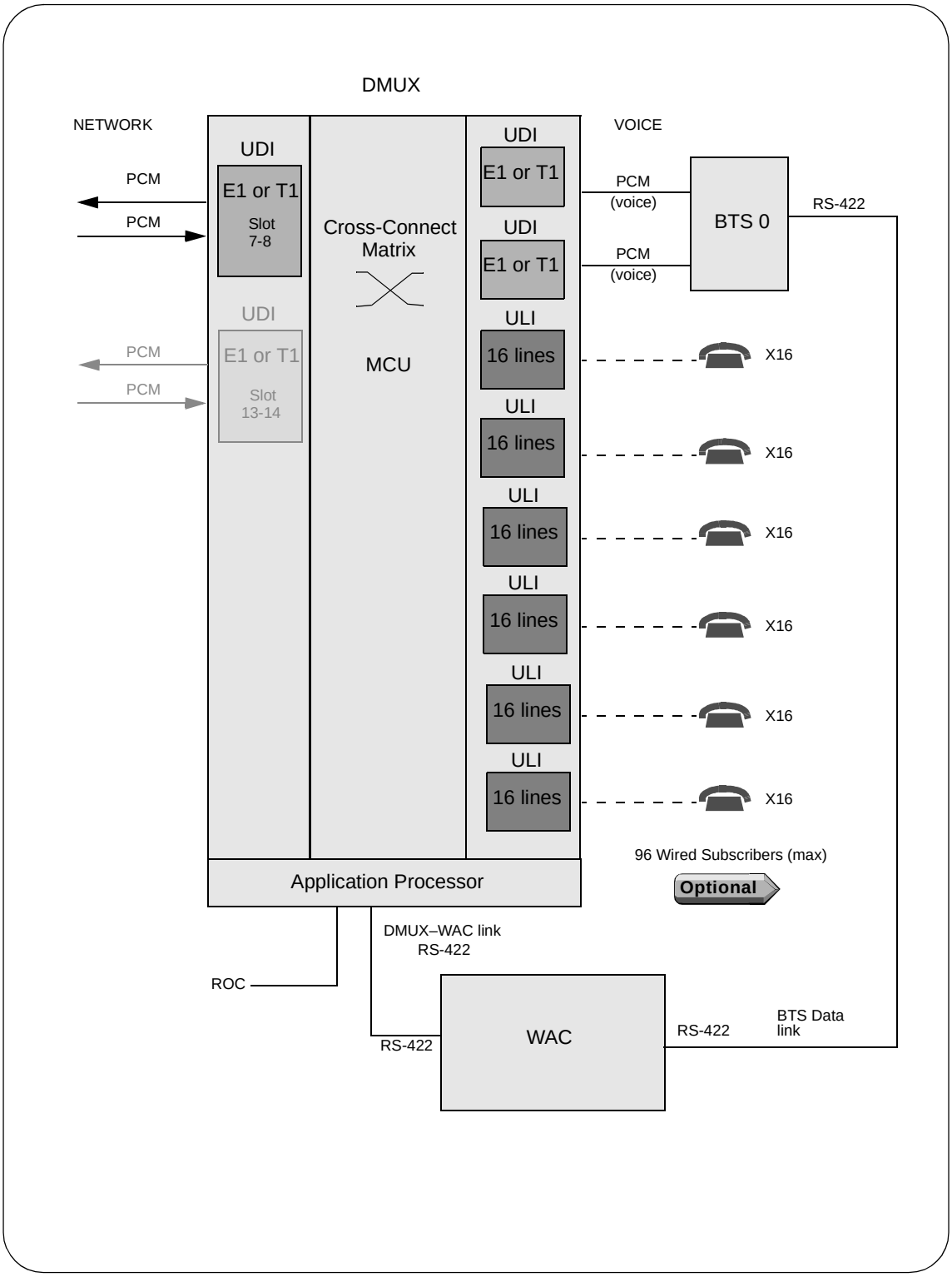


Figure 29 16 RF Channel DMUX with 96 Subscriber Lines



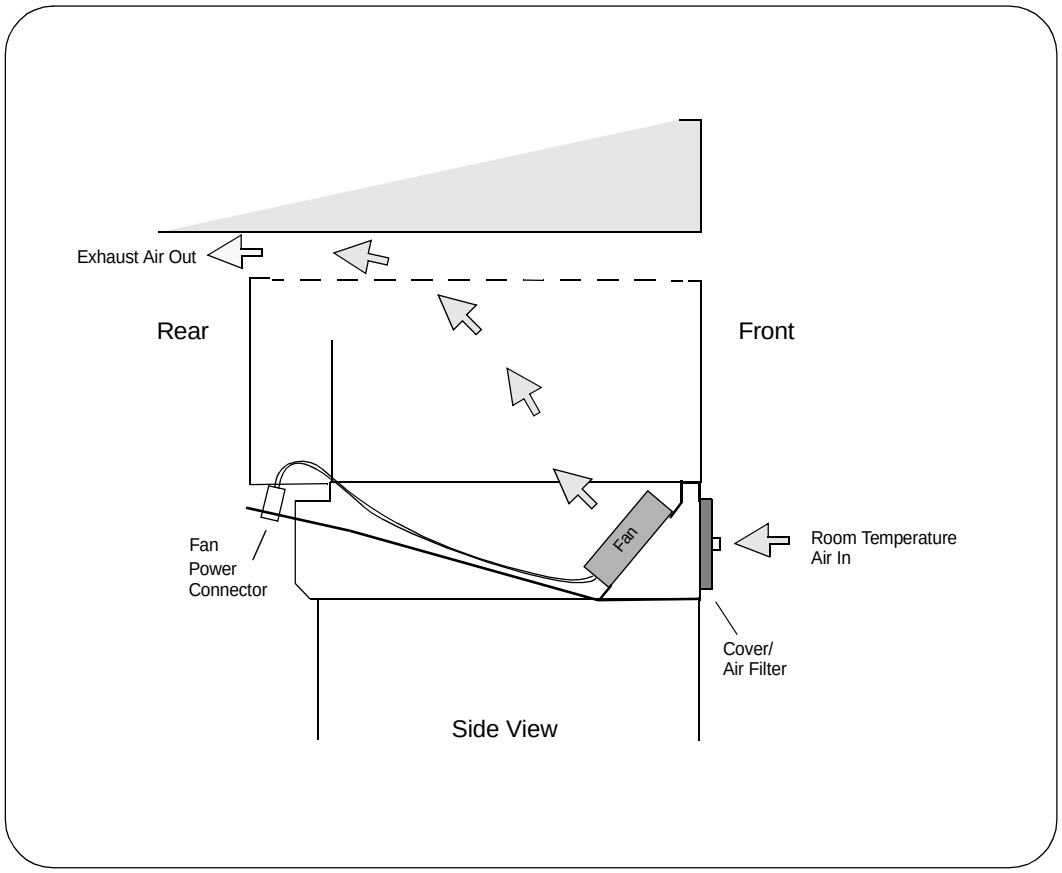
3.8 Fan Tray

Alternate

The fan tray cools the DMUX and other components in the basic frame. Room-temperature air is pulled into the frame by two muffin fans, and directed up into the DMUX. The fans are connected to the alarm system. If one of the fans should fail, an alarm is raised to the ROC.

A fan tray is not required in the expansion frame.

Figure 30 Fan Tray

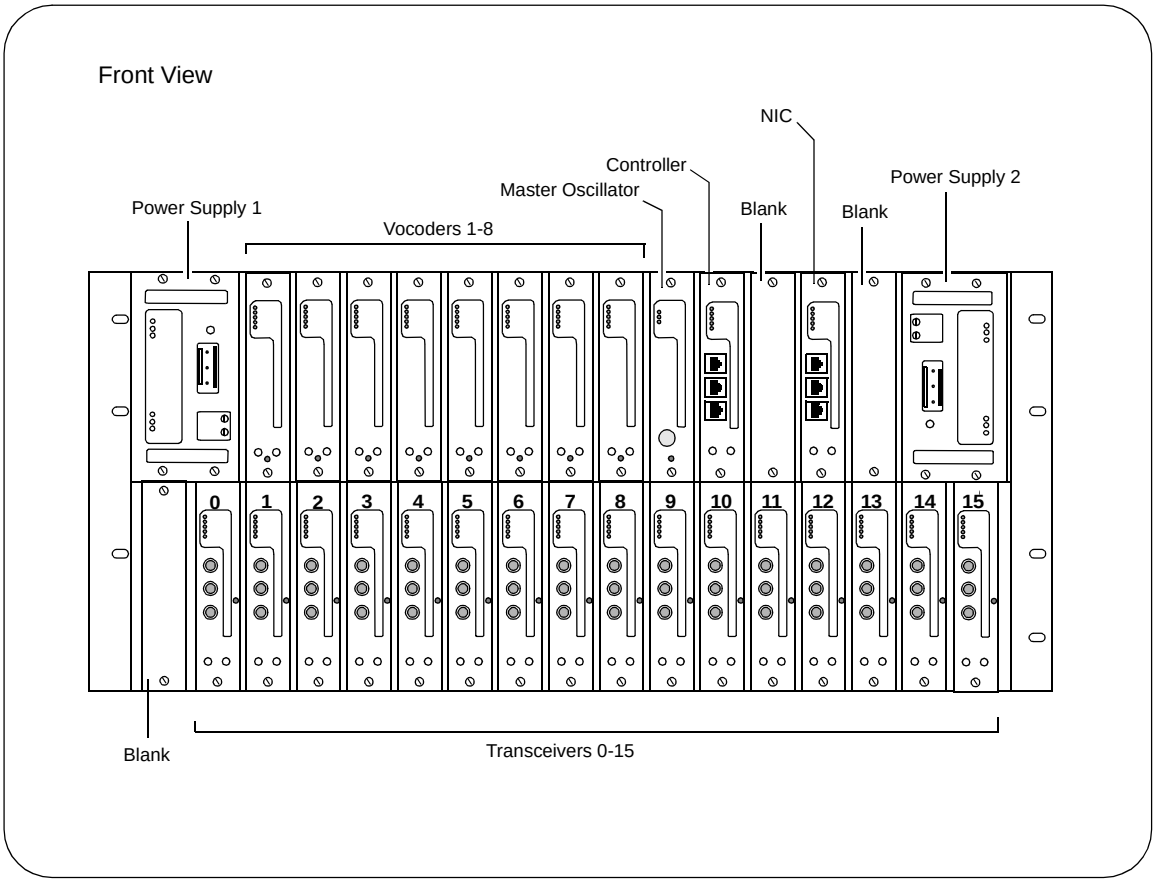


3.9 Base Transceiver System (BTS)

The BTS is the radio signal processing center of the RURALNET 800 and METRONET 800. The BTS converts voice and data information to and from RF signals, under direction of the WAC. Figure 31 shows the BTS components, and Figure 33 shows the BTS block diagram.

A 32 RF channel system requires two BTS shelves: BTS 0 (channels 0-15) located in the basic frame, and BTS 1 (channels 16-32) located in the expansion frame.

Figure 31 BTS



BTS 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	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 baseband digital signal to an FSK (analog mode) or pi/4DQPSK (digital mode) signal that is modulated into RF signals. The tranceivers operate 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 33. In addition, 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 DS0 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. • Handles message translation and IS-136 protocol. • Performs echo cancellation function
Network Interface Card (NIC)	• Provides physical E1 connection between the BTS and the DMUX. • HSCX high-speed serial port (PA) monitors Digital Power Amplifiers (DPAs). • Provides physical RS-422 connection to the WAC (the WAC controls the BTS).
Power supply	• 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 32 BTS Block Diagram

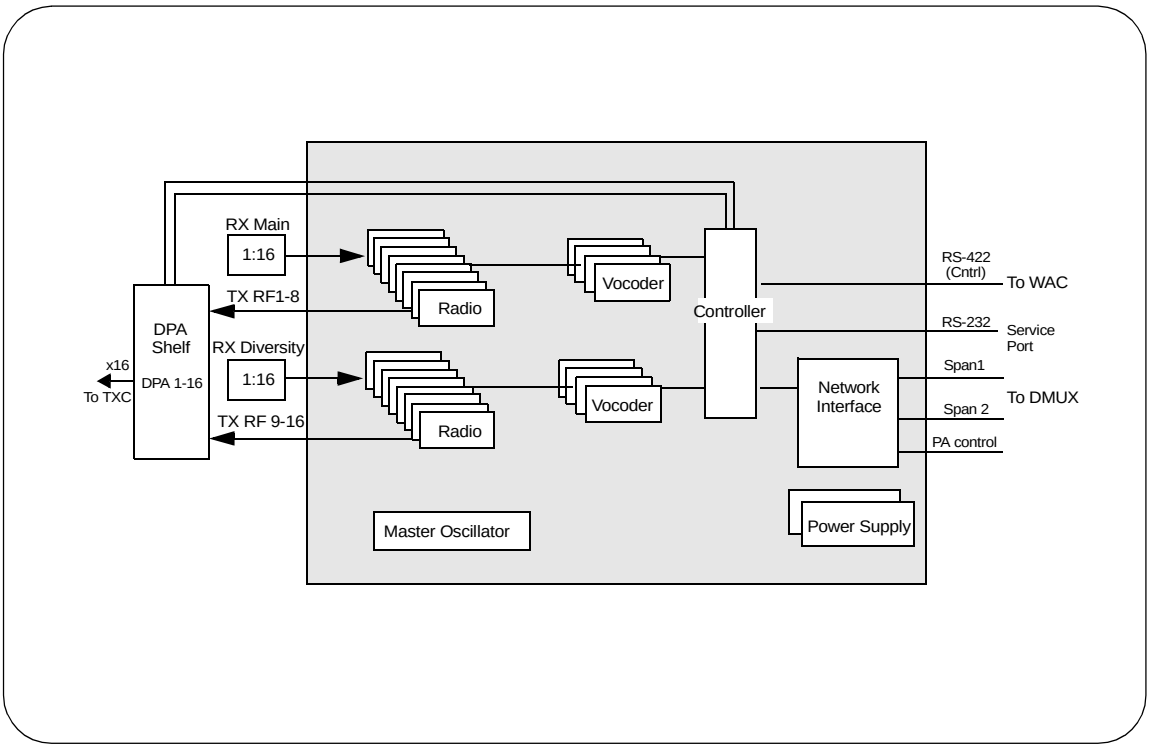
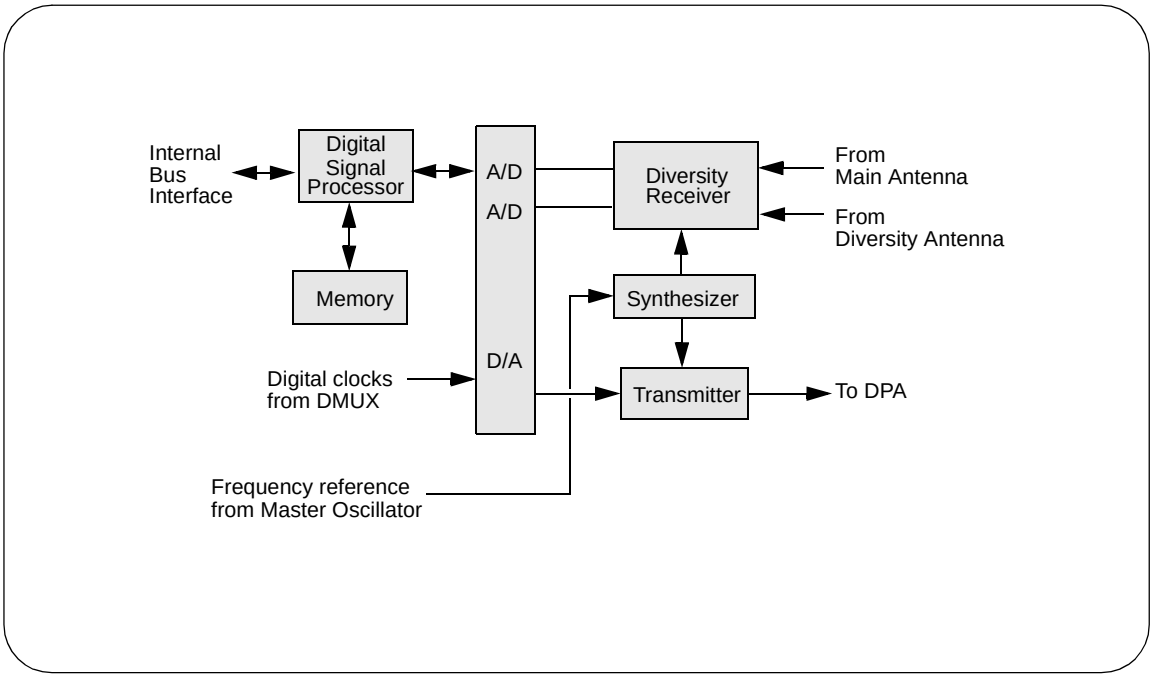


Figure 33 Transceiver Block Diagram



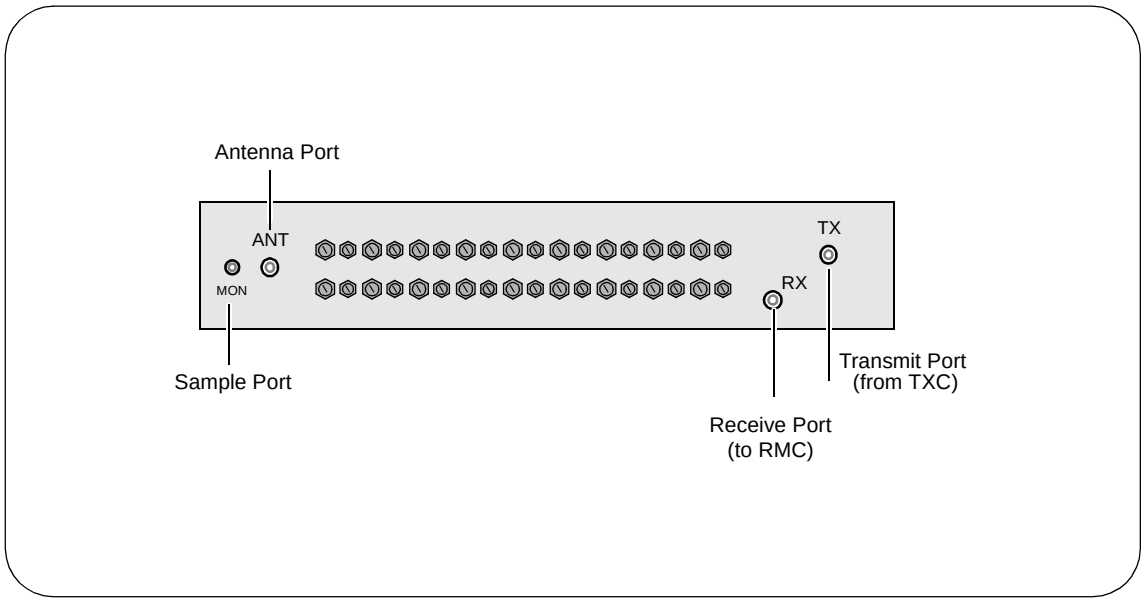
Backup Control Channel Operation

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 is called a backup traffic channel or BTC) . When the change occurs, two transceivers—the BTC and the primary control channel—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. (Assign the DCCH, ACC and designated BTC 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.

3.10 Duplexer

The duplexer enables the RURALNET 800 and METRONET 800 to simultaneously transmit and receive RF signals through a single antenna—see Figure 34. The duplexer is located behind the BTS.

Figure 34 Duplexer, Rear View

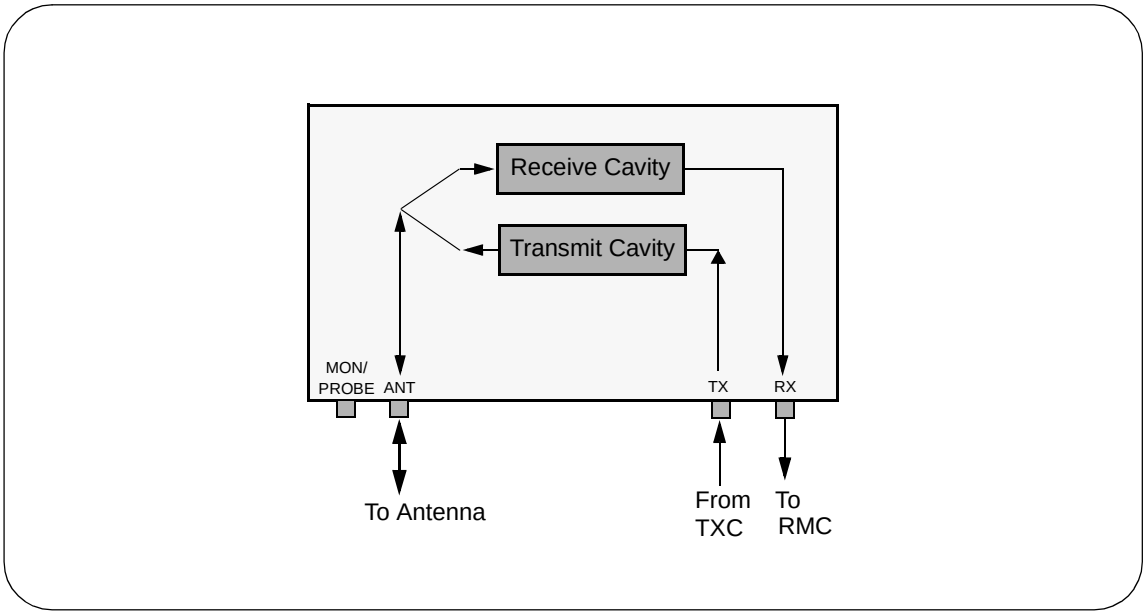


Duplexer Operation

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 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 35.

Figure 35 Duplexer Block Diagram



3.11 Receive Power Splitter

The receive power splitter divides the A and B radio signals from the RMC into eight separate signals, and routes 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 36 and Figure 37.

Figure 36 Receive Power Splitter

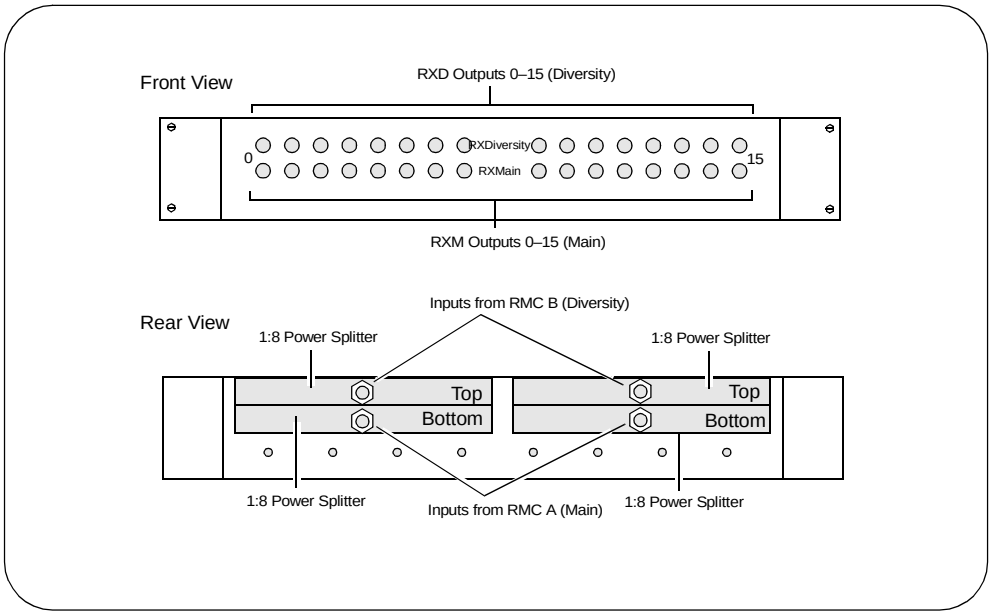
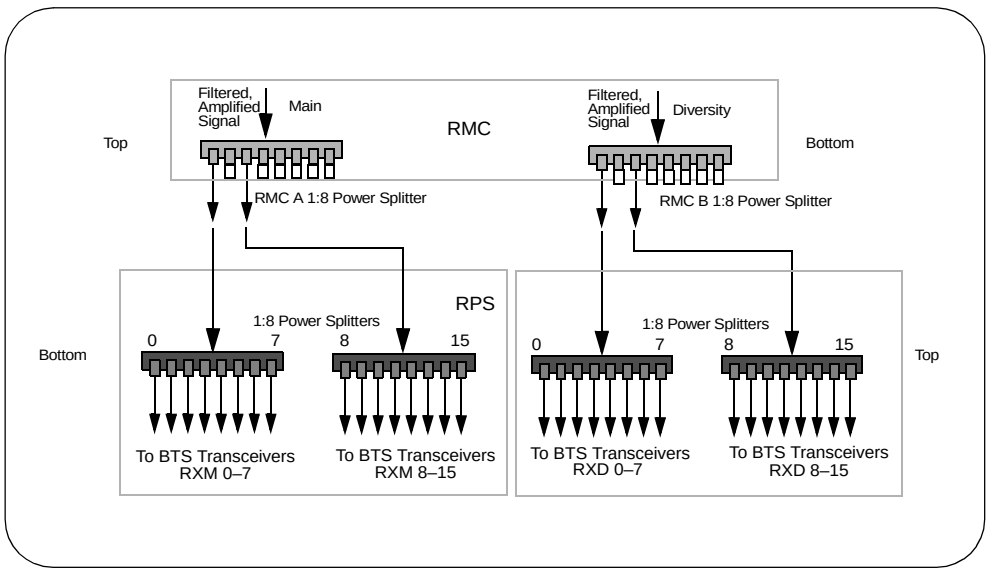


Figure 37 Receive Power Splitter Block Diagram



3.12 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 38 and Figure 39.

Figure 38 DPA Shelf

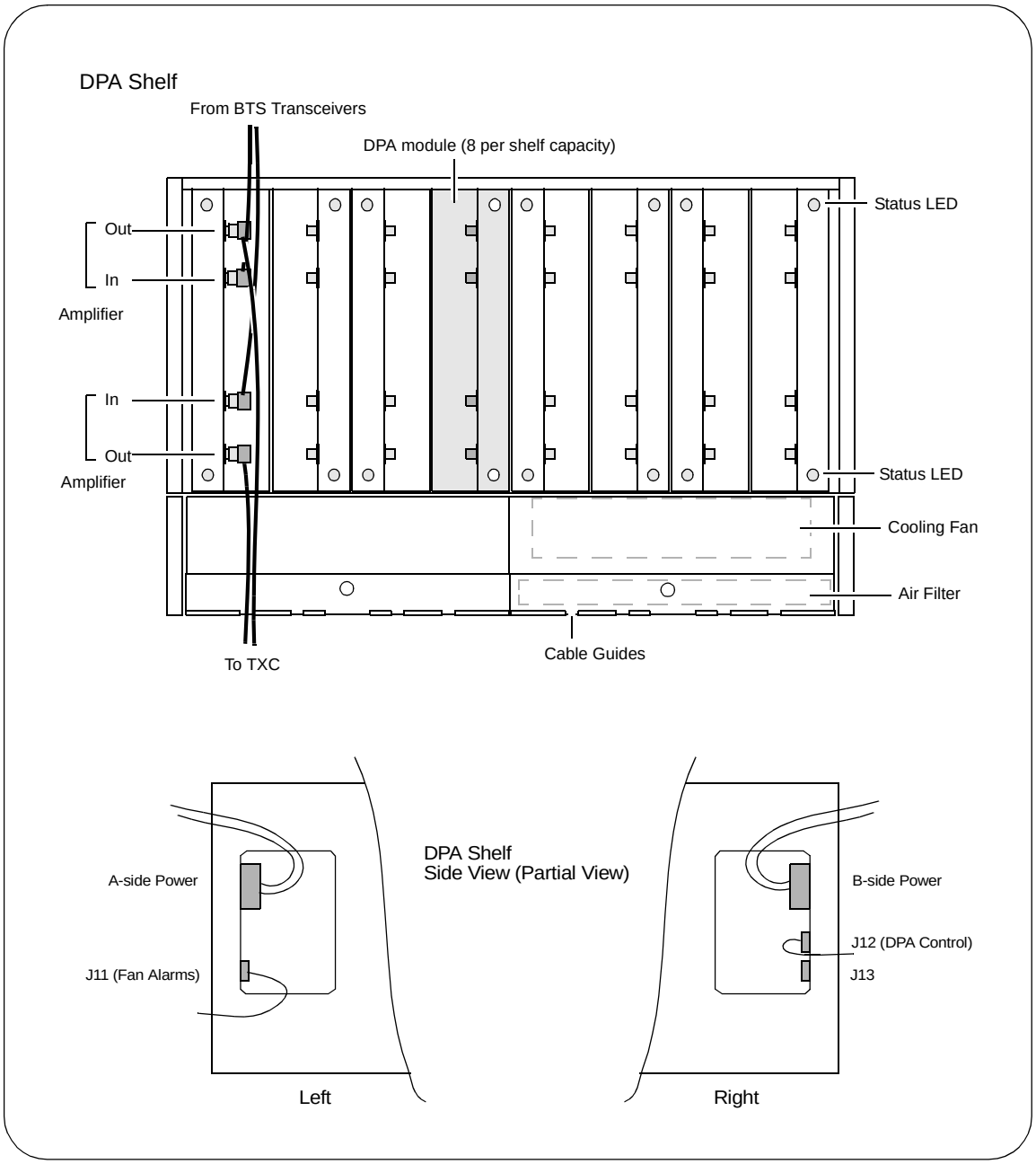
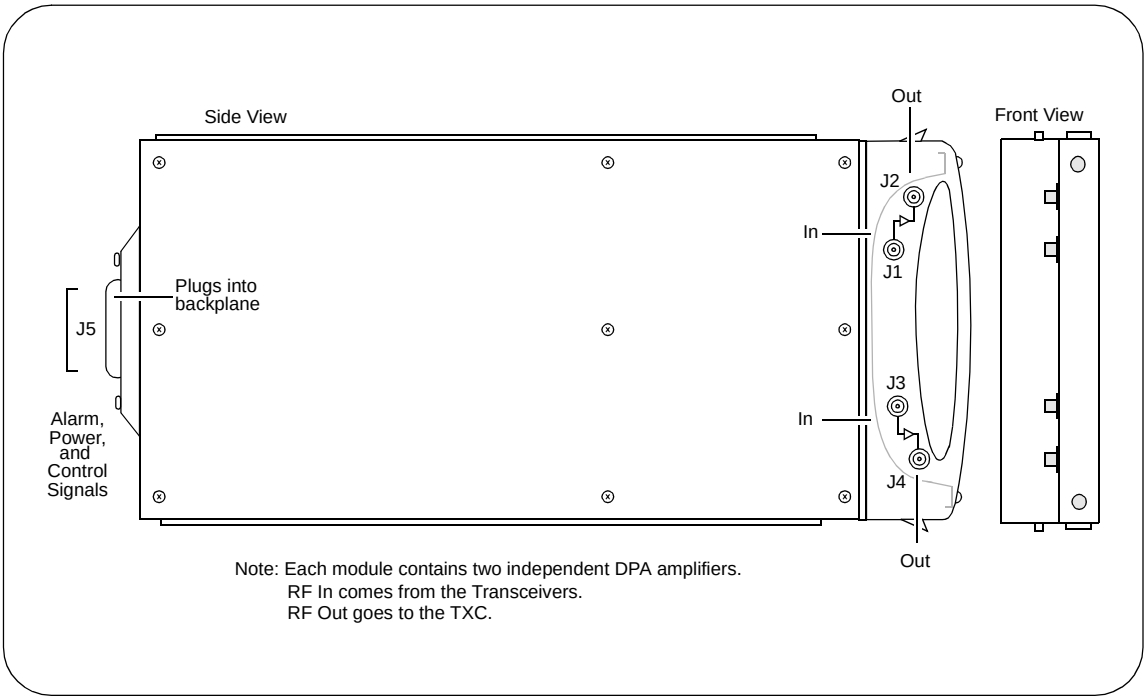


Figure 39 DPA Module



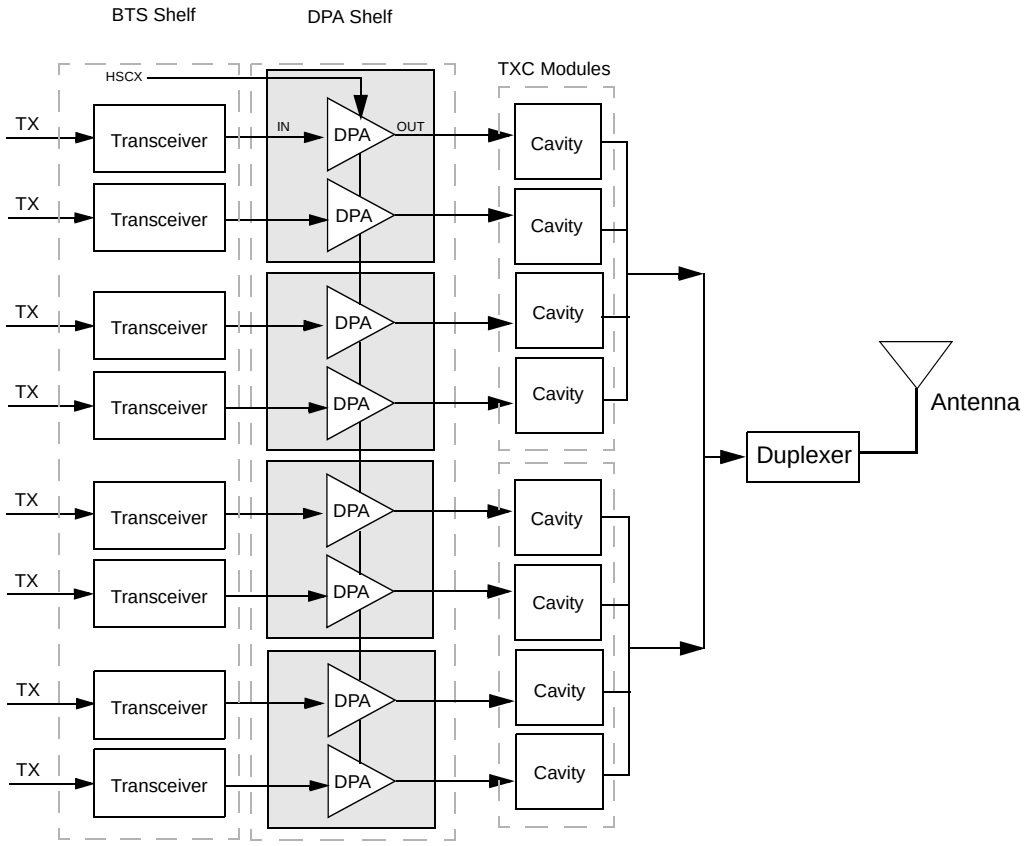
DPA Operation

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 40 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 40 DPA Shelf Block Diagram

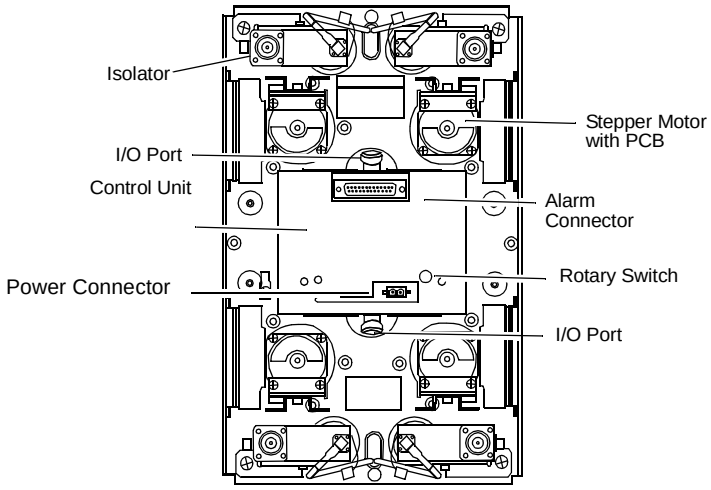


Note: Each DPA module contains two separate DPAs.
TX = Transmit

3.13 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 RURALNET 800 and METRONET 800 uses auto-tune TXCs, so manual adjustment is unnecessary.

Figure 41 4-Channel TXC Module



Auto-tune TXC (Stepper motor-type)

TXC Operation

The TXC receives DPA outputs, isolates and filters them, and routes the combined output to the duplexer—see Figure 42. 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 42 and Figure 43. 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 42 TXC Block Diagram

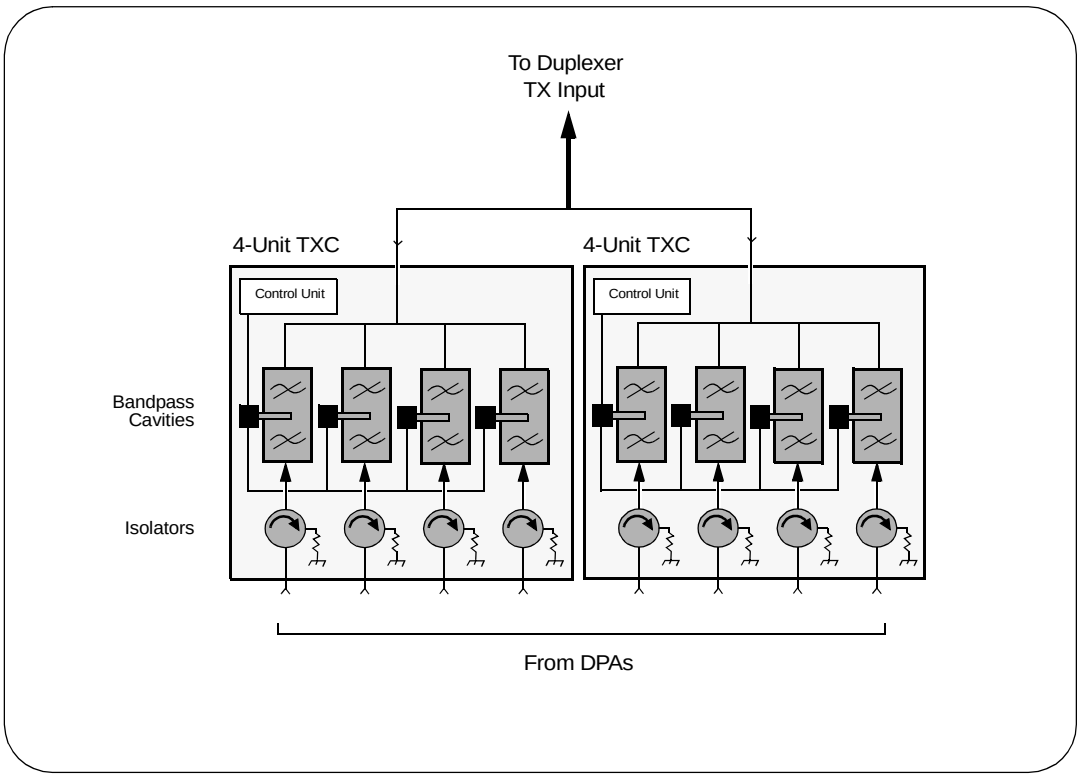
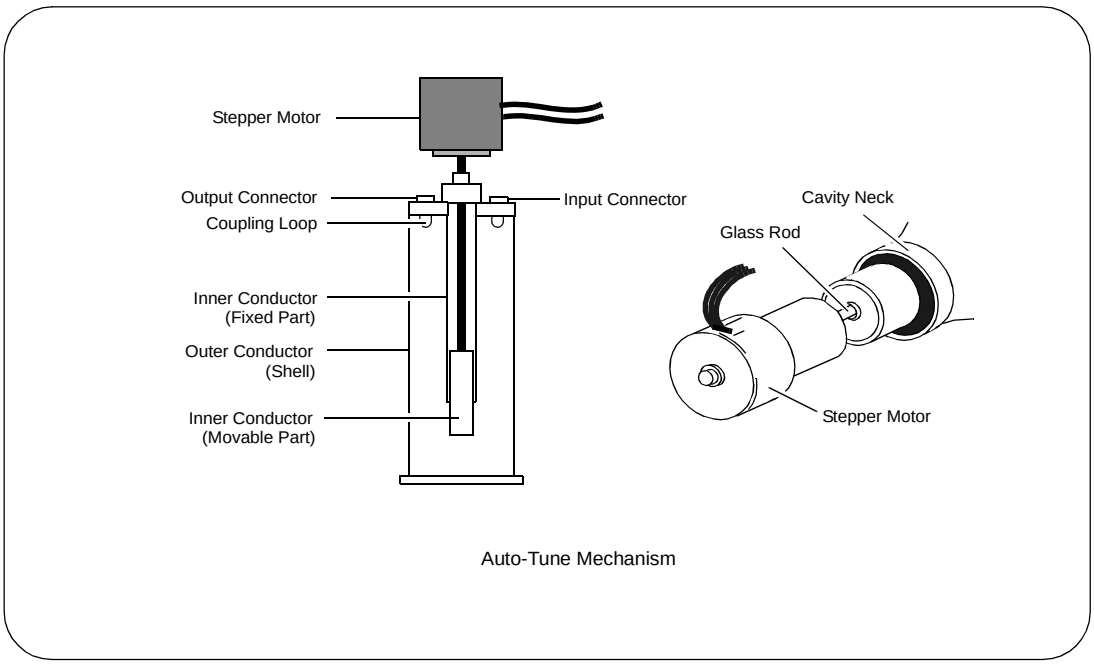


Figure 43 Tuning Mechanism



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4 Advanced Feature Sets

This section is an overview of RURALNET 800 and METRONET 800 software feature sets.

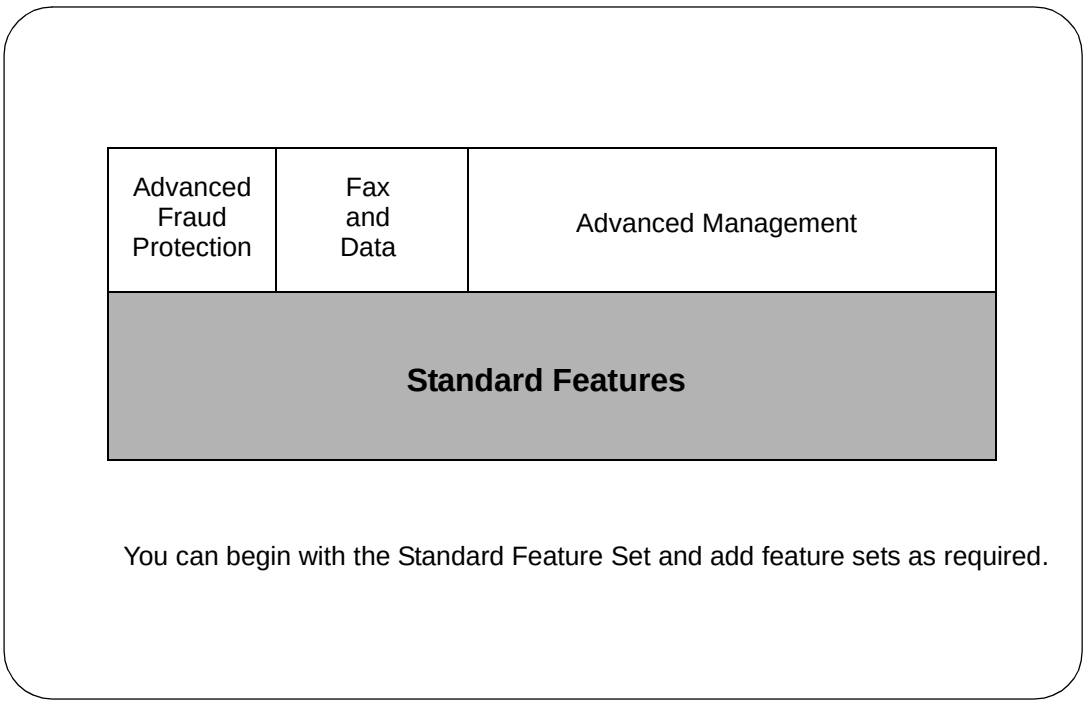
Standard Feature Set, page 48—describes the standard software features included with both the RURALNET 800 and METRONET 800.

Advanced Management Feature Set, page 50—describes advanced software features that enable high level management and administration of your network. These features are standard with the METRONET 800.

FAX and Data Feature Set, page 51—describes optional software features that enable you to provide analog FAX and data capability. These features are standard with the METRONET 800.

FAX and Data Feature Set, page 51—describes software features that protect your system from telephony fraud. These features are standard with the METRONET 800.

Figure 44 Feature Sets Available



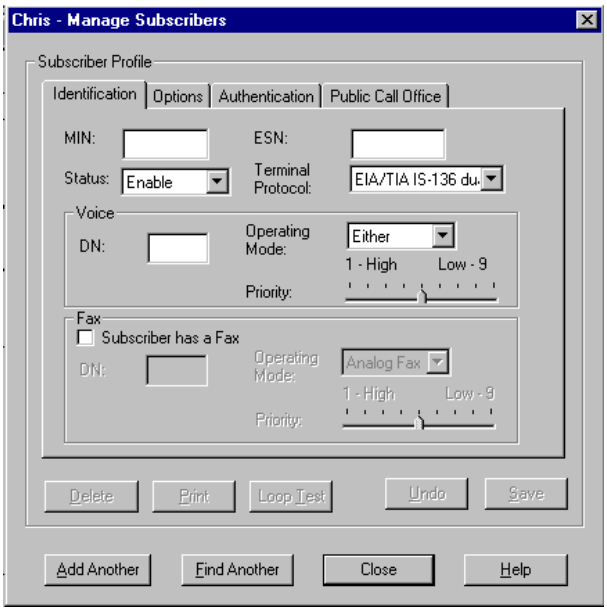
4.1 Standard Feature Set

The Standard Feature Set enables you to provide standard digital or analog telephone service and support to your customers. The basic features are:

- **Digital Voice**—Offers high quality voice communications via digital wireless technology, with high traffic capacity and excellent revenue opportunities. Multiple users share individual radio channels, which lowers the cost per subscriber and increases the number of subscribers that each system can support.
- **Emergency Calling**—Enables you to define emergency numbers, and assigns the highest priority to emergency calls. The system prevents emergency calls from being dropped and processes them even if all voice channels are in use. This feature provides customers with secure, reliable emergency communication.
- **Handheld Mobile Phone Support**—Provides system access to customers in the service area who own 800 MHz cellular phones, and enables a subscriber to move within the range of the base station; similar to the mobility of a cellular network. This feature expands your customer base and revenues by enabling you to provide service and support to customers with existing 800 MHz mobile cellular telephones.
- **Customized Digit Translation**—Enables the creation of new and customized numbers through commands you send to the Digital Multiplexer (DMUX). For instance, you can set up *TAXI (*8294) to dial a taxi-cab company, or *1000 to report a traffic accident. Customized Digit Translation increases revenue and customer satisfaction by enabling you to provide options for specialized numbers.
- **Dual-Tone Multiple Frequency Passthrough**—Enables mobile or fixed subscriber terminals to access touch-tone services and an Automatic Call Distributor. Subscribers can perform touch-tone services, like banking, and hear automatic voice recordings. This feature enables you to increase network usage and revenue per subscriber.
- **Country Tone Support**—Enables different tone sets—rings—for different countries. This provides your customers with a familiar telephone ring or tone. Country Tone Support delivers transparency of service between wired and wireless subscribers.
- **Remote Site Reboot**—For site maintenance or upgrades reboot the WAC or the BTS from the ROC rather than at the actual physical site. Site Reboot saves time and money by lowering operating costs as a maintenance person does not have to travel to the site to reboot the WAC or BTS.
- **Remote Call Management**—View information about calls in progress on your system without having to travel to the site. This allows you to maintain and troubleshoot your system needs remotely. Remote Call Management increases customer satisfaction and lowers your operating costs.
- **E1/T1 Interface to the PSTN**—Interconnects most PBX and class 5 offices using standard telephony interfaces. A class 5 office is the most commonly used network connection, therefore the E1/T1 interface provides a globally compatible interface.
- **Control Channel Redundancy**—Primary and back-up control channels prevent the system from dropping calls, which results in higher reliability of calls and optimized service for your customer.

- **Dial-Up Supportability**—Ability to connect up to four sites simultaneously, including remote sites with ROC*Pilot* graphical user interface. This feature enables you to monitor and operate multiple sites and subscribers, and to provide real-time subscriber support.
- **Basic ROC**—An easy-to-use PC workstation featuring ROC*Pilot* software and operating with state-of-the-art Windows® technology. ROC*Pilot* enables all users familiar with Windows to start administering the network quickly and easily.
- **Basic Fraud Protection**—The system automatically identifies and takes out of service two mobiles using the same user identification number. When a bandit is detected the system disables both the mobile units, preventing fraud. Basic Fraud Protection protects your revenue and increases customer satisfaction by providing a secure network. For added fraud protect for your system and subscribers, see *Advanced Fraud Protection,* page 52.
- **Automatic Overload Control**—Overload Control software protects the system from being overwhelmed by calls due to unexpected events. This prevents the system from either rejecting all calls, or a complete system shutdown.

Figure 45 Example of Subscriber Management Screen

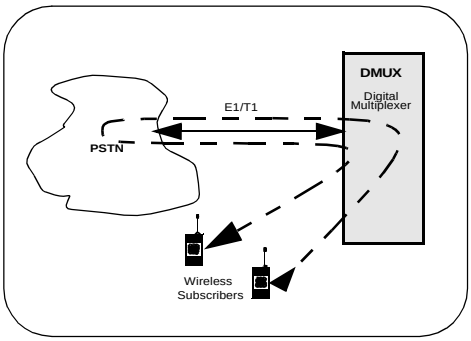


4.2 Advanced Management Feature Set

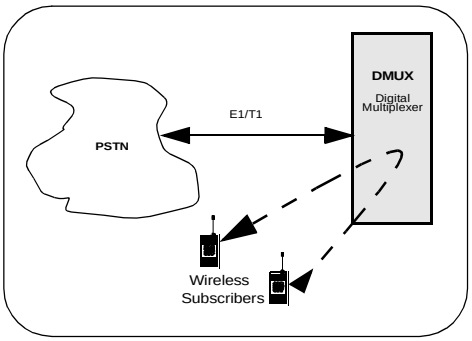
The Advanced Management feature set enables you to perform high level management and administration of your site. Advanced Management also enables you to generate additional revenue by increasing the options and service plans you can provide to your customers. The features are:

- **Local Call Completion**—Routes all wireless to wireless calls directly through the Digital Multiplexer (DMUX), bypassing the Public Service Telephone Network (PSTN). Using the integrated switch located in the DMUX, Local Call Completion increases call reliability, provides more network lines for voice and data, and lowers your network costs by increasing your independence from the PSTN provider.
- **Public Call Office Support**—Set up and maintain public call office telephones that enable you to charge your customer for a call before the call is made, or after the call is finished. This allows you to offer basic telephony service and network access to customers that might not otherwise receive service. Public Call Office Support expands your customer base and generates revenue.
- **Call Detail Record Collection**—Enables you to collect call details for the purpose of billing. It provides your subscribers with an accurate account of billing, and allows you to verify costs charged by your PSTN provider. Call Detail Record Collection ensures customer satisfaction and protects revenue.
- **Priority Calling**—Enables you to provide high priority subscribers with premium service. Priority Calling increases revenue by enabling you to charge a higher rate for high-priority subscribers, or to carry more low-priority subscribers on your system.
- **Manual Overload**—Use Manual Overload with Priority Calling to define and control when subscribers can place calls. For example, you can set up a service plan that allows low-priority subscribers to call on weekends only. Different service plans and options provide maximum flexibility to your subscriber, increase revenue, add to your subscriber base, and increase customer satisfaction.
- **Customizable Tone Sets**—Allows you to create unique telephone tones—rings—for special situations. For instance define a specific tone for emergency calls, or define a different tones for wired or wireless units.
- **DRA Support**—Route call progression reports to a recorded announcement. Digital Recorded Announcement Support enables you to provide your customers with a digital voice response, for instance, “All circuits are busy”, instead of a standard tone or pulse. Personalized messages deliver more accurate, user-friendly service to your customer.

Figure 46 Local Call Completion



Call transmission without Local Call Completion.



Call transmission with Local Call Completion.

4.3 FAX and Data Feature Set

The FAX and Data feature set enables you to provide analog FAX and data service to your customers. The features are:

- **Dual Mode Voice**—The system supports *both* analog and digital voice transmission. This flexibility increases the potential size of your subscriber base by enabling you to provide service to customers with older, analog phones.
- **High Speed Wireline Data Capability**—Enables the transmission of high speed data over wired lines. Wired terminals can be connected directly to the DMUX to enable fast transmission of data.
- **Wireline Telephony**—Enables a number of wired-line subscribers in the same region as the site or office building to connect directly to the WIN*RoLL* system. This feature increases revenue by enabling you to provide service to wired-service subscribers, while reserving wireless digital voice channels for wireless subscribers.

4.4 Advanced Fraud Protection

The Advanced Fraud Protection feature bundle protects your system, and enhances revenues and call reliability by eliminating nearly all telephony fraud, including theft of user identification numbers and eavesdropping. The features are:

- **Message Encryption**—Encrypts all data messages to and from your mobile. Message Encryption reduces fraud and protects customers by preventing the theft of a subscriber's user identification number from a digital system.
- **Digital Authentication**—Using advanced IS-136 security protocol, Digital Authentication detects the unauthorized use of an existing subscriber identification number, and disables the bandit mobile before the illegal user places or receives a call. The feature enables the legitimate subscriber uninterrupted service by eliminating fraud.
- **Voice Privacy**—Eliminates virtually all eavesdropping on digital voice calls, resulting in greater subscriber security.

5 Optional Hardware

This section describes optional hardware and lists the specifications for the RURALNET 800 and METRONET 800. Options include:

5.1 METRONET 95 Traffic Channel Expansion Frame

Optional

The number of channels can be increased up to 95 traffic channels with a METRONET 800 expansion frame. The expansion frame contains a rack assembly, power distribution shelf, BTS shelf, power splitter, DPA shelf, and transmit combiner. The expansion frame is controlled by the WAC and DMUX in the basic frame, therefore additional interframe cabling is required.

Figure 47 shows the expansion frame, and Figure 48 shows a simplified block diagram of the METRONET 800 frames. Note that the expansion frame *does not* have a DMUX or WAC.

Figure 47 METRONET 95 Channel Expansion Frame

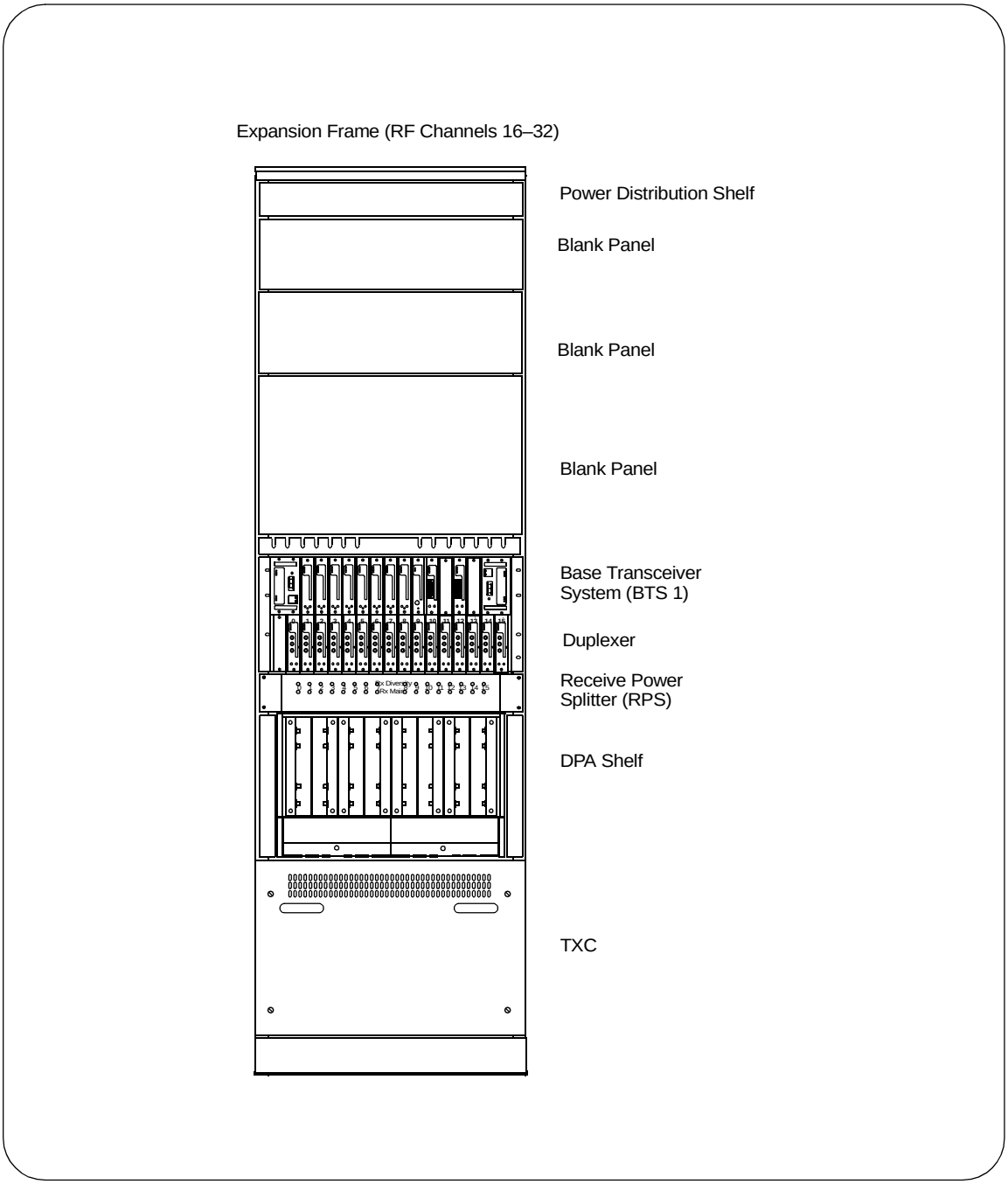
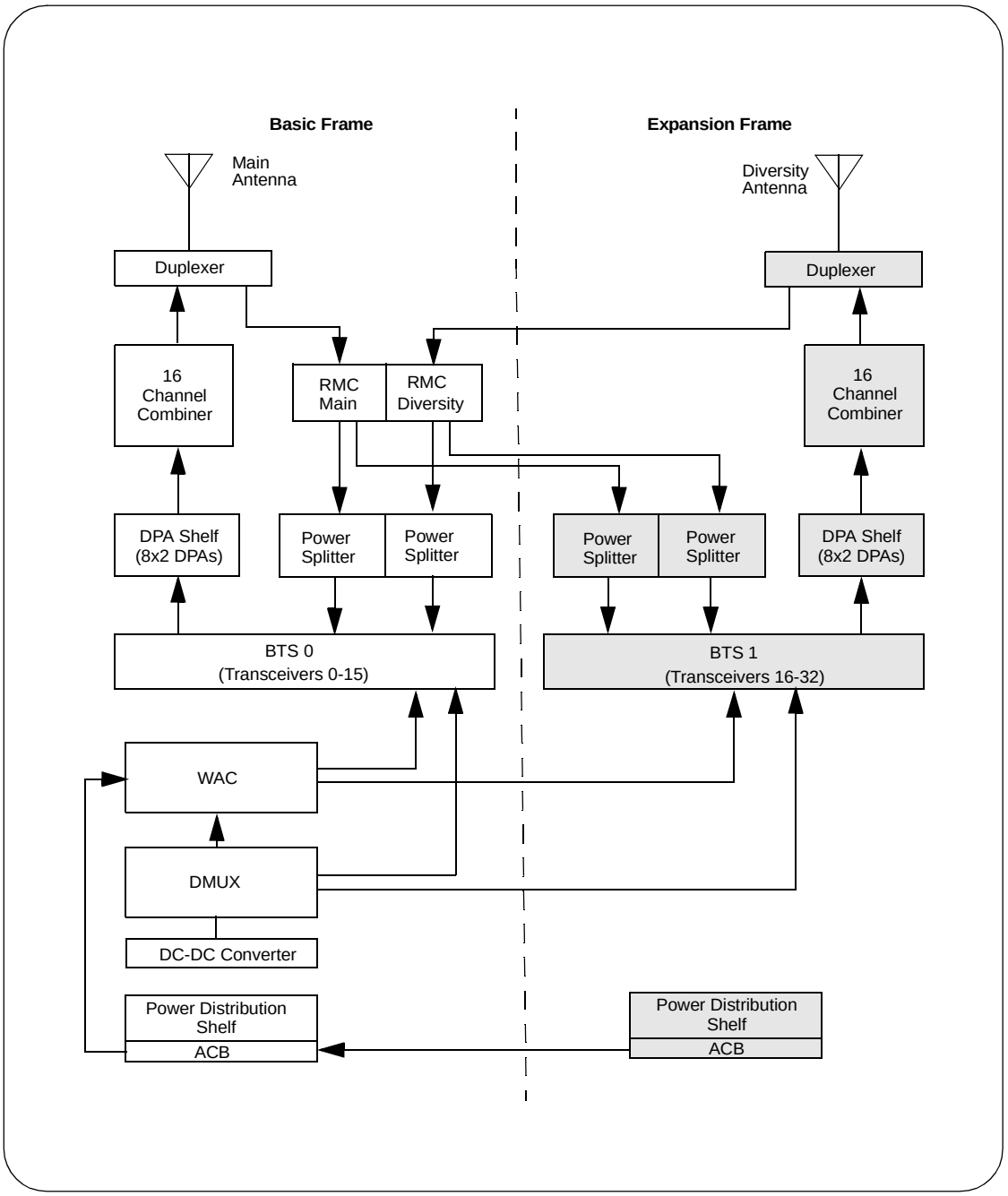


Figure 48 95 Traffic Channel Simpified Block Diagram



5.2 DMUX Options

Optional

ULI and UDI cards, OPX modules, and a CDR SIMM are available as options—see Figure 49. Followed these general rules to achieve a DMUX configuration that performs to Harris specifications:

a) The two slots directly to the right of a UDI equipped with two E1 or T1 daughter cards must remain open.

b) Slots 1-2 and 11-12 can be equipped with single span UDIs.

c) If systems are interconnected, intersystem trunks are required that will reduce the number of spans available for BTS connections (the second span for the expansion frame may not be allowed).

d) For the most flexibility of network connection types in E1 systems, the network spans should be installed in slots 7-8 and, if required, in slots 13-14 to enable access to both 120 ohm balanced and 75 ohm unbalanced connections. All other slots route to balanced 120 ohm (E1) or 100 ohm (T1) connections.

Universal Line Interface (ULI) Cards

Optional

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

Optional

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.

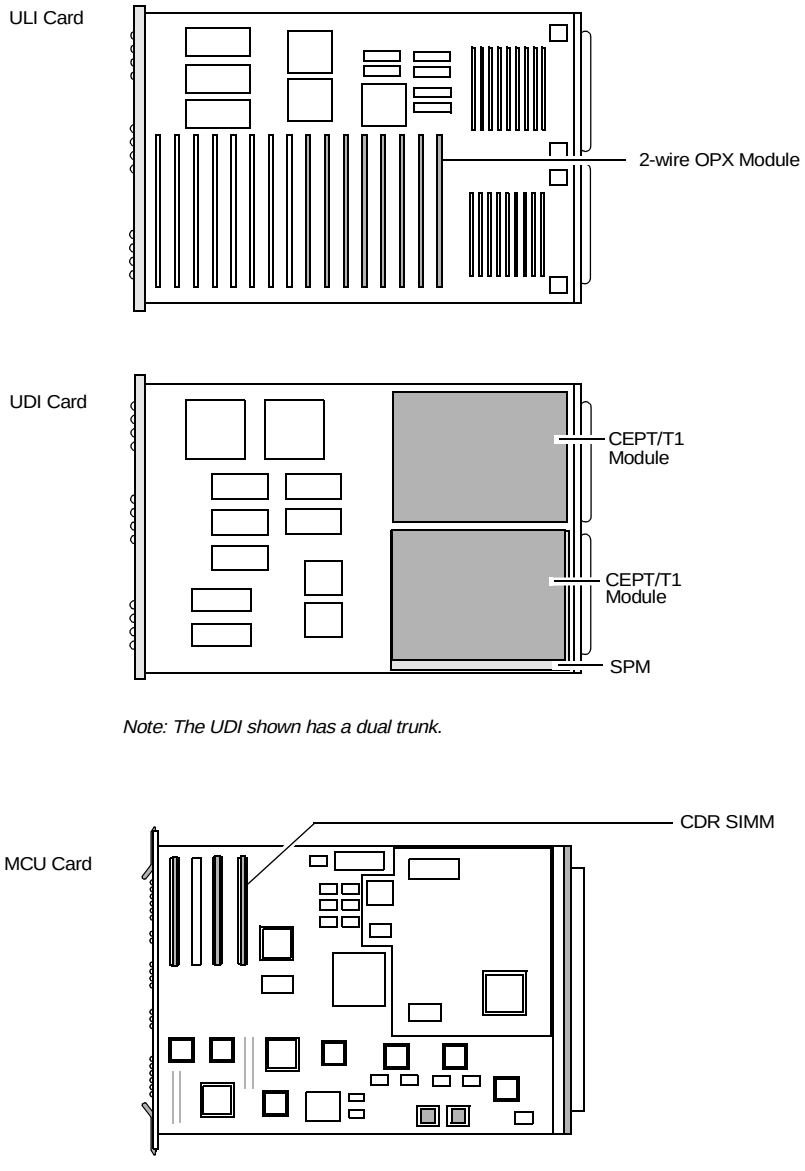
Since wired subscribers “compete” with wireless subscribers, adjust the system performance for wireless subscribers if a large number of wired subscribers are supported.

Call Detail Records (CDR) SIMM

Optional

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 49 DMUX Card Options



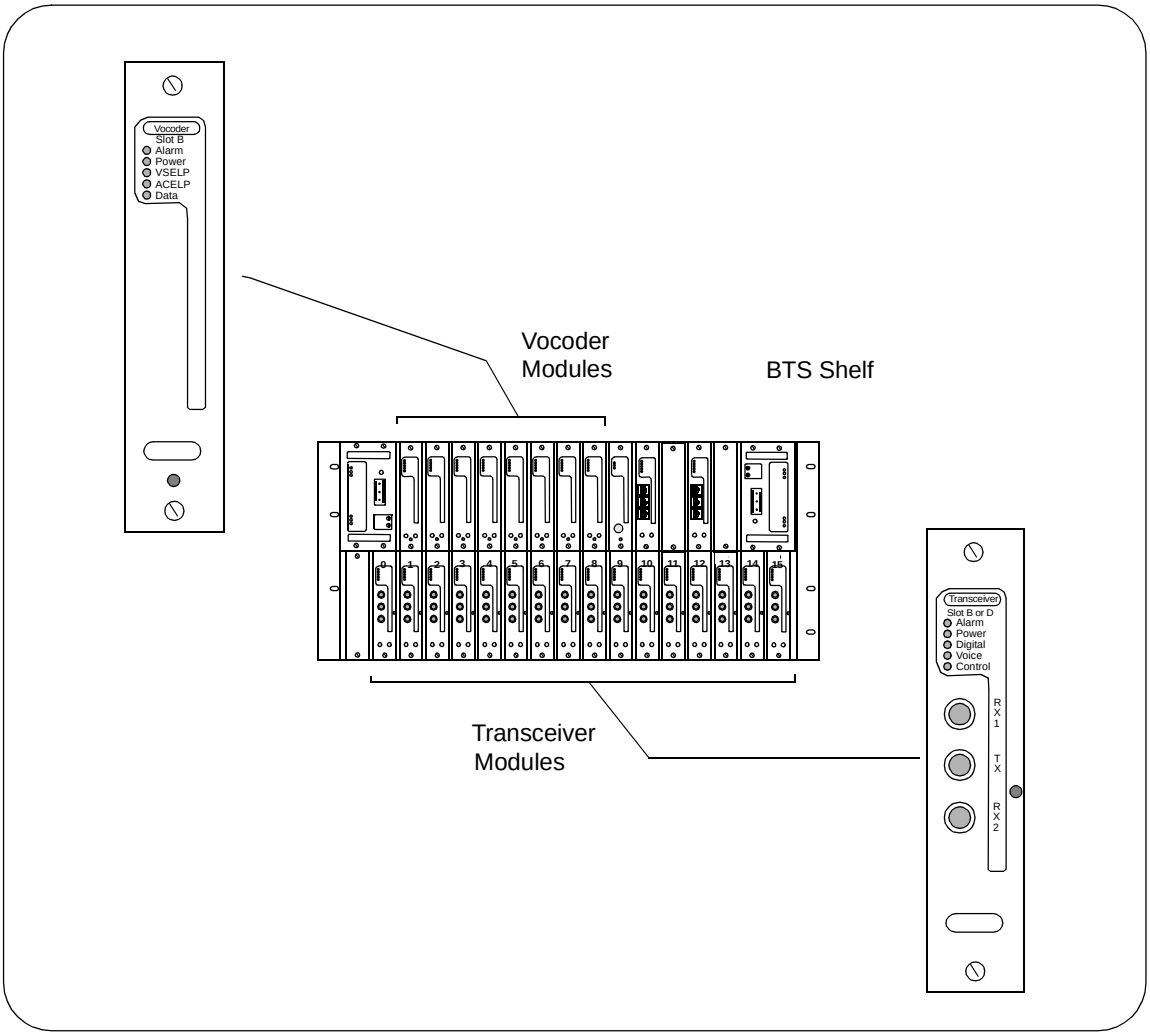
5.3 BTS Transceivers and Vocoders

Optional

Transceiver modules and vocoders can be added to the RURALNET 800 and METRONET 800 to increase its capacity—see Figure 50.

- 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.)
- Add transceivers from left to right in the BTS shelf.

Figure 50 Optional BTS Transceiver and Vocoder Modules

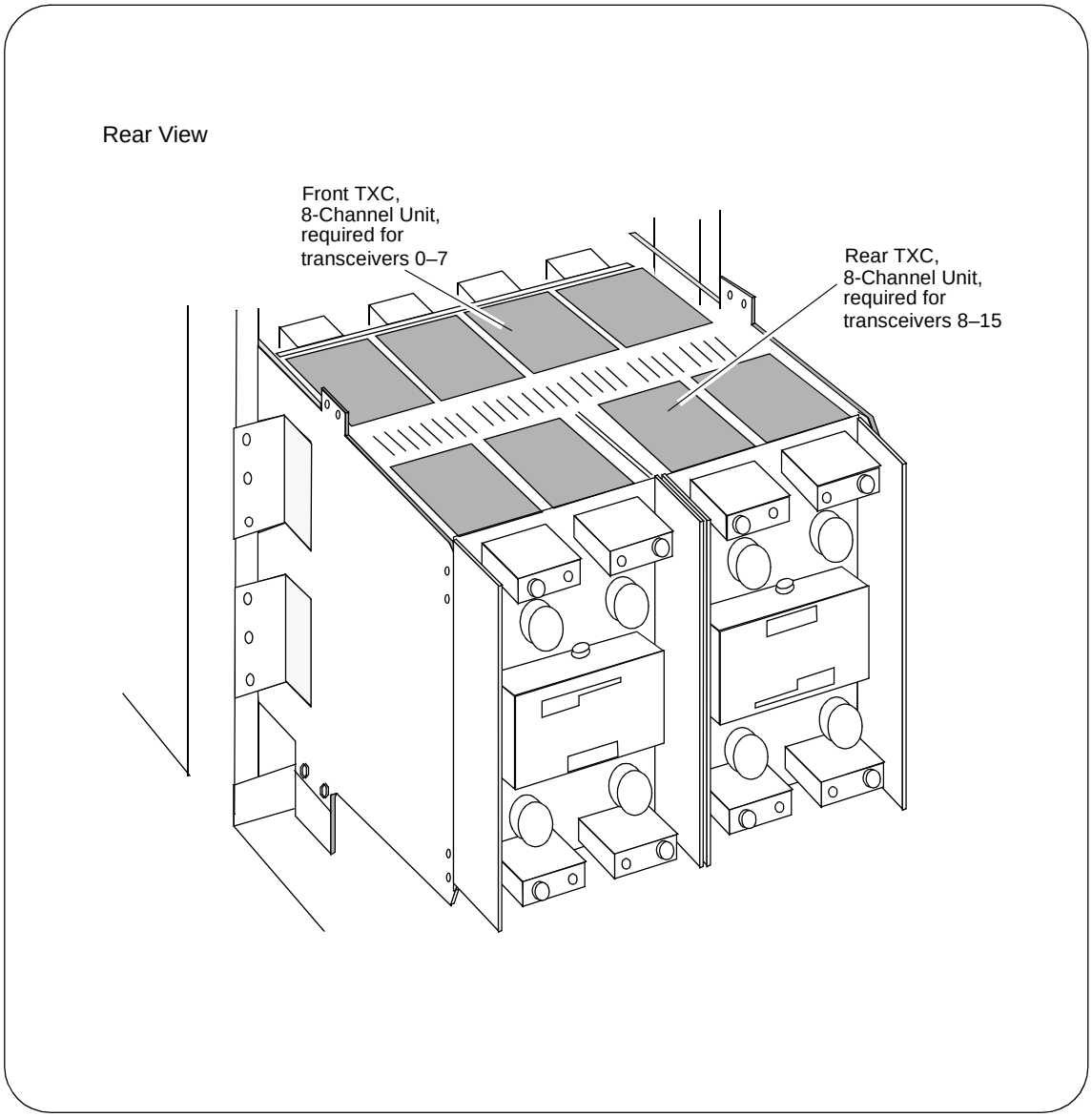


5.4 TXC Expansion

Optional

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 51. The additional (rear) TXC is installed directly behind the front TXC.

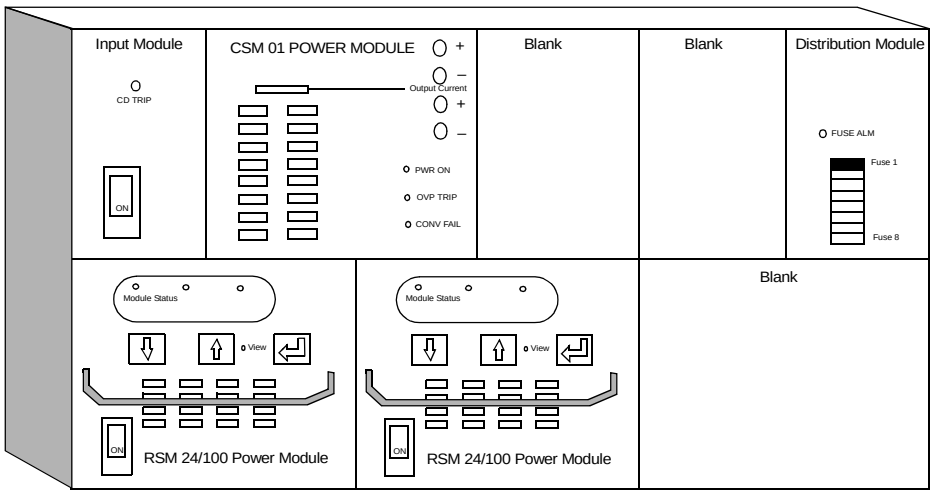
Figure 51 TXC Expansion



5.5 Power Plant

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

Figure 52 Power Supply Unit, Front View



Equipment may not appear exactly as illustrated.

6 Specifications

System Capacity	Subscribers	6000 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	95 (with expansion frame)
	Maximum Analog Voice Channels	31(with expansion frame)
Physical	Depth	610 mm (24 in)
	Height	2134 mm (84 in)
	Width	610 mm (24 in)
	Basic Frame Gross Weight (max)	295 kg (650 lb)
	Expansion Frame 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.

Radio FIxed Station	Transceiver	IS-136
Connectors	InterfaceRJ11 jack DC Power Input Jack Data Interface Data Modem/PC Fax	Phone and Fax Switchcraft 760 Barrel Connector RJ45
Back-up Battery	Optional in External Supply Accessory 4 8AHr sealed lead acid batteries	
Power	AC Power Input DC Power Input	45W 30Q (2.5 A X 12V) (Maximum input power of the terminal at full RF power)
AC Input Range	Voltage Frequency	90-264 Vrms 47-63 KHz
Physical	Enclosure Depth Height Width Weight	ABS plastic cover with Cast Aluminum base 5 cm 21 cm 15.5 cm .55 kg
Environment	Operating Temperature Range Storage Temperature Range Storage Humidity	-30^{o}C to +60^{o}C -40^{o}C to +60^{o}C 0 to 95%