P-COM

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January 1999

Tel-Link
Point-To-Multipoint

System Description Manual

PRELIMINARY

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P-COM

January 1999

Tel-Link Point-to-Multipoint System Description Manual

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1.0 General Information

This manual describes the features and specifications of the Tel-Link Point-to-Multipoint (PMP) System. This manual is intended for personnel who are responsible for installing and testing the Tel-Link Point to Multipoint system. The user should keep this manual next to the system at all times.

For further assistance, contact P-COM's Technical Assistance Center at (407) 674-3699.

1.1 Manual Organization

This manual is part of a set of Tel-Link Point-to-Multipoint manuals that focus on specific aspects of the Point-to-Multipoint system. The set of manuals consist of the following:

- 68132 - Tel-Link Point-to-Multipoint Sector Terminal Installation Manual
- 68133 - Tel-Link Point-to-Multipoint Remote Terminal Installation Manual
- 68134 - Tel-Link Point-to-Multipoint Local Site Manager Manual
- 68135 - Tel-Link Point-to-Multipoint System Description Manual

This manual is divided into five sections providing detailed information regarding the specifications, features and theory of operations of the Tel-Link Point-to-Multipoint equipment. The sections are:

- **Section 1:** General Information – Contains discussions on the use of this manual, summary of the manual, special notations, and general safety reminders
- **Section 2:** Point-to-Multipoint (PMP) System Overview – Provides a high-level description of the PMP equipment in a network environment.
- **Section 3:** Sector Terminal Overview – Provides a theory of operations of a Sector Terminal.
- **Section 4:** Remote Terminal Overview – Provides a theory of operations of a Remote Terminal.
- **Section 5** Network Management - Provides a description of the computerized craft interface (Local Site Manager) available to configure and monitor the equipment performance in the network.
- **Section 6:** Specifications – Provides a listing of specifications for the Sector Terminal and Remote Terminal.

1.2 FCC Requirements Summary

Operators must be familiar with the requirements of the Federal Communications Commission (FCC) Parts 2 and 101 Regulations prior to operating any link using the equipment. For installations outside the United States, contact local authorities for applicable regulations.

1.3 Requesting Changes

We welcome your suggestions for improving this manual. A Reader Comments form is provided at the end of this manual on which you can record your comments and suggestions for improvements.

1.4 Special Notations

This manual uses four levels of special notation to alert you to important information concerning your safety, proper equipment handling, or useful tips for easier operation. These notations are shown below in descending order of importance

DANGER!

Indicates that personal injury can result if you do not comply with the given instruction. A DANGER! statement will describe the potential hazard, its possible consequences, and the steps you must take to avoid personal injury.

WARNING!

Indicates that serious damage to the equipment can result if you do not comply with the given instruction. A **WARNING!** statement will describe the potential hazard, its possible consequences, and the steps you must take to avoid serious equipment damage.

CAUTION!

Indicates that equipment damage and/or process failure can result if you do not comply with the given instruction. A **CAUTION!** statement will describe the potential hazard, its possible consequences, and the steps you must take to avoid equipment damage and/or process failure.

NOTE

Provides supplementary information to emphasize a point or procedure, or gives a tip for easier operation.

1.5 General Safety Reminders

To prevent possible personal injury or equipment damage, always observe the following rules:

- Installation and operations personnel should be familiar with the safety requirements before attempting installation or operation of the equipment covered by this manual. Failure to follow the requirements could result in death or injury to personnel and/or damage to the equipment.
- Always examine the general area for any potential hazards (such as wet floors or overhead powerlines) before beginning installation.
- Observe all safety precautions. Dangerously high voltages are present within this equipment, when in operation. Lethal line voltages may be present unless the main line power has been disconnected.
- Always remove any jewelry or other personal items that may conduct electricity before beginning installation.
- Keep away from live circuits. Whenever feasible in verifying circuits, check by continuity and resistance methods with all power off, rather than directly checking voltages.
- Observe grounding precautions. Verify that the unit under test or being installed and all measurement equipment are properly grounded.
- Do not test alone. Testing or adjusting the equipment should only be carried out in the presence of a person qualified to render aid.
- When lifting the equipment, use proper lifting techniques to prevent injury.
- It is the responsibility of the installer and the user to ensure that the public is not exposed to excessive RF levels. Such information must be posted near the antenna in the form of caution or warning notes and signs.

1.6 P-COM PMP Terminology

For the ease of the reader, a Glossary is provided at the end of the manual defining terminology used in P-COM Tel-Link Point-to-Multipoint manuals

2.0 Tel-Link Point-to-Multipoint (PMP) System Overview

2.1 Introduction

Tel-Link Point-to-Multipoint (PMP) provides wideband and broadband services for business customers. These services include telephony, data, LAN, and video. The Tel-Link PMP systems provides solutions for Fixed Wireless Access (FWA), Wireless Local Loop (WLL), Local Multi-Point Communications Services (LMCS) and Local Multi-Point Distribution Services (LMDS).

Employing integrated star topology, the PMP system uses digital wireless cell-based transmission to carry both wideband telephone services and broadband multimedia services to customers. Minimal delay is provided for voice traffic and very low bit error rates are achieved to support data services.

The unique architecture of the Tel-Link PMP system has the following benefits:

- Flexibility
- Scalability
- Bandwidth management
- Integrated Network Management
- Software Distribution
- Wide variety of User Interfaces
- Wide range of frequency bands available: 10 - 40 GHz

2.2 System Architecture

Tel-Link PMP wireless system addresses the requirements for alternative access to local circuit, packet and cell switching facilities within metropolitan areas. It interfaces with existing PABX, Key Systems, host computers, LANs, Multiplexers, Routers/Bridges, etc. and provides transport to local switching centers via a highly reliable, wireless communications link.

Figure 2.1 shows a simplified block diagram of the Tel-Link PMP system architecture.

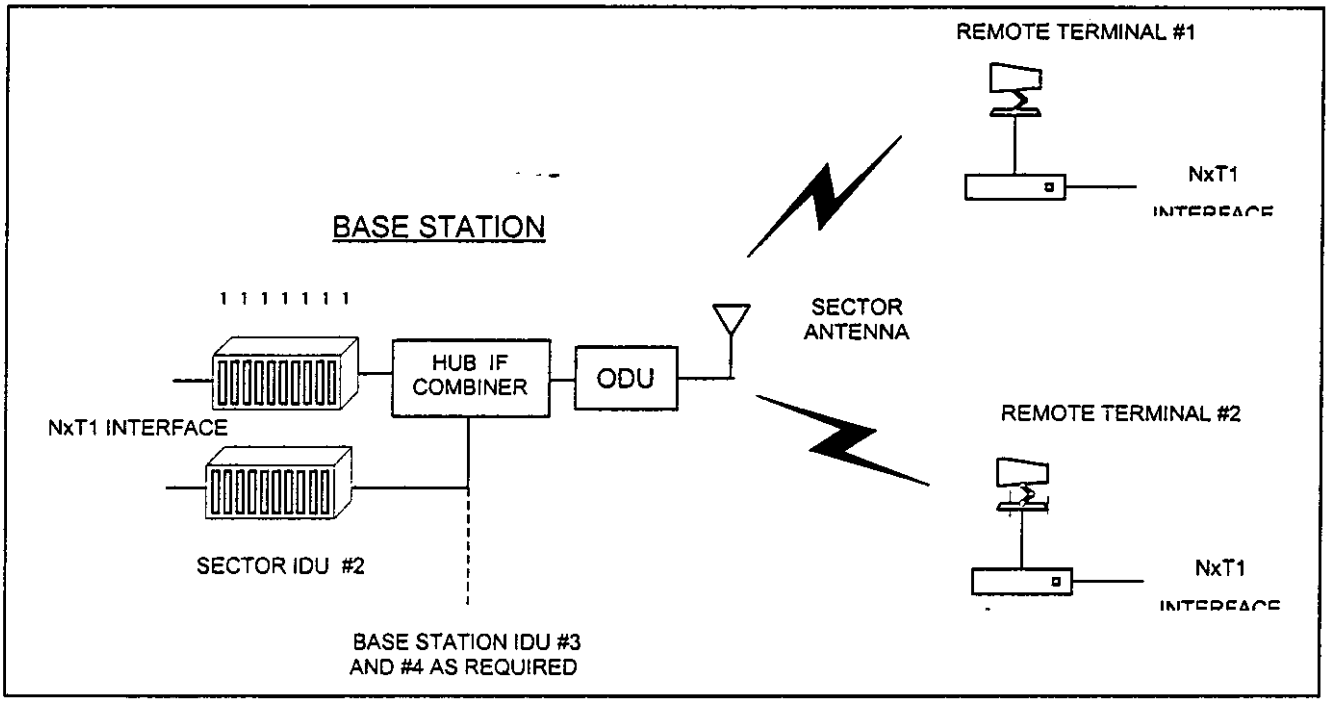

Figure 2-1 – Simplified PMP System Architecture

2.2.1 Base Station Terminal Components

A Base Station Terminal consists of the following components:

- One to five Sector Indoor Units (IDUs)
- One Hub IF Combiner
- One (or two, for redundancy) Sector Outdoor Unit (ODU)
- Transmit and Receive Horn Antenna
- An Interfacility Link (IFL)

Multiple Sector IDUs may be used to increase the bandwidth capacity of a particular sector coverage area. These Sector IDUs are combined with a Hub IF Combiner. A single IFL coaxial cable connects the IF Hub Combiner to the Sector ODU. The Sector ODU is integrated with an antenna of selected beamwidth to provide coverage over a selected area.

2.2.2 Remote Terminal Components

A Remote Terminal consists of four basic components:

- Indoor Unit (IDU)
- Outdoor Unit (ODU)
- Antenna
- Interfacility Link (IFL)

2.2.3 PMP Network

The PMP network is designed around a series of Base Station sites strategically located within the desired coverage area, with each site supporting line-of-sight connections to numerous Remote Terminals. A Base Station provides 360° coverage through the use of segmented sectors, each providing 15°-90° coverage around the Base Station (refer to Figure 2-2). Each Base Station also interfaces to the Public Switched Network (PSN) through concentrated access links. A sectorized area of a Base Station Sector is supported by from 1 to r Sectors Terminals, depending on the number of Remote Terminals located in that secotr. A Sector Terminal consisting of an Indoor Unit (IDU) and an integrated RF/Antenna Outdoor Unit (ODU). The Sector IDU is a standard 19-inch rack-mount chassis with redundant power supplies, and space for plug-in cards. All cards are hot pluggable/swapable. Each sector antenna contains a transmit and receive horn, with azimuth beamwidth of 15° and 90°.

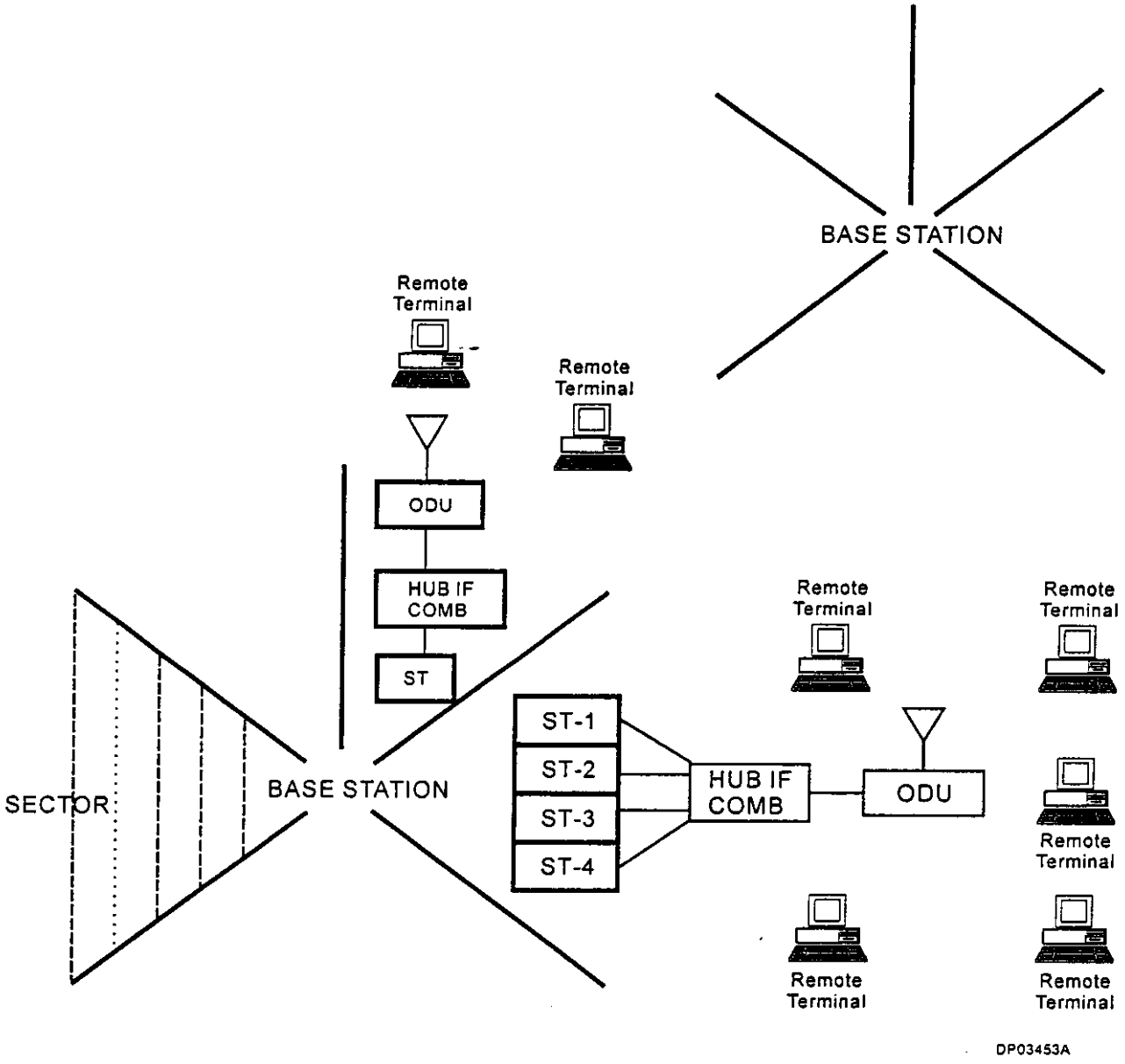

Figure 2-2 –Example of Simplified Base Station Site

The system utilizes a cell-multiplexed, continuous carriers to transmit data Sector Terminal to Remote Terminals. A separate carrier is used by each Sector Terminal to deliver these cells to the Remote Terminals. The carriers are typically transmitted at slightly different frequencies to avoid interference. Frequency Division Multiple Access (FDMA) method is used by the Remote Terminals to transmit information to the Sector Terminal. The Remote Terminals communicate on separate carriers with demodulators at the Sector Terminal.

Each Remote Terminal consists of an integrated RF/Antenna ODU and an IDU. The IDU is a chassis supporting a power supply, Modulator, Demodulator, Remote Controller and T1 User Interface Modules. The ODU consists of a RF electronic subsystem and a 1-foot parabolic antenna. The IDU can be connected to an external Customer Premise Equipment (CPE) which can provide POTS, ISDN and data interfaces.

The system makes extensive use of cell transport over the wireless link between the Base Station and the Remote Terminals. It efficiently supports traffic such as T1, Fractional T1, ISDN, analog voice, Frame Relay and Nx64 kbps data, providing highly reliable connections with very low error rates.

Network management agents provide detailed fault isolation, traffic level monitoring and remote control and configurability. Network management information is provided via the PC-based Local Site Manager (LSM) software tool. The LSM is connected to the management port of a Sector Controller and is capable of monitoring and controlling the Sector Terminal equipment and all the Remote Terminals located within the sector.

The system is designed for rapid fault isolation and repair in the field. All active elements are contained on front-loaded cards with front-mounted LEDs indicating status.

A critical feature of the system is its scalability. It is possible to start with a Base Station and a single sector coverage area, and later add more Modulators to increase capacity, additional Demodulators as the Remote Terminal population grows, and additional sectors as the coverage area expands. Simplified installation also enhances the versatility of the system. Pre-configured Remote Terminals and simplified antenna pointing will further reduce the time and effort required to complete the Remote Terminal installation. Automated performance monitoring and installation reporting are additional features that add to the installability of the Remote Terminal sites.

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3.0 Base Station Terminal Theory of Operations

3.1 Introduction

Base Stations are located at the center of each cell and have a radius depending on the RF frequency, climate type, desired network availability, line-of-sight profiles, and traffic capacity requirements. A Base Station consists of 1 to 5 Sector IDUs per sector. Each Sector Terminal communicates directly with the Remote Terminals within a sector area of 15° to 90°, depending on the antenna used at the Sector Terminal.

A Sector Terminal consists of the following components:

- 1 to 5 Sector IDU(s) consists of a Modulator, Demodulator, Controller and User Interface Module (UIM)
- A Hub IF Combiner used to combine multiple IDUs
- An ODU containing the RF electronics
- An Antenna and mounting hardware
- An IFL consisting of a single coaxial cable connecting the Indoor Unit to the Outdoor Unit

3.2 Sector Terminal Indoor Unit (IDU)

The Sector Terminal Indoor Unit (IDU) is located inside the customer's facility and is connected to an Outdoor Unit (ODU) via a coaxial cable. The Sector IDU is comprised of the following components:

- A software configurable QPSK, 16-QAM, or 64-QAM Modem consisting of a Modulator and Demodulator that provides the physical layer wireless communication link between the Sector Terminal IDU and the Remote Terminal IDU
- A Controller card that is responsible for controlling and monitoring local functions, and processing Network Management messages from the Network Operation Center.
- Network Interface Cards (NICs) which supports user interfaces, as well as signal monitoring and port statistics collection.

The Sector Indoor Unit (IDU) chassis consists of a modulator(s), demodulator(s), and controller(s) and can accommodate up to 6xT1/E1 Network Interface Cards (NICs) (refer to Figure 3-1). Chassis configuration is performed from a Local Site Manager (LSM) laptop or desktop PC using the P-COM's Local Site Manager Lite Windows application. Each card has specific variables, which need to be properly configured to establish a RF link to the PMP Remote Terminals and pass user data. Each card in the chassis has a physical and logical slot number and are individually addressed by logical slot number (refer to Figure 3-2).

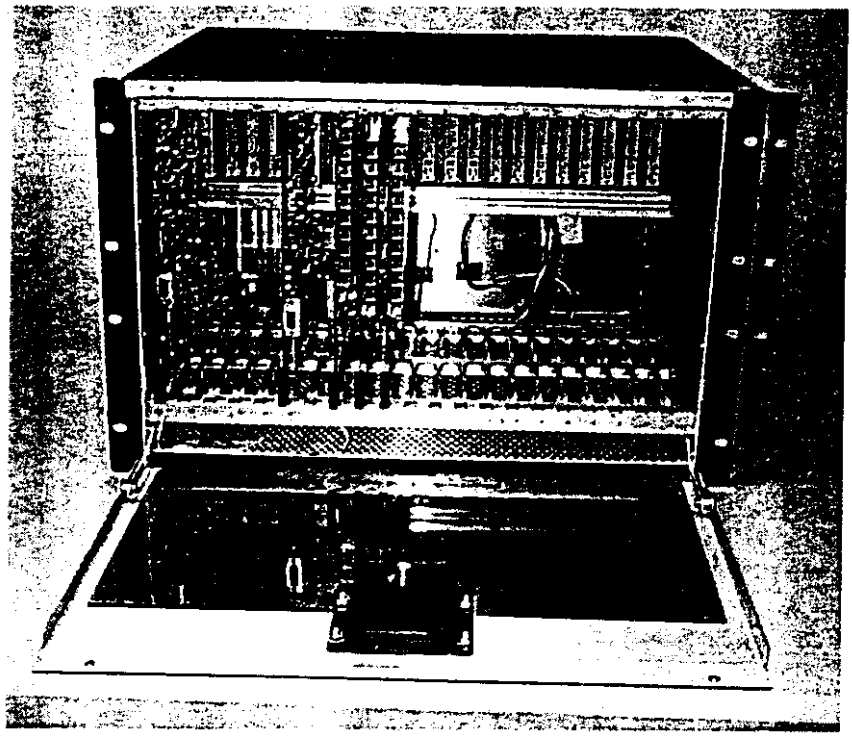


Figure 3-1 – Sector Indoor Unit Chassis

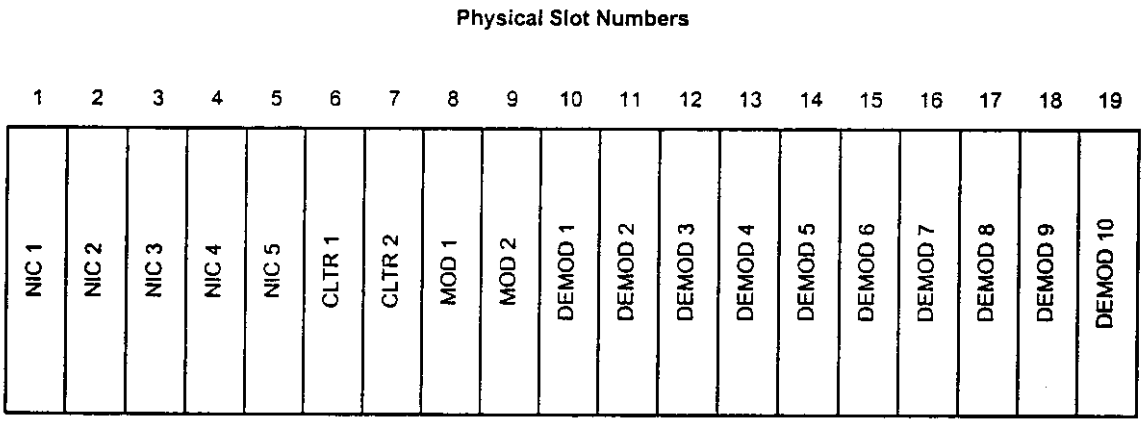


Figure 3-2 – Sector IDU Slot Identification

Figure 3-3 shows a simplified block diagram of the IDU.

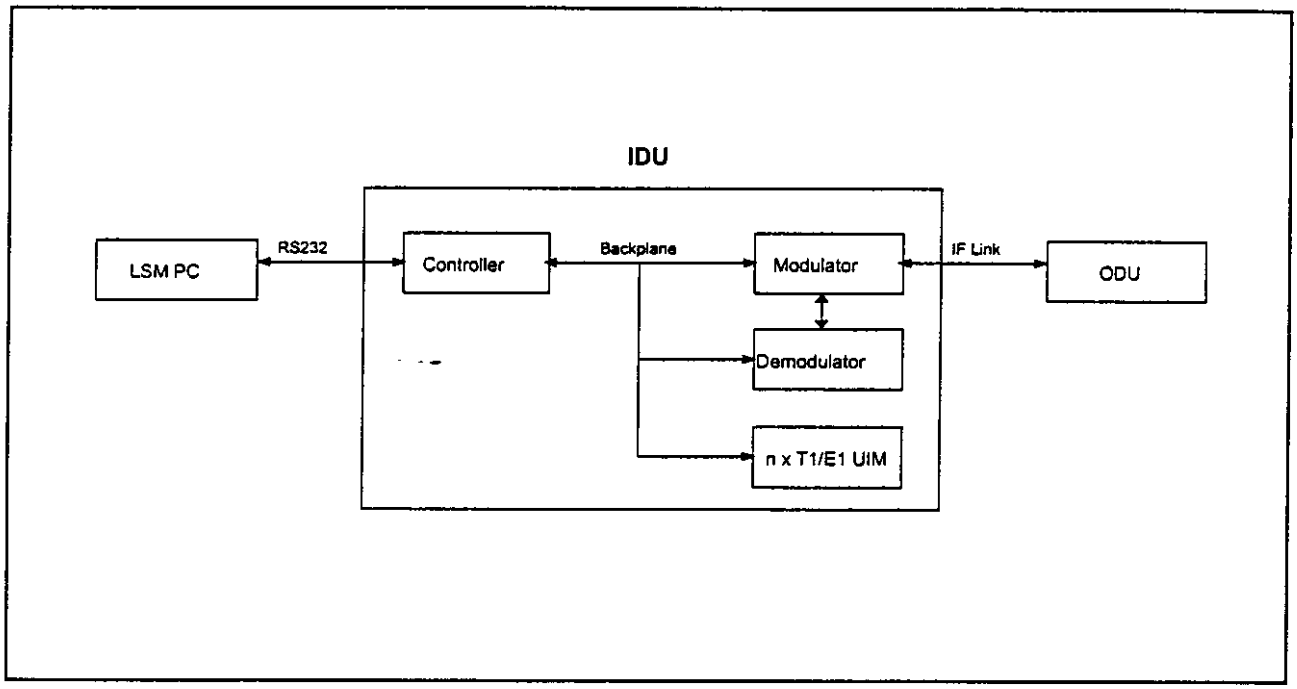


Figure 3-3 – IDU Block Diagram

3.2.1 Sector Controller (P/N 28520)

The Sector IDU controller is responsible for distributing and obtaining responses to configuration and status messages to all cards in the chassis and the ODU. It is also responsible for distributing software downloads from the Local Site Manager (LSM) or over the air NMS channel.

A serial port is provided on the Sector Controller allowing local management through the connection of the LSM software tool. All configuration data received from the LSM is stored in local nonvolatile RAM for configuration of the chassis when power is applied. In addition, a second serial-port can be used to connected to a modem for dial back-up of management.

Features:

- Serial port for local management
- Complete management of the Sector IDU
- Complete management of all Remote Terminals located within the sector
- Dial back-up management
- Hot pluggable
- Remote Terminal provisioning and software updates

Sector Controller LED front-mounted indications:

- RED-SOLID - System is non-operational
- RED-BLINKING - Configuration and Initialization mode active
- GREEN-BLINKING - Normal operation

Any chassis errors detected will first be indicated by a flashing red. Further specific information can be obtained using the LSM to query the controller or associated card.

3.2.2 Modulator (P/N 28020-2)

The Modulator card supports a continuous outbound TDM carrier to all Remote Terminals located within a sector. All messages received from the NICs are routed and modulated before being transmitted to the Remote Terminals.

Features:

- Data Rates: up to 16 T1
- Forward Error Correction encoding
- Scrambling
- Power management
- Hot pluggable
- Remote provisioning and software updates
- QPSK, 16-QAM, and 64-QAM continuous modulation
- Multiplexing function that combines the following signals on to a single coaxial cable:
  - Transmit IF
  - Receive IF
  - Monitor and Control

Modulator LED front-mounted indications:

- RED-SOLID - System is non-operational
- RED-BLINKING - Configuration and Initialization mode active
- GREEN-SOLID - Normal operation

3.2.3 Demodulator (P/N 28023-2)

The FDMA demodulator card receives a continuous carrier and is used to receive traffic from a FDMA Remote Terminal. It demodulates the received traffic from the Remote Terminal and separates network management messages. All user data is sent to the Network Interface Cards.

Features:

- Continuous Frequency Division Multiple Access (FDMA)
- Data rates up to 16 T1 each
- 4-QAM, 16-QAM, 64-QAM continuous demodulation
- Forward Error Correction decoding
- Hot pluggable

Demodulator LED front-mounted indications:

- RED-SOLID - System is non-operational
- RED-BLINKING - Link Acquisition mode
- GREEN-SOLID - Receiving reference signal, Normal operation

The Demodulator supports three levels of modulation: QPSK, 16-QAM and 64-QAM. There are discrete symbol rates supported and are listed below in Table 3-1.

Table 3-1 – TX and RX Rate Chart

Modulation	# of T1s (Integer)	Chan. Spacing (MHz)	Hub or Remote Supported
64-QAM	2	1.0	Remote Tx only
64-QAM	4	2.0	Hub and Remote
64-QAM	8	4.0	Hub and Remote
64-QAM	12	5.6	Hub and Remote
64-QAM	16	8.0	Hub Tx only
16-QAM	1	1.0	Remote Tx only
16-QAM	2	2.0	Hub and Remote
16-QAM	5	4.0	Hub and Remote
16-QAM	8	5.6	Hub and Remote
16-QAM	11	8.0	Hub and Remote
16-QAM	14	10.0	Hub Tx only
QPSK	1	2.0	Remote Tx only
QPSK	2	4.0	Hub and Remote
QPSK	4	5.6	Hub and Remote
QPSK	5	8.0	Hub and Remote
QPSK	7	10.0	Hub Tx only

3.2.4 6 x T1 Network Interface Card (P/N 28530)

The T1 Network Interface Card (T1-NIC) provides up to six (6) T1 interfaces. Each 6 x T1 NIC is used at the Sector Terminal to allow the interconnectivity of up to six full duplex T1 circuits. Each T1 port at the Sector Terminal is mapped and routed to a T1 port at a Remote Terminal. All data bits from the Sector Terminal are transported to the Remote Terminals – the transport is clear channel. Therefore, the port supports any type of T1 framing transparently.

Features:

- Six (6) DSX interfaces
- AMI/B8ZS encoding
- Signal formats include SF/D4 or ESF
- Line build-out to 655 feet (218 meters)
- Loopback: far-end, local
- Alarms: loss of signal, AIS, red alarm, yellow alarm
- Statistics: line code violations, framing errors, parity errors, FEBE events
- Hot pluggable
- Remote provisioning and software updates

T1 Network Interface Card LED front-mounted indications:

- RED-SOLID - System is non-operational
- RED-BLINKING - Port(s) mis-configured
- GREEN-SOLID - Normal operation

3.2.5 Power Supply

The Sector Terminal IDU may be configured to operate on AC or DC input power. The power supply modules and input power connector are identified in the Table 3-2.

Table 3-2 – Sector Terminal Power Supply Configuration Matrix

Power Supply Type	Model Number
Universal AC Input Voltage (90-260 VAC, 47-63 Hz)	XXXXXX
40-56 VDC Input Voltage	XXXXXX

3.2.5.1 Input Power

AC Power

A rear view of the Sector Terminal IDU configured to operate on AC input power is shown in Figure 3-4. Units that operate from AC power have an IEC 320 power connector on the rear panel of the IDU (refer to Figure 3-5).

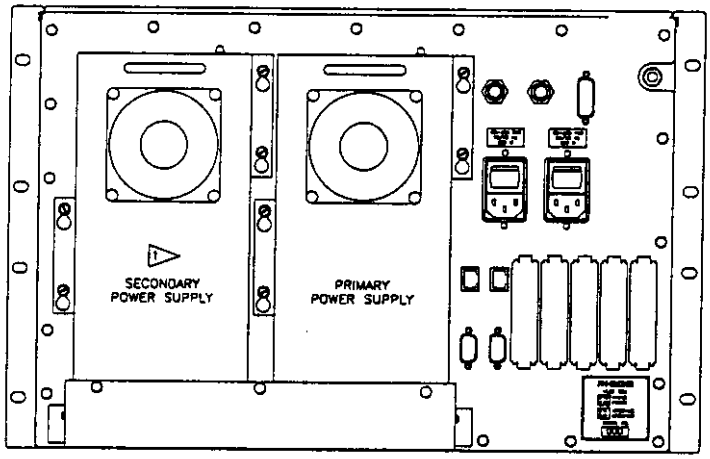


Figure 3-4 – Sector Terminal IDU Rear View (AC Input Power)

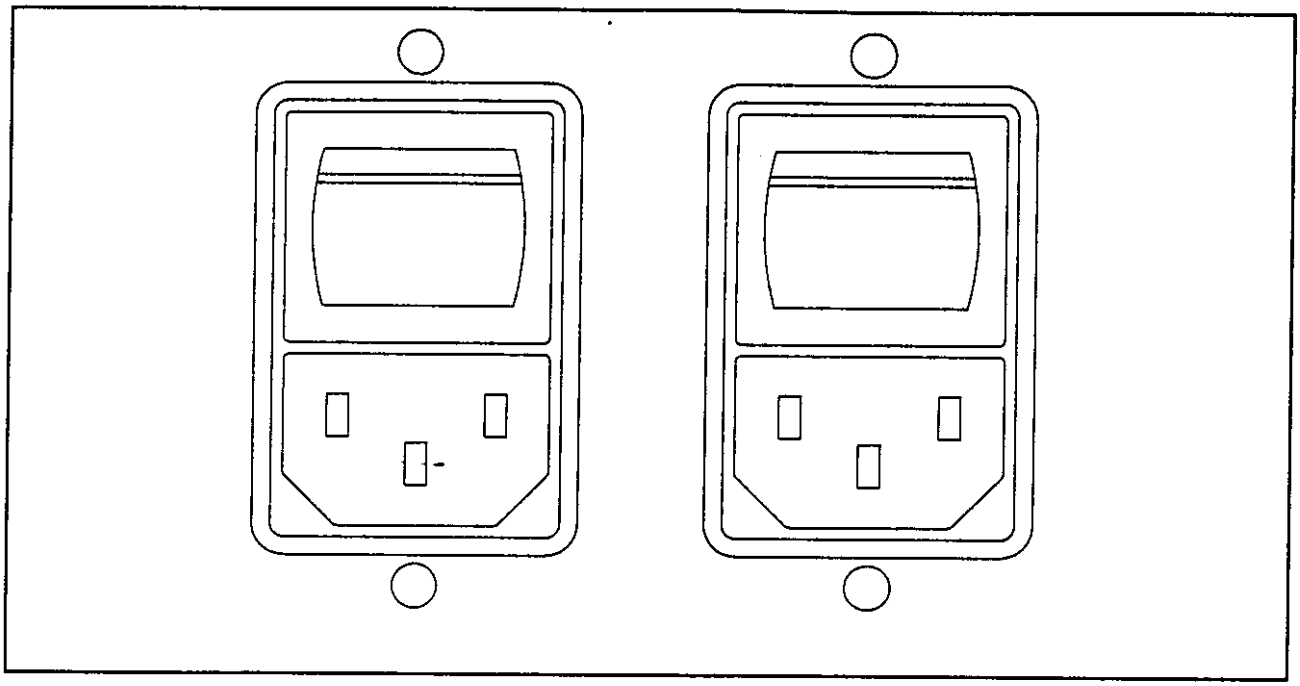


Figure 3-5 – AC Power Connector

DC Power

A rear view of the Sector Terminal IDU configured to operate on DC input power is shown in Figure 3-6. Units that operate from DC power have a 4-pin plugable terminal block on the rear panel of the IDU (refer to Figure 3-7).

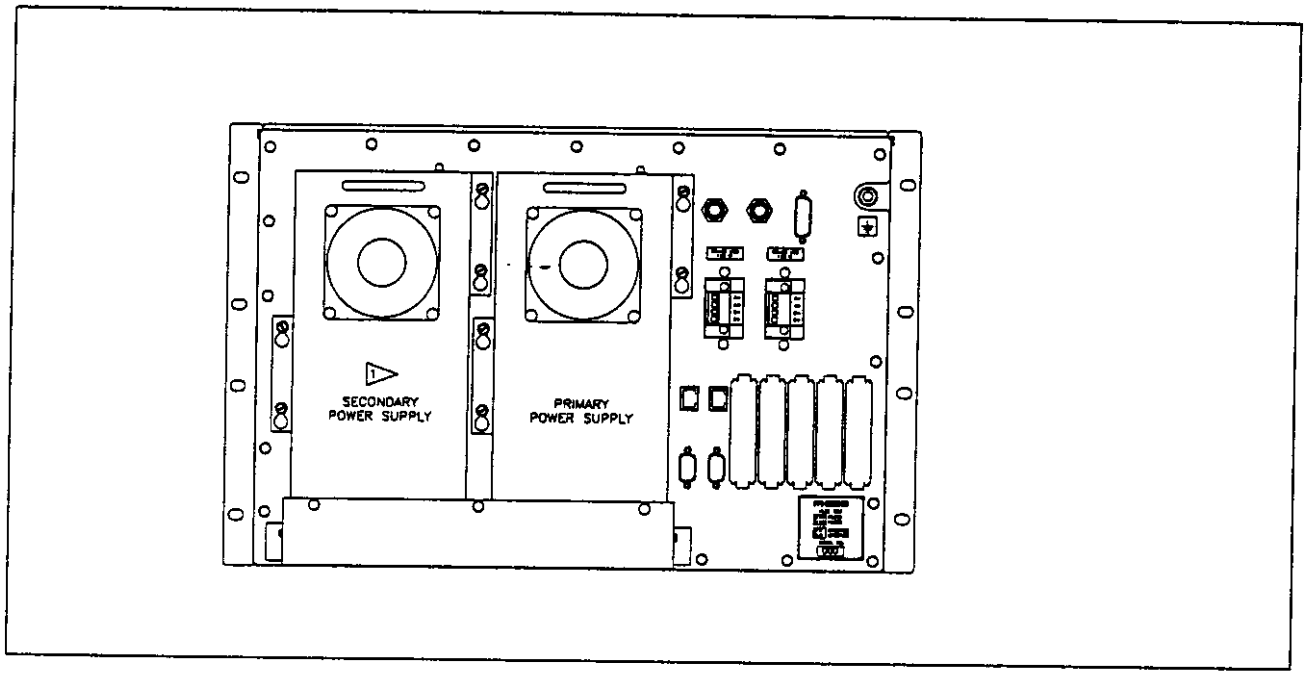


Figure 3-5 - Sector Terminal IDU Rear View (DC Input Power)

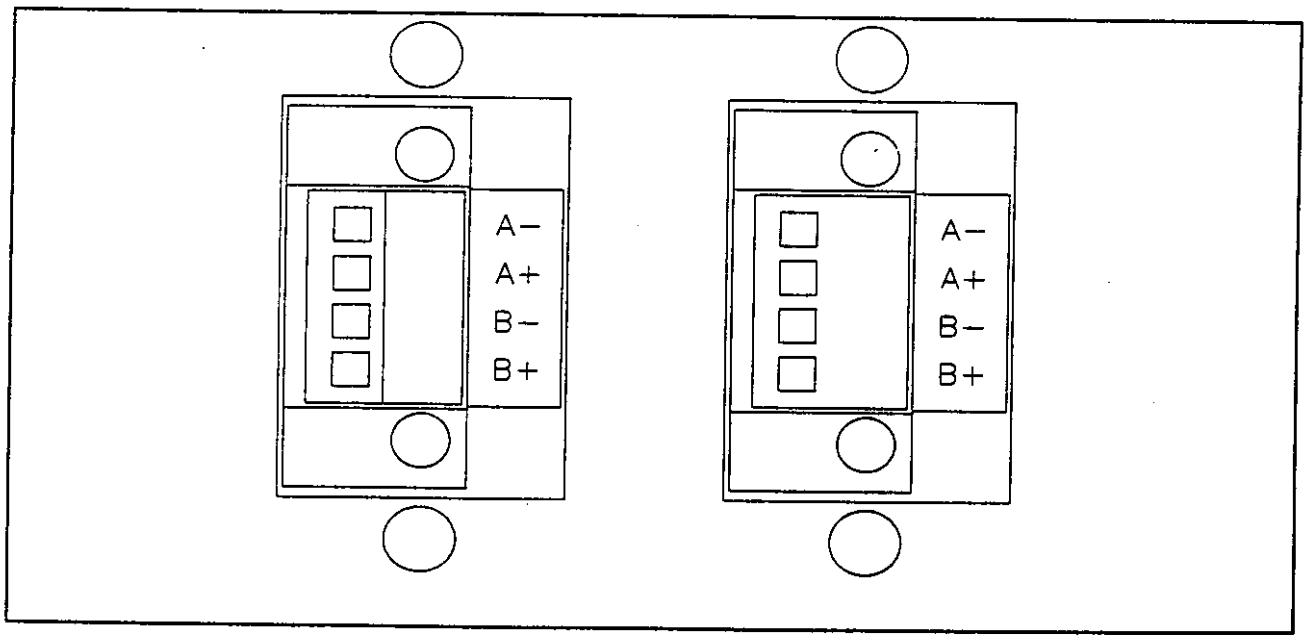


Figure 3-7 – DC Power Terminal Block

3.2.5.2 Hot Plug-in Impact on Power Supply

In addition, each signal circuit card power input includes a reverse blocking diode along with bulk filtering components and a fuse on each supply voltage. If a circuit card fails with a short to ground on one of the power supplies, its fuse will open and allow the rest to recover and reset. The reverse blocking diodes provide protection from momentary power supply drops while "hot plugging" new circuit cards into the backplane. They will not protect the system from momentary disruption in the case of a power supply fault to ground that results in an open fuse.

3.3 Hub IF Combiner

The Hub IF Combiner is necessary to combine multiple Sector Terminal signals and to route them to a single Outdoor Unit (ODU). This unit is capable of combining up to four Sector Terminal signals. Sector Terminal signals include Transmit IF and Receive IF signals along with carrying telemetry information. After these signals enter the HUB IF Combiner they are coupled together with a high stability frequency oscillator and 48 Vdc power supply. The high stability frequency oscillator operates as a system reference for the ODU and its control circuitry. The 48 Vdc voltage is the supply voltage for the ODU. The Sector Terminal IF signals, the reference signals, the telemetry information and the 48 Vdc are all distributed to the ODU by a single cable.

On the back panel of the Hub IF Combiner is a switch that enables the user to select whether the unit is operating Link A or Link B. On the front panel a LED will be illuminated to identify which configuration has been selected.

The HUB IF Combiner is powered by AC (refer to Figure 3-7), or DC (refer to Figure 3-8) if the unit was ordered with the optional DC configuration.

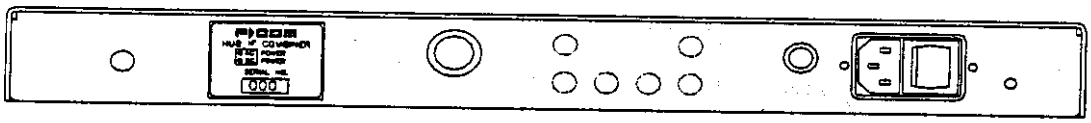


Figure 3-7 – HUB IF Combiner Rear View (AC Input Power)

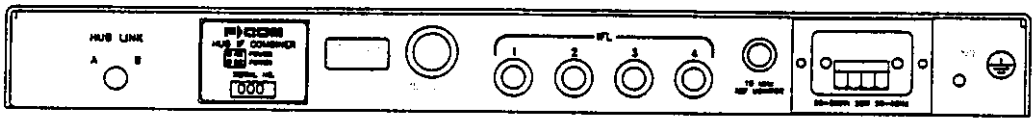


Figure 3-8 – HUB IF Combiner Rear View (DC Input Power)

Figure 3-9 is a block diagram that represents the signal flow through the Hub IF Combiner.

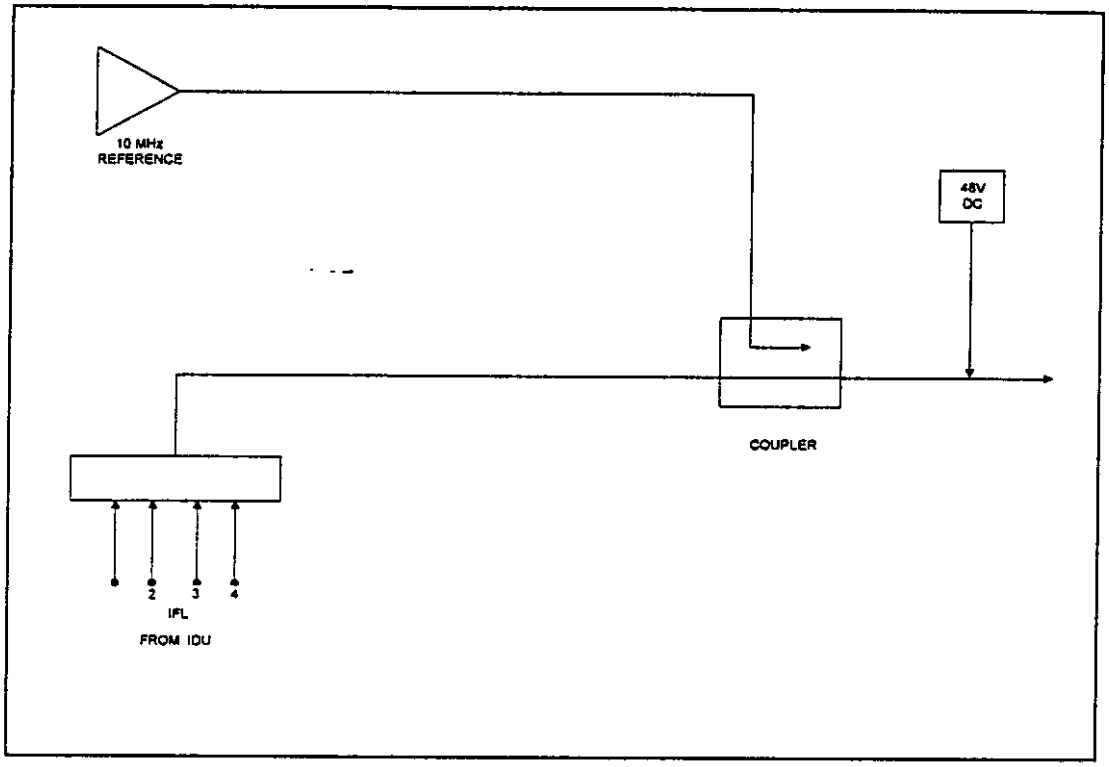


Figure 3-9 – Hub IF Combiner Block Diagram

3.4 Sector Terminal Outdoor Unit (ODU)

The Sector Terminal Outdoor Unit (ODU) is a single integrated enclosure containing all RF components mounted directly to a dual lensed-horn antenna. Antennas have azimuth beamwidth angles of 15°, 22.5°, 45° or 90°.

Each Outdoor Unit (ODU) is a self contained radio transmitter weighting approximately 13.2 pounds (6 Kg) attaching directly to an antenna by flexible waveguide to a Sector Terminal antenna. The ODU's are designed to provide frequency diversity, and installed to transmit on either horizontal or vertical polarity.

The ODU transmits modulated RF signals to the Remote Terminals and receives RF signals from the Remote Terminals via line-of-sight wireless communication links. Due to rain attenuation considerations operating at 38 GHz, both the Sector Terminal and the Remote Terminals receive and transmit on the vertical polarization. For operating frequencies of 24 and 26 GHz, orthogonal polarized antenna feeds are used.

Based on the operating RF frequency in use, ODUs are available to operate in the 10 GHz, 24 GHz, 26 GHz, 28 GHz, 31 GHz and 38 GHz bands.

Figure 3-10 illustrates the RF/Antenna configuration for the Sector Terminal Outdoor Unit. The packaging includes the following components:

- ODU Enclosure
- RF Electronics
- ODU Controller Card responsible for controlling and monitoring ODU functions and for interfacing with the IDU

The ODU is frequency agile so that the same ODU can typically be used throughout the entire allocated frequency band. Subsequently, this reduces sparing levels.

The ODU meets all National Electrical Code requirements pertaining to lightning and power transients and meets or exceeds FCC and ETSI regulations pertaining to conducted and radiated Electromagnetic Emissions.

The ODU is sealed against the environment and is capable of functioning in ambient temperatures ranging from -40°C to +60°C, with up to 100% relative humidity. The ODU can survive steady state winds of 40 m/s with gusts to 55 m/s (89 mph/123 mph).

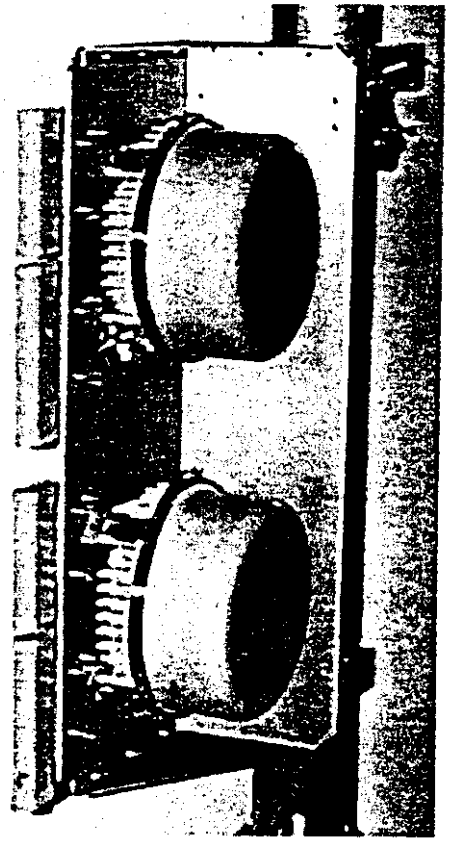


Figure 3-10 – Sector Terminal Outdoor Unit (Redundant Configuration)

Figure 3-11 illustrates the interior and interface baseplate of the Sector Terminal ODU.

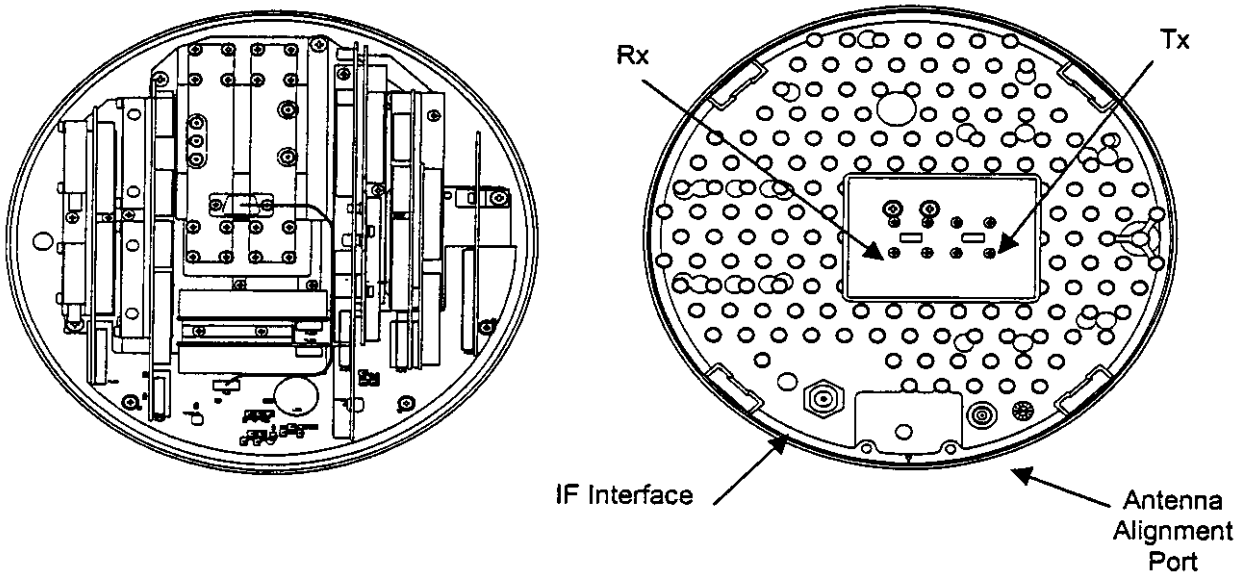


Figure 3-11 – Sector Terminal ODU & Baseplate

The ODU exchanges many multiplexed signals with the IDU through the same cable, and distributes the necessary signals to the ODU controller. The ODU receives +48Vdc, a 10 MHz reference signal, user data modulated onto an IF carrier, and telemetry messages for the Sector IDU controller all on the same cable. In addition, on the same cable, the ODU transmits received user data modulated onto another IF carrier and telemetry messages to the IDU (Refer to Figure 3-12).

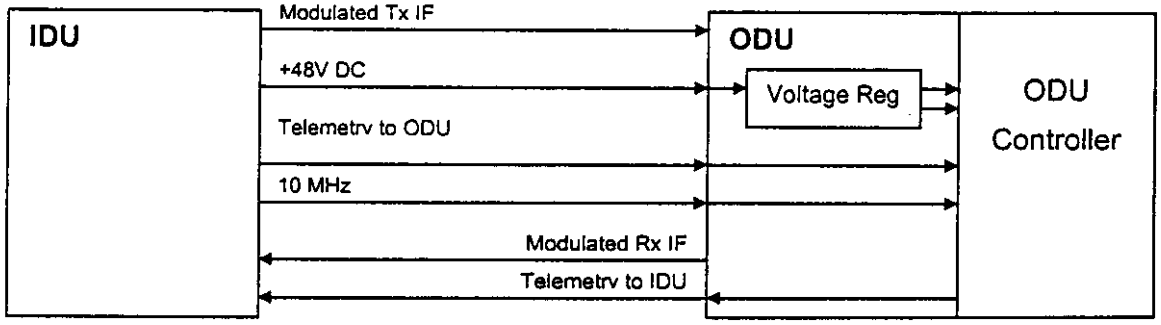


Figure 3-12 – Signal Distribution in the IDU/ODU System

The ODU Controller sets a slope control signal at power-up, based on the detected cable length. The Controller also monitors cable length once a second, and mutes the transmitter if a cable is not detected. The controller monitors antenna alignment if that function is enabled via the Local

Site Manager (LSM). It also monitors and controls transmitter power if enabled configuration parameters are stored in on-board NVRAM.

3.4.1 TX IF Module

The TXIF Module up-converts the modulated VHF signal received from the IDU to a C or E Band signal used to drive the Microwave Module. An internal AGC loop corrects for power variations related to coaxial cable length between the IDU and ODU, and provides an analog signal to the Controller Module for slope correction. Two voltage-controlled attenuators under Controller Module direction sets the drive power to the Microwave Module to establish the overall ODU transmitter power.

3.4.2 RX IF Module

The RXIF Module is a dual conversion system that down-converts the C or E Band signal received from the Microwave Module into an UHF signal passed to the IDU through the coaxial cable. In addition, the RXIF Module provides gain to amplify signals over a wide dynamic range guaranteeing a constant signal level is fed through the coaxial cable connecting the ODU to the IDU. An internal AGC maintains a constant signal level and generates an analog Received Signal Strength Indicator (RSSI) signal passed to the Controller Module. This signal level is also available on a Bayonet Nut Connector (BNC) connector for antenna pointing.

3.4.3 Controller PCB

The ODU Controller monitors several ODU PMP link variables and conditions; and either transmits these to the IDU or internally adjusts levels within the ODU as appropriate. Communication with the IDU is accomplished by multiplexing and transmitting the signals through the coaxial cable connecting the two units. One major function of the Controller is to monitor and adjust transmitting power; ensuring adequate signal strength is achieved. The Controller will not adjust to unnecessarily high levels that increase the potential for interference with other PMP stations.

3.4.4 Signal Flow-Transmit Direction

The transmit IF signal from the IDU arrives at the ODU Motherboard where it is extracted by the multiplexer and routed to the TX IF Module. Simultaneously, the reference signal and telemetry are extracted and routed to the VCXO and Controller Modules respectively.

The IF signal is up-converted and filtered by the TX IF Module, and routed to the Microwave Module where it is further up-converted to the output frequency, amplified and filtered. Transmit power control is applied to the process at the output of the TX IF Module. Sector ODU's route the signal via flexible waveguide to the transmit horn of the sector antenna for broadcasting.

3.4.5 Signal Flow-Receive Direction

Signal routing in the receive direction is nearly the reverse of the Signal Flow-Transmit Direction. Received signals in Sector units are passed from the horn antenna to the Microwave Module through flexible waveguide. At the Microwave Module signals are amplified by the Low Noise Amplifier (LNA) and down-converted to the first receive IF, and then sent to the RX IF Module. The first IF is determined by the frequency programmed into the TX IF Module, plus or minus the duplex frequency (depending on whether the unit is set to transmit either high or low band). At the RXIF Module, the receive IF is further down-converted, filtered, amplified and passed to the Motherboard Module, after AGC is applied, and then multiplexed and fed into the cable connecting the ODU and IDU. (Refer to Figure 3-13).

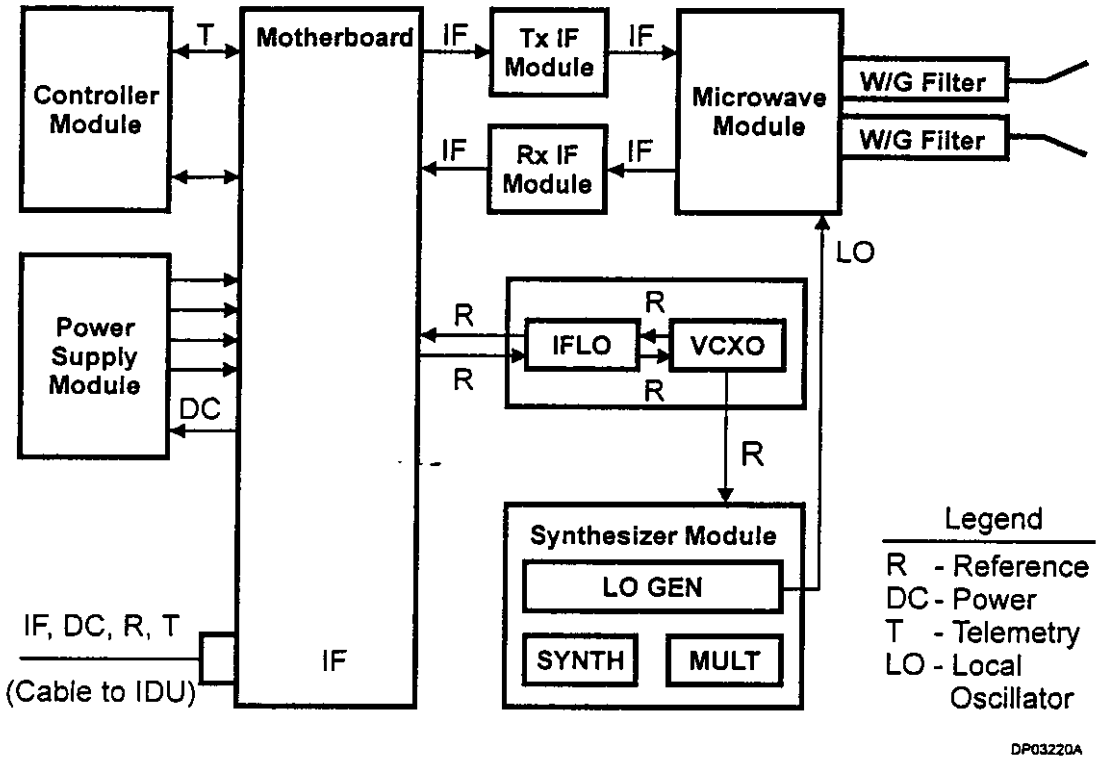


Figure 3-13 – Sector ODU Block Diagram

3.5 Antenna

The antenna is a lensed-horn antenna. For 24-26 GHz, two horns are used for transmit and receive functions. At 38 GHz, a single horn antenna is used. Specific antennae are used for horizontal or vertical polarizations and for azimuth beamwidths of 15°, 22.5°, 45° or 90°. The elevation beamwidth is typically 6°.

The antennae are mounted onto a rectangular mounting plate with mounting hinges used to install on a pole. One of the hinges allows for elevation adjustment.

- Feed
- Radome
- Mount

3.6 IF Cable Run

A single coaxial cable is used to connect the ODU to the IDU. The cable carries transmit IF signal, receive IF signal, telemetry 10 MHz reference signal and DC power. The IDU and ODU contain "N" type female connectors for interconnection of the coaxial cable. For increased EMC performance, P-COM recommends the use of Times-Microwave LMR-400, double screened, coaxial cable. Other coaxial cables with equivalent performance characteristics of the LMR-400, shown below in Table 3-3, may be used. LMR-400 may be used in continuous lengths up to 1000 feet. The maximum bend radius of LMR-400 is 6 inches (15 cm).

Table 3-3 – LMR-400 Performance Characteristics

Property	LMR-400
Dielectric	Cellular PE (low loss closed cell polyethylene foam) 0.285" nominal diameter
Shield	Aluminum laminated tape bonded to the dielectric with tinned/copper over braid. Diameter: 0.320" nominal
Jacket	Black PE Nominal jacket thickness: 0.045"
Capacitance	23.0 pf/ft
Impedance	50 Ω
Velocity of propagation	85%
DCR	Conductor 1.39 Ω/1000 ft.
Attenuation	30 MHz: 0.70 dB/100 ft
	220 MHz: 1.80 dB/100 ft
	450 MHz: 2.70 dB/100 ft
	900 MHz: 3.90 dB/100 ft

The signals that are carried between the IDU and the ODU on the coaxial IFL cable are provided in Table 3-4.

Table 3-4 – IFL Signals

IFL Signal	Frequency	Variation
IDU Transmit	205 MHz	±25 MHz
IDU Receive	490 MHz	±25 MHz
Telemetry	500-800 kHz	30 kHz
Reference Signal	10 MHz	1 ppm
IFL Power	**Voltage**	**Variation**
ODU Power	+48 Vdc	+40 to +57Vdc
IFL Connector	**Termination 1**	**Termination 2**
Type N male	IFL Combiner	ODU
Type BNC – N male	IFL Combiner	IDU

4.0 Remote Terminal Theory of Operations

4.1 Introduction

The Remote Terminal provides the interface to network services at the customer premise. The basic Indoor Unit (IDU) is provided with various interfaces and communicates with the Sector Terminal. The Remote Terminal consists of the following components:

- An IDU containing a Modulator, Demodulator, Power Supplies, Controller and User Interface Module (UIM)
- An ODU containing the RF electronics
- An Antenna and mounting hardware
- An IFL consisting of a single coaxial cable connecting the Indoor Unit to the Outdoor Unit

4.2 Remote Terminal Indoor Unit (IDU)

The IDU is located inside the customer's facility at a remote site and is connected to an ODU via a coaxial cable. The IDU is comprised of the following components:

- A software configurable QPSK, 16-QAM, or 64-QAM Modem consisting of a Modulator and Demodulator that provides the physical layer wireless communication link between the Remote Terminal and the Sector Terminal.
- A Controller card that is responsible for controlling and monitoring local functions, and processing Network Management messages from the Network Operation Center.
- User Interface Module(s) (UIM) which supports user interfaces, as well as signal monitoring and port statistics collection.

Figure 4-1 shows the interior of a Remote Terminal IDU.

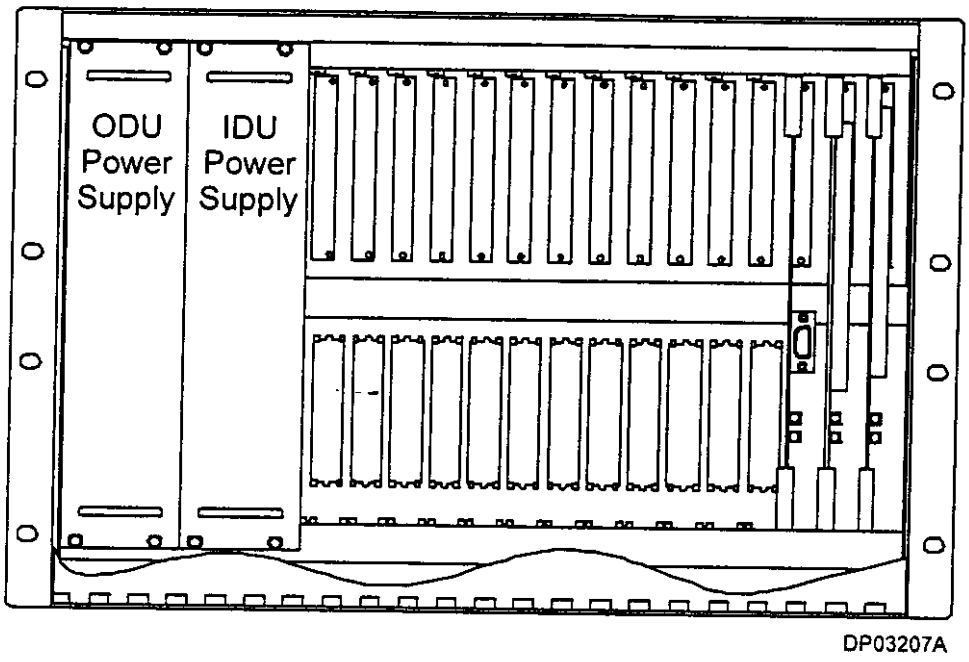
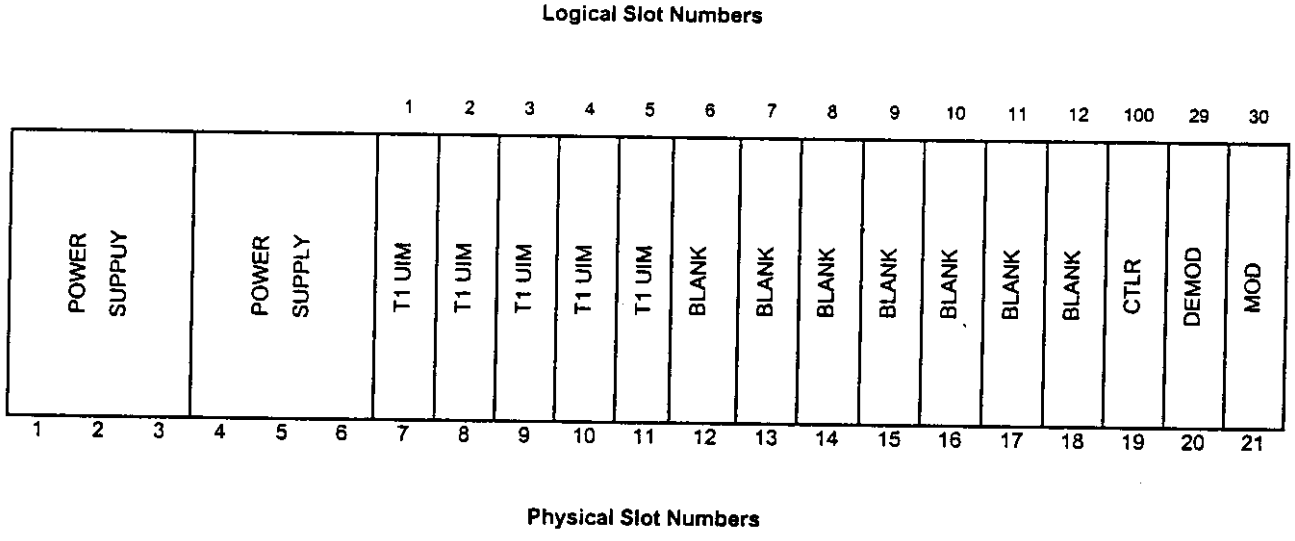


Figure 4-1 – Remote Terminal Indoor Unit Chassis

Each card in the chassis has a physical and logical slot number and are individually addressed by logical slot number (refer to Figure 4-2).



*ODU Is Logical Slot Number 0

Figure 4-2 – Logical/Physical Slot Numbers for Remote Terminal

The Indoor Unit (IDU) chassis consists of a modulator, demodulator, and controller can accommodate up to 3 T1 User Interface Modules (UIM's) and 2 Power Supplies. Chassis configuration is performed from a Local Site Manager (LSM) laptop or desktop PC using the P-COM's Local Site Manager Lite Windows application. Each card has specific variables, which need to be properly configured to establish a RF link to the PMP Base.

The IDU is connected to the Outdoor Unit (ODU) with an IF coaxial. The IF cable provides the link for receive IF, transmit IF, control and status telemetry link and DC power (refer to Figure 4-3).

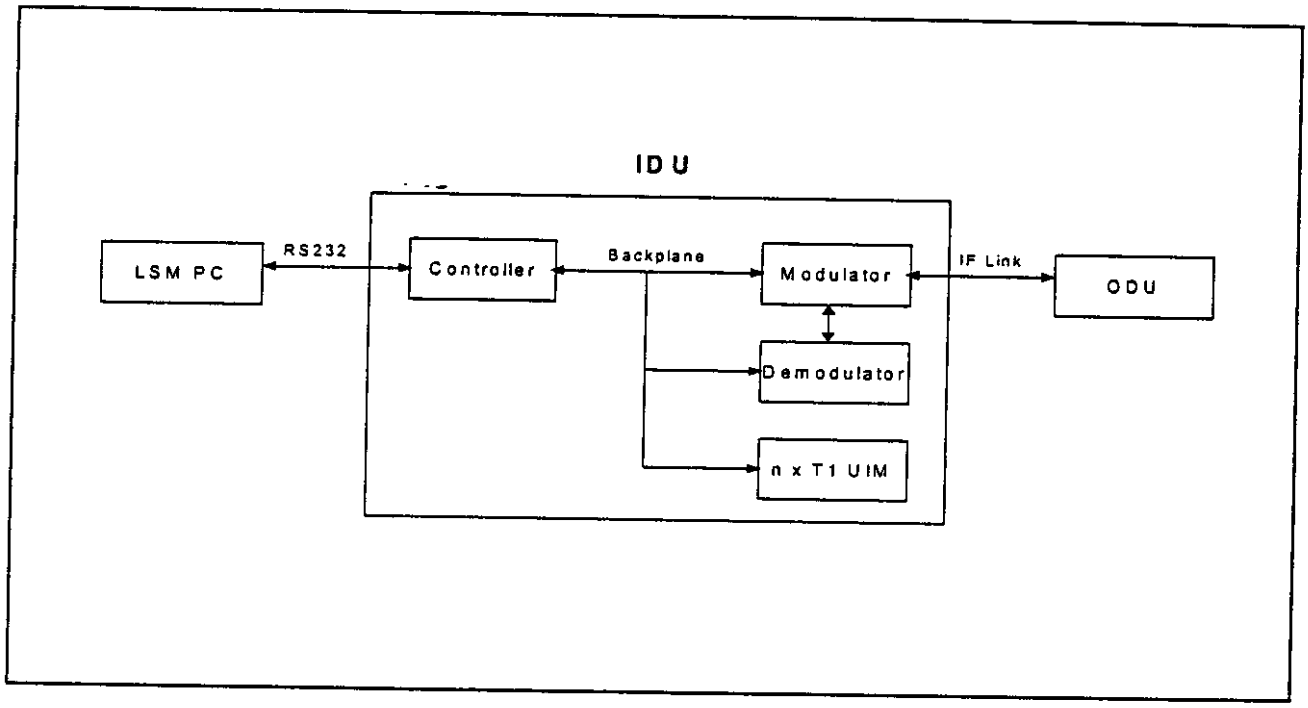


Figure 4-3 – IDU Block Diagram

4.2.1 Remote IDU Circuit Boards (P/N 48070)

The Remote IDU controller is responsible for distributing and obtaining responses to configuration and status messages to all cards in the chassis and the ODU. It is also responsible for distributing software downloads from the Local Site Manager (LSM) or over the air NMS channel.

A serial port is provided on the Remote Controller allowing local management through the connection of the LSM software tool. All configuration data received from the LSM is stored in local nonvolatile RAM for configuration of the chassis when power is applied. In addition, a second serial-port can be used to connected to a modem for dial back-up of management.

Features:

- Serial port for local management
- Complete management of the Sector IDU
- Complete management of all Remote Terminals located within the sector
- Dial back-up management
- Hot pluggable
- Remote Terminal provisioning and software updates

Remote Controller LED front-mounted indications:

- RED-SOLID - System is non-operational
- RED-BLINKING - Configuration and Initialization mode active
- GREEN-BLINKING - Normal operation

Any chassis errors detected will first be indicated by a flashing red. Further specific information can be obtained using the LSM to query the controller or associated card.

4.2.2 Modulator (P/N 28020-1)

The Modulator card supports a continuous outbound TDM carrier to all Remote Terminals located within a sector. All messages received from the NICs are routed and modulated before being transmitted to the Remote Terminals.

Features:

- Data Rates: up to 16 T1
- Forward Error Correction encoding
- Scrambling
- Power management
- Hot pluggable
- Remote provisioning and software updates
- QPSK, 16-QAM, and 64-QAM continuous modulation
- Multiplexing function that combines the following signals on to a single coaxial cable:
  - Transmit IF
  - Receive IF
  - Monitor and Control

Modulator LED front-mounted indications:

- RED-SOLID - System is non-operational
- RED-BLINKING - Configuration and Initialization mode active
- GREEN-SOLID - Normal operation

4.2.3 Demodulator (P/N 28023-1)

The FDMA demodulator card receives a continuous carrier and is used to receive traffic from a FDMA Remote Terminal. It demodulates the received traffic from the Remote Terminal and separates network management messages. All user data is sent to the Network Interface Cards.

Features:

- Continuous Frequency Division Multiple Access (FDMA)
- Data rates up to 16 T1 each
- 4-QAM, 16-QAM, 64-QAM continuous demodulation
- Forward Error Correction decoding
- Hot pluggable

Demodulator LED front-mounted indications:

- RED-SOLID - System is non-operational
- RED-BLINKING - Link Acquisition mode
- GREEN-SOLID - Receiving reference signal, Normal operation

The Demodulator supports three levels of modulation: QPSK, 16-QAM and 64-QAM. There are discrete symbol rates supported and are listed below in Table 4-1.

Table 4-1 – TX and RX Rate Chart

Modulation	# of T1s (Integer)	Chan. Spacing (MHz)	Hub or Remote Supported
64-QAM	2	1.0	Remote Tx only
64-QAM	4	2.0	Hub and Remote
64-QAM	8	4.0	Hub and Remote
64-QAM	12	5.6	Hub and Remote
64-QAM	16	8.0	Hub Tx only
16-QAM	1	1.0	Remote Tx only
16-QAM	2	2.0	Hub and Remote
16-QAM	5	4.0	Hub and Remote
16-QAM	8	5.6	Hub and Remote
16-QAM	11	8.0	Hub and Remote
16-QAM	14	10.0	Hub Tx only
QPSK	1	2.0	Remote Tx only
QPSK	2	4.0	Hub and Remote
QPSK	4	5.6	Hub and Remote
QPSK	5	8.0	Hub and Remote
QPSK	7	10.0	Hub Tx only

4.2.4 6 x T1 User Interface Module (P/N 28530)

The T1 User Interface Module (T1-UIM) provides up to six (6) T1 interfaces. Each 6 x T1 UIM is used at the Remote Terminal to allow the interconnectivity of up to six full duplex T1 circuits. Each T1 port at the Remote Terminal is mapped and routed to a T1 port at a Remote Terminal. All data bits from the Remote Terminal are transported to the Sector Terminal – the transport is clear channel. Therefore, the port supports any type of T1 framing transparently.

Features:

- Six (6) DSX interfaces
- AMI/B8ZS encoding
- Signal formats include SF/D4 or ESF
- Line build-out to 655 feet (218 meters)

- Loopback: far-end, local
- Alarms: loss of signal, AIS, red alarm, yellow alarm
- Statistics: line code violations, framing errors, parity errors, FEBE events
- Hot pluggable
- Remote provisioning and software updates

T1 User Interface Module LED front-mounted indications:

- RED-SOLID - System is non-operational
- RED-BLINKING - Port(s) mis-configured
- GREEN-SOLID - Normal operation

4.2.5 Power Supply

The Remote Terminal contains two power supply modules. Each module fits into a 7 U tall by 3 VME card pitch slot in the IDU chassis. One power supply provides power to the ODU via the modulator card and through the coaxial cable link to the ODU, and the second provides power to the IDU circuit cards. Figure 4-4 shows the relative location of each of the power supplies in the Remote Terminal IDU. There are a total of 4 power supply module configurations and all are keyed to only plug into the correct slot. Table 4-2 shows the 4 power supply configurations and their application. Both the ODU power supply and the IDU power supply plug into the IDU backplane through VME H15 style connectors.

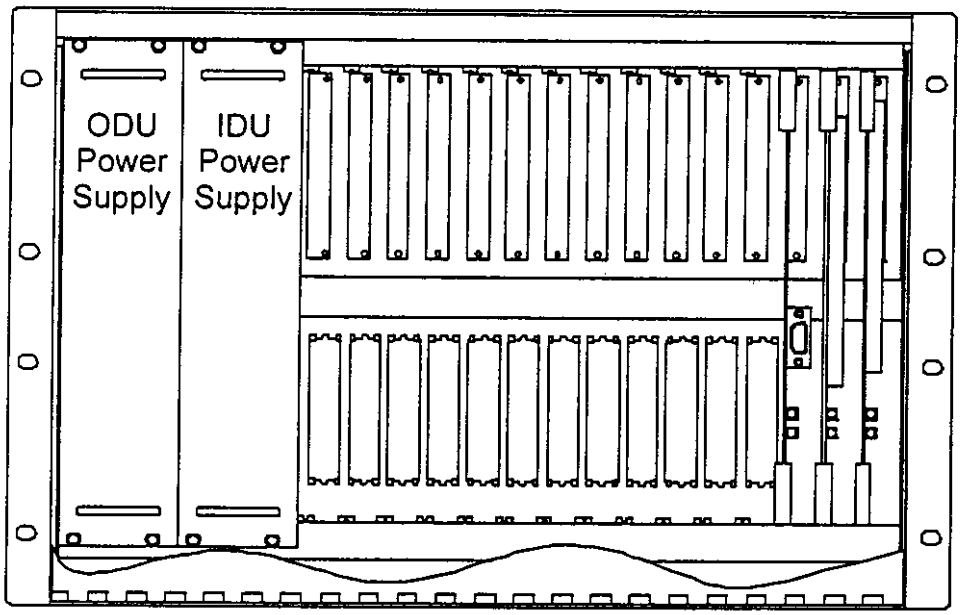


Figure 4-4 – Remote Terminal Power Supplies

Table 4-2 – Remote Power Supply Configuration Matrix

	+5.5, ±15.5 VDC Output	+48 VDC Output
Universal AC Input Voltage	48008-1	48008-2
20-56 VDC Input Voltage	48008-3	48008-4

AC Input Power

A rear view of the Remote Terminal IDU configured to operate on AC input power is shown in Figure 4-5. Units that operate from AC power have an IEC 320 power connector on the rear panel of the IDU (refer to Figure 4-6).

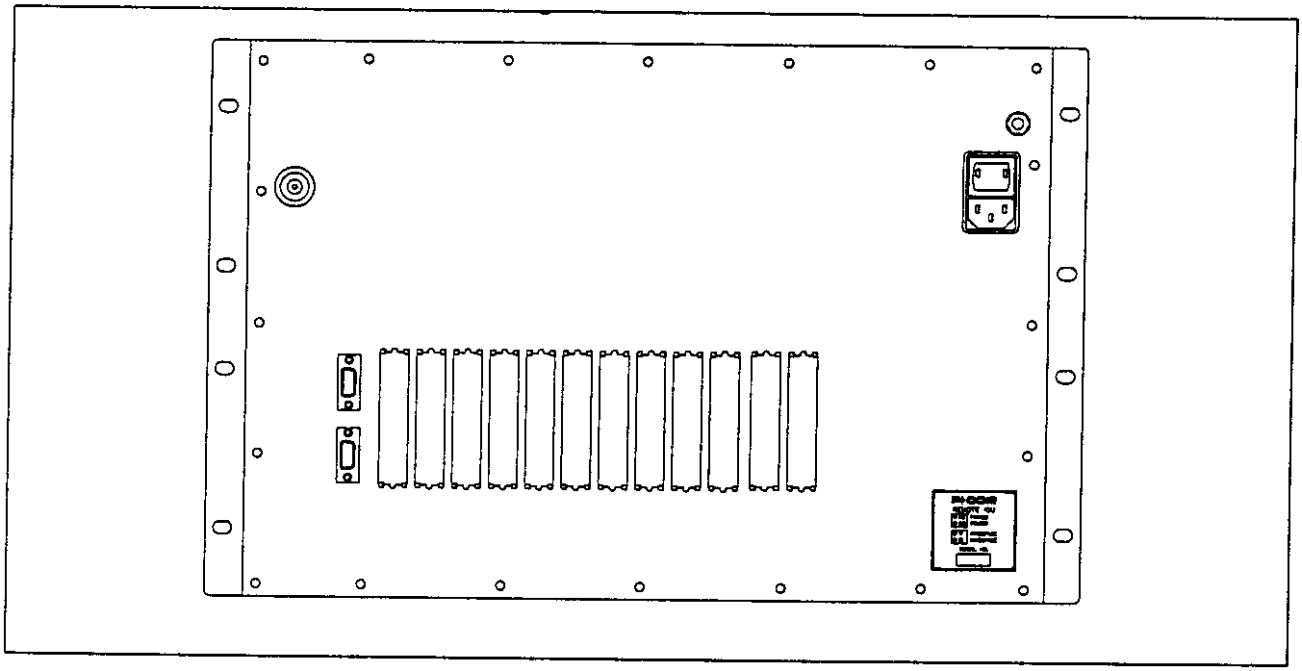


Figure 4-5 - Remote Terminal Rear View (AC Input Power)

Figure 4- 6 - AC Power Connector

DC Input Power

A rear view of the Remote Terminal IDU configured to operate on DC input power is shown in Figure 4-7. Units that operate from AC power have an IEC 320 power connector on the rear panel of the IDU (refer to Figure 4-8).

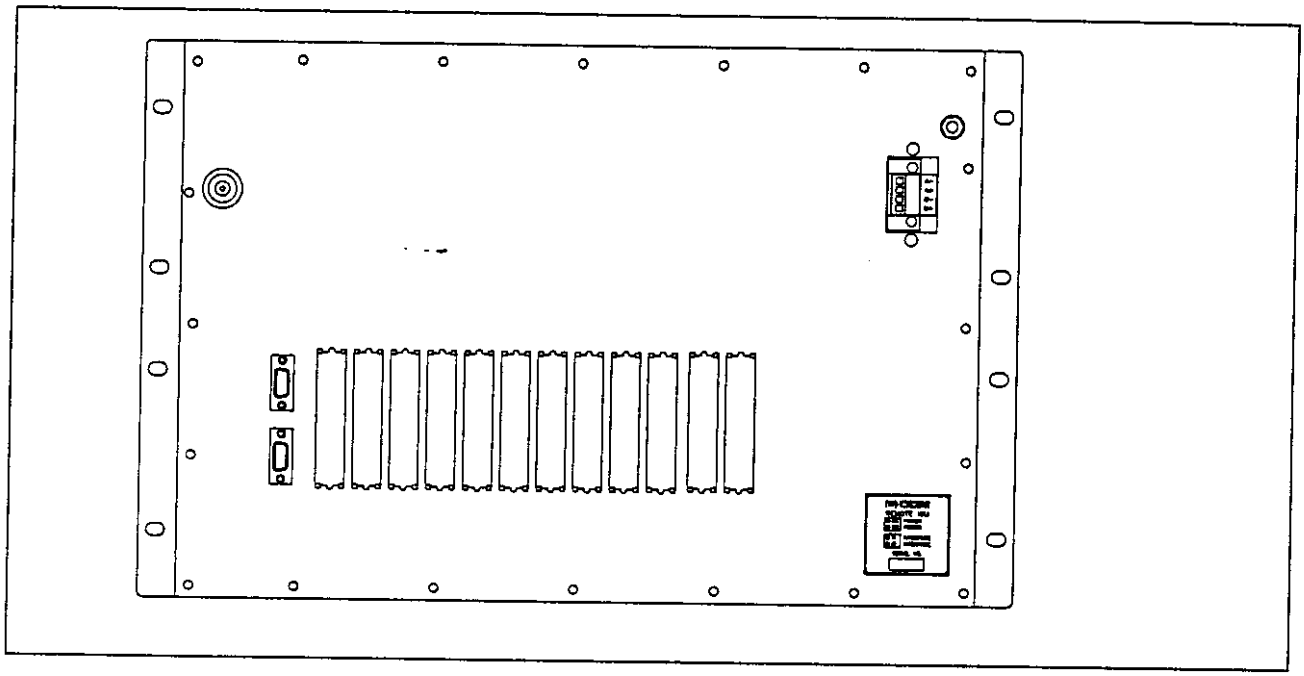


Figure 4-7 - Remote Terminal Rear View (DC Input Power)

Figure 4- 8 - DC Power Connector

Output Power

ODU Pwr Supply The ODU power supply plugs into the left end of the IDU chassis and provides nominally 43.2V +/-5V through the backplane and through the modulator card to the coaxial feed line to the ODU. The voltage range assures adequate voltage at the ODU including cable drops without exceeding ODU input voltage limits on short runs.

IDU Pwr Supply The IDU power supply plugs into the IDU chassis next to the ODU power supply and provides three voltages to the IDU backplane as follows:

- +5.5 +/-25VDC (Up to 20 A)
- +15.5 +/-0.75 VDC (Up to 2 A)
- -15.5 +/-0.75 VDC (Up to 2 A)

4.2.6 Hot Plug-in Impact on Power Supply

In addition to the protection provided by the Power Supply, each signal circuit card power input includes a reverse blocking diode along with bulk filtering components and a fuse on each supply voltage. If a circuit card fails with a short to ground on one of the power supplies, its fuse will open and allow the rest to recover and reset. The reverse blocking diodes provide protection from momentary power supply drops while "hot plugging" new circuit cards into the backplane. They will not protect the system from momentary disruption in the case of a power supply fault to ground that results in an open fuse.

4.3 Remote Terminal Outdoor Unit (ODU)

Figure 4-5 illustrates the RF/Antenna configuration for the Remote Terminal Outdoor Unit. The packaging includes the following components:

- ODU Enclosure
- RF Electronics
- ODU Controller Card responsible for controlling and monitoring ODU functions and for interfacing with the IDU

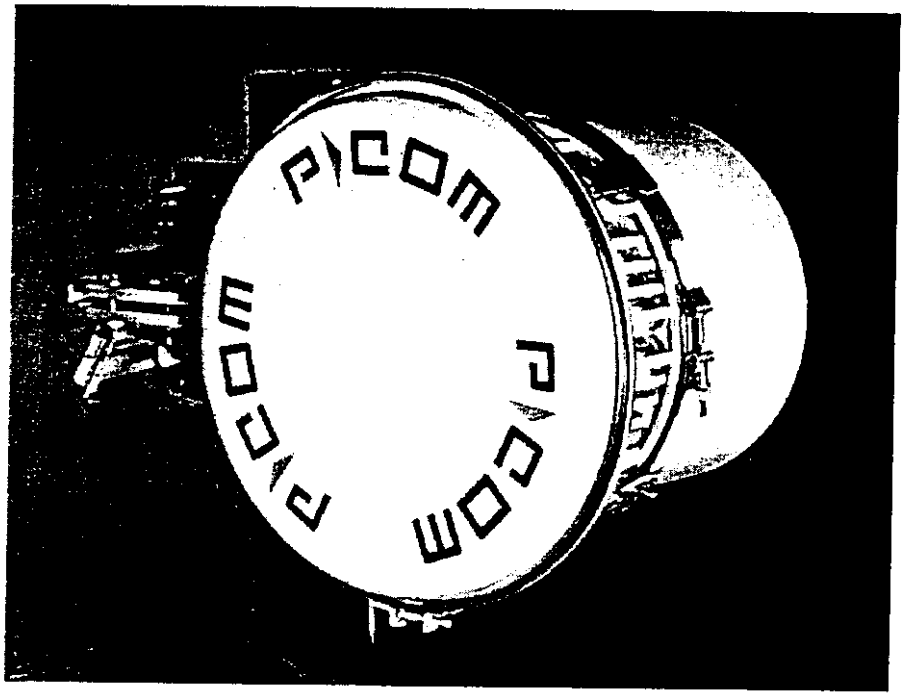


Figure 4-5 – Remote Terminal Outdoor Unit with 30 cm Parabolic Antenna

The ODU is frequency agile so that the same ODU can typically be used throughout the entire allocated frequency band. Subsequently, this reduces sparing levels.

The ODU meets all National Electrical Code requirements pertaining to lightning and power transients and meets or exceeds FCC and ETSI regulations pertaining to conducted and radiated Electromagnetic Emissions.

The ODU is sealed against the environment and is capable of functioning in ambient temperatures ranging from -40°C to +60°C, with up to 100% relative humidity. The ODU can survive steady state winds of 40 m/s with gusts to 55 m/s (89 mph/123 mph).

Each Outdoor Unit (ODU) is a self contained radio transmitter weighting approximately 13.2 pounds (6 kg) attaching directly to an antenna at the subscribers location, or connected by flexible waveguide to a sector antenna at a central location. The ODU's are designed to provide frequency diversity, and installed to transmit on either horizontal or vertical polarity. Figure 4-6 shows the baseplate of the Remote Terminal ODU.

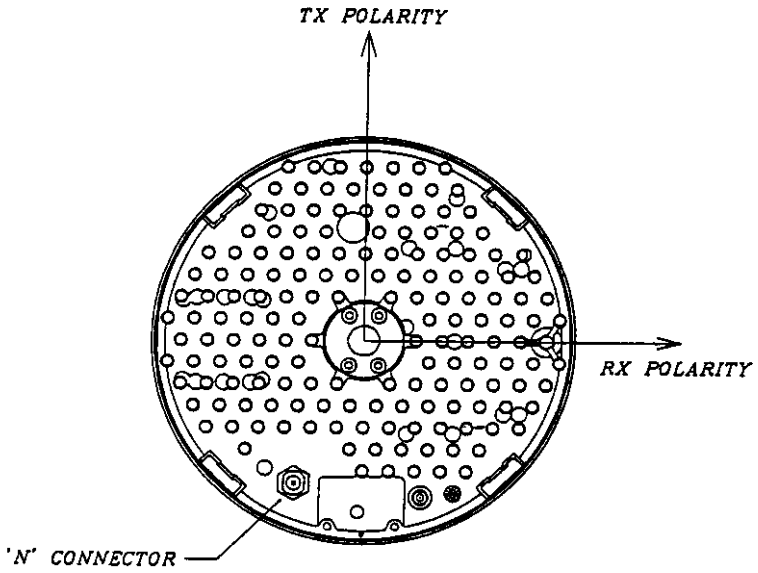


Figure 4-6 – Remote ODU Baseplate

The ODU exchanges many multiplexed signals with the IDU through the same cable, and distributes the necessary signals to the ODU controller. The ODU receives +43V, a 10 MHz reference signal, user data modulated onto an IF carrier, and telemetry messages from the Remote Terminal controller all on the same cable. In addition, on the same cable, the ODU transmits received user data modulated onto another IF carrier and telemetry messages for the IDU (Refer to Figure 4-7).

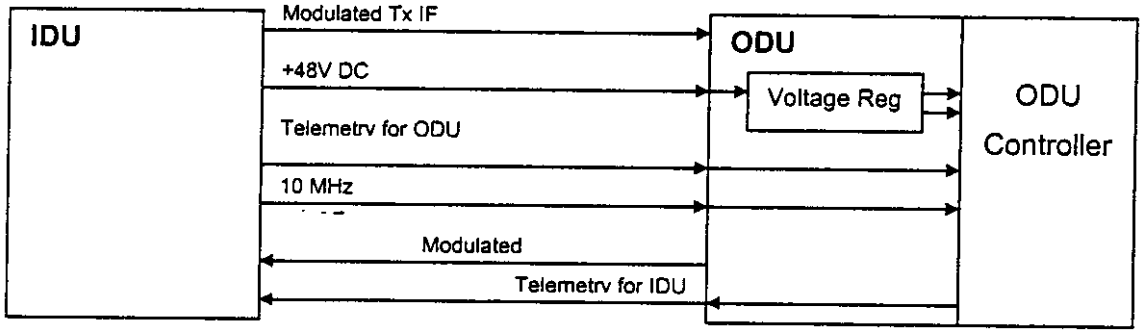


Figure 4-7 – Signal Distribution in the IDU/ODU System

The ODU Controller sets a slope control signal at power-up, based on the detected cable length. The Controller also monitors cable length once a second, and mutes the transmitter if a cable is not detected. The controller monitors antenna alignment if that function is enabled via the Local Site Manager (LSM). It also monitors and controls transmitter power if enabled configuration parameters are stored in on-board NVRAM.

4.3.1 TX IF Module

The TXIF Module up-converts the modulated VHF signal received from the IDU to a C or E Band signal used to drive the Microwave Module. An internal AGC loop corrects for power variations related to coaxial cable length between the IDU and ODU, and provides an analog signal to the Controller Module for slope correction. Two voltage-controlled attenuators under Controller Module direction sets the drive power to the Microwave Module to establish the overall ODU transmitter power.

4.3.2 RX IF Module

The RXIF Module is a dual conversion system that down-converts the C or E Band signal received from the Microwave Module into an UHF signal passed to the IDU through the coaxial cable. In addition, the RXIF Module provides gain to amplify signals over a wide dynamic range guaranteeing a constant signal level is fed through the coaxial cable connecting the ODU to the IDU. An internal AGC maintains a constant signal level and generates an analog Received Signal Strength Indicator (RSSI) signal passed to the Controller Module. This signal level is also available on a Bayonet Nut Connector (BNC) connector for antenna pointing.

4.3.3 Controller PCB

The ODU Controller monitors several ODU PMP link variables and conditions; and either transmits these to the IDU or internally adjusts levels within the ODU as appropriate. Communication with the IDU is accomplished by multiplexing and transmitting the signals through the coaxial cable connecting the two units. One major function of the Controller is to monitor and

adjust transmitting power; ensuring adequate signal strength is achieved. The Controller will not adjust to unnecessarily high levels that increase the potential for interference with other PMP stations.

4.3.4 Signal Flow-Transmit Direction

The transmit IF signal from the IDU arrives at the ODU Motherboard where it is extracted by the multiplexer and routed to the TX IF Module. Simultaneously, the reference signal and telemetry are extracted and routed to the VCXO and Controller Modules respectively.

The IF signal is up-converted and filtered by the TX IF Module, and routed to the Microwave Module where it is further up-converted to the output frequency, amplified and filtered. Transmit power control is applied to the process at the output of the TX IF Module. Remote ODU's route the signal through an Orthogonal Mode Transducer (OMT) to the remote antenna for broadcasting. The OMT separates transmit and receive paths into horizontal and vertical polarities respectively in addition to separating horizontal and vertical polarities into transmit and receive paths.

4.3.5 Signal Flow-Receive Direction

Signal routing in the receive direction is nearly the reverse of the Signal Flow-Transmit Direction. Received signals in Remote units are passed to the Microwave Module through the OMT. At the Microwave Module signals are amplified by the Low Noise Amplifier (LNA) and down-converted to the first receive IF, and then sent to the RX IF Module. The first IF is determined by the frequency programmed into the TX IF Module, plus or minus the duplex frequency (depending on whether the unit is set to transmit either high or low band). At the RXIF Module, the receive IF is further down-converted, filtered, amplified and passed to the Motherboard Module, after AGC is applied, and then multiplexed and fed into the cable connecting the ODU and IDU. (Refer to Figure 4-8).

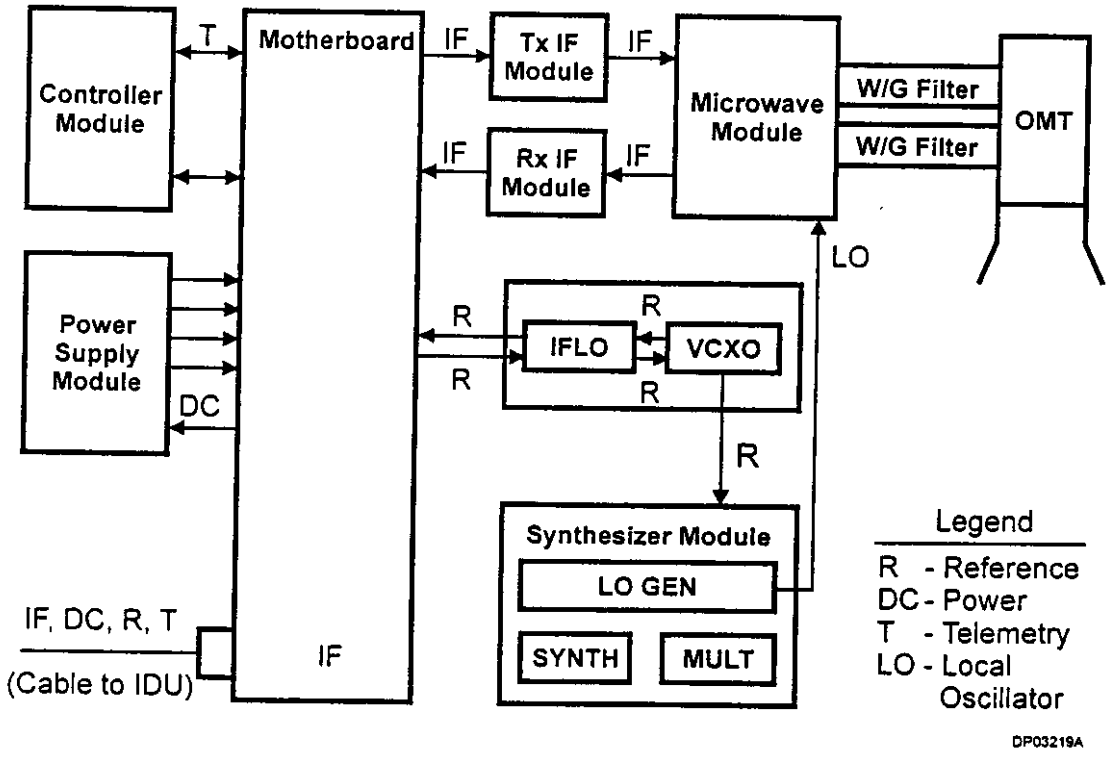


Figure 4-8 – Remote ODU Block Diagram

4.4 Antenna

The Antenna is typically a 30-cm parabolic and can be directly mounted to an 8.85 cm – 11.385 cm pipe. The mount will support a minimum of ±25 degrees of elevation and 360 degrees of azimuth adjustment. The packaging includes the following components:

- Reflector
- Feed
- Radome
- Mount

4.5 IF Cable Run

A single coaxial cable is used to connect the ODU to the Remote Terminal IDU. The cable carries transmit IF signal, receive IF signal, telemetry 10 MHz reference signal and DC power between the IDU and ODU. The IDU and ODU contain "N" type female connectors for interconnection of the coaxial cable. For increased EMC performance, P-COM recommends the use of Times-Microwave LMR-400 in Table 4-3, double screened, coaxial cable. Other coaxial cables with equivalent performance characteristics of the LMR-400, shown below, may be used. LMR-400 may be used in lengths up to 1000 feet. The maximum bend radius of LMR-400 is 6 inches (15 cm).

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Dielectric	Cellular PE (low loss closed cell polyethylene foam) 0.285" nominal diameter
Shield	Aluminum laminated tape bonded to the dielectric with tinned/copper over braid. Diameter: 0.320" nominal
Jacket	Black PE Nominal jacket thickness: 0.045"
Capacitance	23.0 pf/ft
Impedance	50 Ω
Velocity of propagation	85%
DCR	Conductor 1.39 Ω/1000 ft.
Attenuation	30 MHz: 0.70 dB/100 ft
	220 MHz: 1.80 dB/100 ft
	450 MHz: 2.70 dB/100 ft
	900 MHz: 3.90 dB/100 ft

The signals that are carried between the IDU and the ODU on the coaxial IFL cable are provided in Table 4-4.

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IDU Receive	490 MHz	±25 MHz
Telemetry	500-800 kHz	300 kHz
Reference Signal	10 MHz	1 ppm
IFL Power	**Voltage**	**Variation**
ODU Power	+48 Vdc	+40 to +57Vdc
IFL Connector	**Termination 1**	**Termination 2**
Type N male	Remote Terminal IDU	ODU

5.0 Network Management

Network Management is provided through the use of a PC based software configuration tool: Local Site Manager. Refer to the manual "68134 - Tel-Link Point-to-Multipoint Local Site Manager Manual" for information regarding the features and use of the LSM.

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6.0 Specifications

6.1 General

Configuration	Sectorized, Point-to-Multipoint	
Multiple Access		
Sector Terminal Outlink	TDM (cell multiplexed)	
Sector Terminal Return Link	FDMA	
Transmission Mode (per Sector)		
Sector Terminal Outlink	Up to five, 16 T1 carriers, received by subset of remote sites within the sector.	
Sector Terminal Return Link	Individual carriers each up to 16 T1s	
Modulation		
Sector Terminal Outlink	4-QAM, 16-QAM or 64-QAM	
Sector Terminal Return Link	4-QAM, 16-QAM or 64-QAM	
Hub Antenna Sectorization	15° to 90°	
Circuit Capacity (64-QAM)	Aggregate Rate	Chan. Size
2 T1	3.989 Mbps	1.0 MHz
4 T1	7.899 Mbps	2.0 MHz
8 T1	15.718 Mbps	4.0 MHz
12 T1	23.695 Mbps	5.6 MHz
16 T1	33.750 Mbps	8.0 MHz
Circuit Capacity (16-QAM)	Aggregate Rate	Chan. Size
1 T1	2.660 Mbps	1.0 MHz
2 T1	5.266 Mbps	2.0 MHz
5 T1	10.479 Mbps	4.0 MHz
8 T1	15.797 Mbps	5.6 MHz
11 T1	22.500 Mbps	8.0 MHz
14 T1	29.063 Mbps	10. 0 MHz
Circuit Capacity (4-QAM)	Aggregate Rate	Chan. Size
1 T1	2.633 Mbps	2.0 MHz
2 T1	5.240 Mbps	4.0 MHz
4 T1	7.898 Mbps	5.6 MHz
5 T1	11.250 Mbps	8.0 MHz
7 T1	14.531 Mbps	10.0 MHz

Transmit/Receive Symbol Rate	Refer to Table 6-1
Bandwidth Allocation	
FDMA	Fixed
Network Management	Local management port
Bit Error Rate	Refer to Figure 6-1
Clear Sky	$\leq 1 \times 10^{-11}$
Faded Outage Threshold	1×10^{-6}

Table 6-1 – Symbol Rate

Modulation Type	Number of T1s	Symbol rate (Msym/s)	Channel spacing (MHz)	Demod Supported (Hub or Remote)
64-QAM	2	0.664902	1.0	Hub only
64-QAM	4	1.316528	2.0	Sector and Remote
64-QAM	8	2.619781	4.0	Sector and Remote
64-QAM	12	3.949127	5.6	Sector and Remote
64-QAM	16	5.625000	8.0	Sector and Remote
16-QAM	1	0.664902	1.0	Hub only
16-QAM	2	1.316528	2.0	Sector and Remote
16-QAM	5	2.619781	4.0	Sector and Remote
16-QAM	8	3.949127	5.6	Sector and Remote
16-QAM	11	5.625000	8.0	Sector and Remote
16-QAM	14	7.265625	10.0	Remote only
QPSK	N/A	0.664902	1.0	Hub only
QPSK	1	1.316528	2.0	Sector and Remote
QPSK	2	2.619781	4.0	Sector and Remote
QPSK	4	3.949127	5.6	Sector and Remote
QPSK	5	5.625000	8.0	Sector and Remote
QPSK	7	7.265625	10.0	Remote only

* Five selectable SAW filters will be available on each demodulator PCB in the IDU.

** These rates are not supported with the present clear channel Cell Engine design.

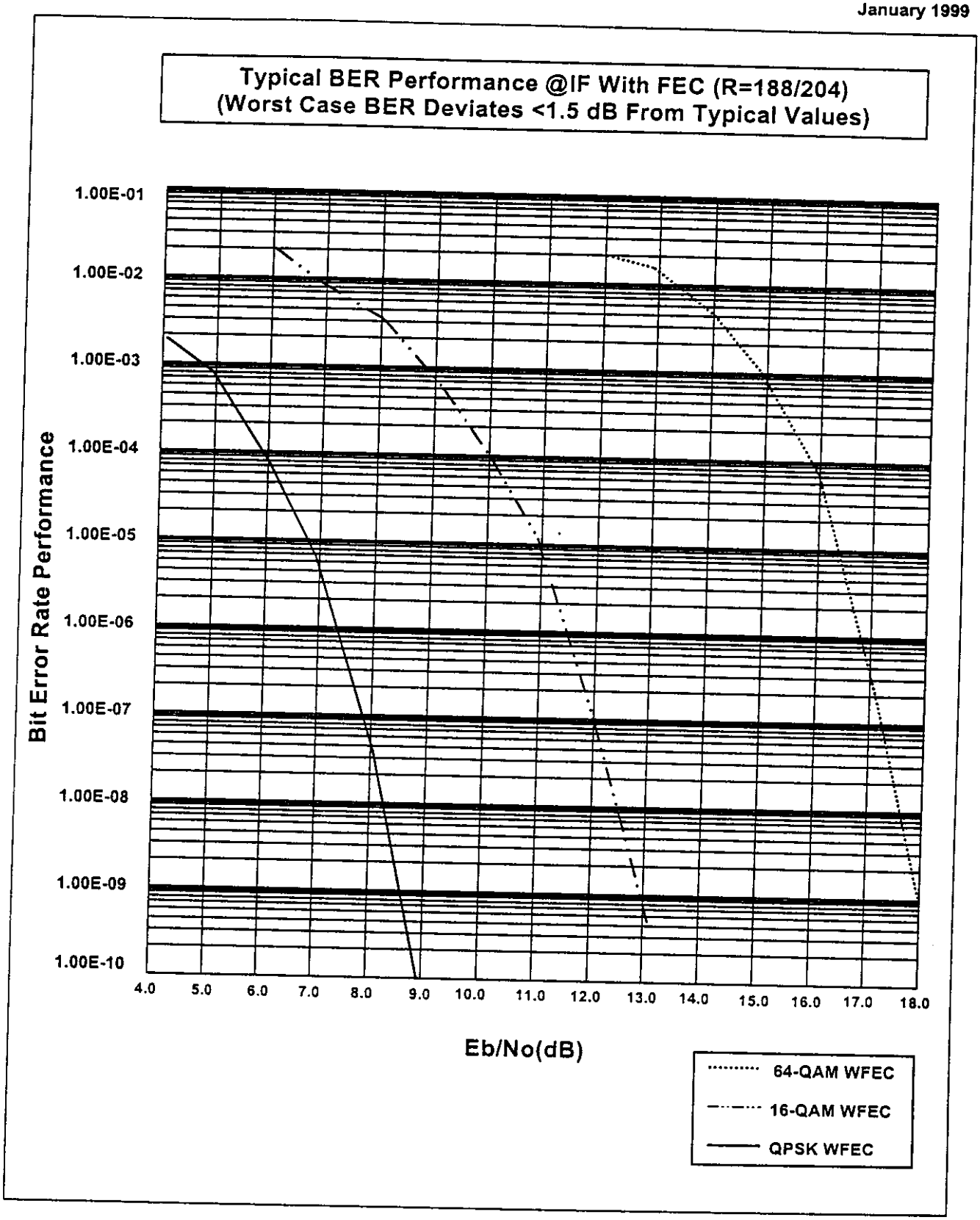

Figure 6-1 – Bit Error Rate Performance

6.2 Sector Terminal Subsystems

6.2.1 Sector Terminal Antenna

Description	Quantity/Specifications	
Type	Lensed Horn	
Beamwidth (3 dB)	15° to 90°	
Gain	Beam Center	Beam Edge
90 degrees	17.5 dBi	14.5dBi
Elevation Beamwidth	6°°	

6.2.2 Sector Terminal Outdoor Unit

Description	Quantity/Specifications
Frequency Bands	38 GHz
T/R Separation	700 MHz
Single Carrier P1dB Output Power	
4-QAM	+20 dBm
16-QAM	+18 dBm
64-QAM	+16 dBm
Noise Figure at Antenna Interface	9.0 dB
TX Output Frequency	
IF Center Frequency	205 MHz
TX IF Input Level	0 ±3 dBm (<10 meters cable) -18 ±5 dBm (300 meters cable)
TX IF Input Return Loss	<-12 dB
TX Gain Slope vs TX RF Frequency	<0.2 dB/MHz Max.
TX Output Power Control Range (typically 45 dB) Set by RX Power or Sector Controller	+20 to -25 dBm
TX Output Power Stability (within control range)	≤ ±3.0 dB over Frequency & Temperature
TX Output Power Level (1 dB compression)	+25 dBm
TX Output Mute Level	<-50 dBm
TX Frequency Stability	Set by IDU 10 MHz ref.
RX Input Frequency	490 MHz
RX IF Input Level	-20 to -90 dBm (0 dBm no damage)

Description	Quantity/Specifications
RX Image Noise Rejection	>56 dB
RX Gain Slope vs RX IF Frequency	<0.2 dB/MHz Max.
RX Noise Figure	9.0 dB Max
RX IF Output Frequency	
Center Frequency	490 MHz
RX IF Output Level	0 dBm ±1 dBm (-28 ±3 dBm at IDU with 300 meters cable)
Reference Frequency from IDU	10.0 MHz
Reference Stability over temperature and 5 year aging	Set at IDU
Reference Frequency Level	-10 ±1 dBm (<10 meters cable) -14 ±2 dBm (300 meters cable)
Telemetry Description	**Quantity/Specifications**
Loss of TX IF	TBD
TX Power Control	TBD
TX Mute	TBD
Summary TX, RX PLO or Synth Lock	TBD
Security ID Code	TBD
RX Power Level	TBD
DC Voltages (up to 4 voltages)	TBD
Voltage (Supplied by the IDU)	30-48 Vdc
Power Consumption	40 Watts (Zero Cable Length), provided by the IDU
Dimensions	12 in. Diameter (30.48 cm) x 2 in. (5.08 cm) Dp Target
Weight	3 lbs. (6.5 Kg), maximum
Connectors	
IF, DC, Telemetry, and Reference	N-Type
TX & RX (RF)	Rectangular Waveguide
Reliability	
MTBF Based on PTP in Field Data	10 years

6.2.3 IFL Cabling

Description	Quantity/Specifications
Type	Times Microwave LMR-400 or cables with the equivalent characteristics
Dielectric	Cellular PE (low loss closed cell polyethylene foam) 0.285" nominal diameter
Shield	Aluminum laminated tape bonded to the dielectric with tinned/copper over braid. Diameter: 0.320" nominal
Jacket	Black PE Nominal jacket thickness: 0.045"
Capacitance	23.0 pf/ft
Impedance	50 Ω
Velocity of propagation	85%
DCR	Conductor 1.39 Ω/1000 ft.
Attenuation	30 MHz: 0.70 dB/100 ft
	220 MHz: 1.80 dB/100 ft
	450 MHz: 2.70 dB/100 ft
	900 MHz: 3.90 dB/100 ft
Minimum Bend Radius	6"
Maximum Length	1000 Feet (300m) (W/LMR-400) without Line drivers
IF Connector	Type N Female

The signals that are carried between the IDU and the ODU on the coaxial IFL cable are provided in Table 6-2.

Table 6-2 – IFL Signals

IFL Signal	Frequency	Variation	Level
IDU Transmit	205 MHz	±25 MHz	0 to -23 dBm
IDU Receive	490 MHz	±25 MHz	0 to -31 dBm
Telemetry	500-800 kHz	300 kHz	10 dBm, ±3 dB
Reference Signal	10 MHz	1 ppm	-10 to -16 dBm
IFL Power	**Voltage**	**Variation**	
ODU Power	+48 Vdc	+40 to +57Vdc	

6.2.4 Sector Terminal Indoor Unit Chassis

Description	Quantity/Specifications
Card Slot Capacity	21
Configuration (slot space)	2 Power Supplies (rear-mounted
	2 Sector Controllers
	2 Modulators
	12 Demodulators
	5 T1 Network Interface cards
Dimensions	12.25" (h) x 17.75" (w) x 17" (d)
Cooling	Forced-air provided by fan in cabinet

6.2.5 Sector Terminal Controller

Description	Quantity/Specifications
NMS Ports	
Local (from LSM	DB-9 (F), Front Panel
Mounting	Front, Slide-in Card
Indicators	Fault, Online/Standby

6.2.6 Sector Terminal Modulator

Description	Quantity/Specifications
Modulation	QPSK 16-QAM 64QAM
FEC Encoding	
Type	Reed-Solomon
Rate	187/204
Data Rate Range (10 MHz Channel)	
QPSK	7 T1
16-QAM	14 T1
64-QAM	16 T1
Mounting	Front, Slide-in Card
Indicators	Fault, Online/Standby

6.2.7 Sector Terminal FDMA Demodulator

Description	Quantity/Specifications
Demodulation	QPSK 16-QAM 64QAM
FEC Encoding	
Type	Reed-Solomon
Rate	187/204
Data Rate Range (10 MHz Channel)	
QPSK	7 T1
16-QAM	14 T1
64-QAM	16 T1
Mounting	Front, Slide-in Card
Indicators	Fault, Online/Standby

6.2.8 Sector Terminal Power Supply

Description	Quantity/Specifications
Input Voltage	
AC	90-260 VAC, 47 - 63 Hz
DC	+20 to 56 VDC 3 Amp
Output Power	260 W, max
Mounting	Rear of Chassis (2)

6.2.9 Network Interface Card (NIC)

Description	Quantity/Specifications
Physical Interface	6 x T1
Mounting	Front, Slide-in Card
Indicators	Fault, Online/Standby

6.3 Hub IF Combiner

Description	Quantity/Specifications
Dimensions	16.84" x 6.46" x 1.50"
Weight	<4 lbs
Indicators, Front Panel	3 LEDs, Link A, Link B and Power
Switches, Back Panel	1 Rocker Type (AC Power) 1 Slide Type (Link A, Link B)
Connectors, Back Panel	4 BNC Type (F) Coaxial (IFL 1,2,3 and 4) 1 BNC Type (F) Coaxial (Reference Monitor) 1 N Type (F) Coaxial (RF Unit)
Power Consumption	< 35 W (1 Amp AC circuit protection; 1.5 Amp DC circuit protection)
TX IF Center Frequency (HUB IF to Combiner to ODU)	205 MHz ±25 MHz
RX IF Center Frequency (ODU to Combiner to HUB IF)	490 MHz ±25 MHz
Ref Frequency for LO Generation	10 MHz
Ref Sourced to:	Controller Cards, Digital CMOS ODU, Analog 50 Ohms
Hub Ref Stability (Inclusive of Temperature Aging, Load & Voltage Variations	±1.0 ppm
Ref Level (analog)	> -1 dBm, 50 Ohms@RF Connector
Configure	Link A, Link B

6.4 Remote Terminal

6.4.1 Antenna

Description	Quantity/Specifications
Type	Parabolic; 1 ft round.
Gain (mid-band)	38.0 dBi
Beamwidth (3 dB)	1.9 degrees
Mounting	2 - 4" diameter pole

6.4.2 Remote Terminal Outdoor Unit

Description	Quantity/Specifications
Frequency Band	38 GHz
T/R Separation	700 MHz
Output Power Level@Ant Input	
QPSK	+20 dBm
16-QAM	+18 dBm
64-QAM	+16 dBm
Noise Figure at Antenna	9.0 dB
TX Output Frequency	
IF Center Frequency	205 MHz
TX IF Input Level	0 ±3 dBm (<10 meters cable) -18 ±5 dBm (300 meters cable)
TX IF Input Return Loss	<-12 dB
TX Gain Slope vs TX RF Frequency	<0.2 dB/MHz Max.
TX Output Power Control Range (typically 45 dB) Set by RX Power or Sector Controller	+20 to -25 dBm
TX Output Power Stability (within control range)	≤ ±3.0 dB over Frequency & Temperature
TX Output Power Level (1 dB compression)	+25 dBm
TX Output Mute Level	<-50 dBm
TX Frequency Stability	Set by IDU 10 MHz ref.
RX Input Frequency	
RX IF Input Level	-20 to -90 dBm (0 dBm no damage)
RX Noise Figure	9.0 dB Max
IF Center Frequency	490 MHz
RX IF Output Level	0 dBm ±1 dBm (-28 ±3 dBm at IDU with 300 meters cable)
Reference Frequency from IDU	10.0 MHz
Reference Stability over temperature and 5 year aging	Set at IDU
Reference Frequency Level	-10 ±1 dBm (<10 meters cable) -14 ±2 dBm (300 meters cable)

Telemetry Description	Quantity/Specifications
Loss of TX IF	TBD
TX Power Control	TBD
TX Mute	TBD
Summary TX, RX PLO or Synth Lock	TBD
Security ID Code	TBD
RX Power Level	TBD
DC Voltages (up to 4 voltages)	TBD
Input Voltage	30-48 Vdc (provided by the IDU)
Power Consumption	40 Watts (Zero Cable Length)
Dimensions	12 in. Diameter (30.48 cm) x 2 in. (5.08 cm) Dp Target
Weight	3 lbs. (6.5 Kg), maximum
Connectors	
IF, DC, Telemetry, and Reference	N-Type
TX & RX (RF)	WR42 or WG20
RX Level	BNC
Reliability	
MTBF Based on PTP in Field Data	10 years

6.4.3 IFL Cabling

Description	Quantity/Specifications
Type	Times Microwave LMR-400 or cables with the equivalent characteristics
Dielectric	Cellular PE (low loss closed cell polyethylene foam) 0.285" nominal diameter
Shield	Aluminum laminated tape bonded to the dielectric with tinned/copper over braid. Diameter: 0.320" nominal
Jacket	Black PE Nominal jacket thickness: 0.045"
Capacitance	23.0 pf/ft
Impedance	50 Ω
Velocity of propagation	85%
DCR	Conductor 1.39 Ω/1000 ft.
Attenuation	30 MHz: 0.70 dB/100 ft
	220 MHz: 1.80 dB/100 ft
	450 MHz: 2.70 dB/100 ft
	900 MHz: 3.90 dB/100 ft
Minimum Bend Radius	6"
Maximum Length	1000 Feet (300m) (W/LMR-400) without Line drivers
IF Connector	Type N Female

The signals that are carried between the IDU and the ODU on the coaxial IFL cable are provided in Table 6-3.

Table 6-3 – IFL Signals

IFL Signal	Frequency	Variation	Level
IDU Transmit	205 MHz	±25 MHz	0 to -23 dBm
IDU Receive	490 MHz	±25 MHz	0 to -31 dBm
Telemetry	500-800 kHz	300 kHz	10 dBm, ±3 dB
Reference Signal	10 MHz	1 ppm	-10 to -16 dBm
IFL Power	**Voltage**	**Variation**	
ODU Power	+48 Vdc	+40 to +57Vdc	

6.4.4 Remote Terminal Indoor Unit Chassis

Description	Quantity/Specifications
Card Slot Capacity	21
Controllers	1
Modulators	1
Demodulators	1
Interface	5
Plug-in Power Supplies	2
Card Insertion/Extraction	Hot Plugability
Power Consumption	40 W ODU 35 W IDU (2 amp AC circuit protection ; 2.5 Amp DC circuit protection)
Dimensions	12.25 in (31.115 cm) x 17.5 in (44.45 cm) x 14 in. (35.56 cm)
Weight	10 lbs., maximum
Connectors	
IF	N Connector Female
Power	AC: EIA Connector DC: 4 contact screw
User Interface	Telecom Connector per interface card terminal (50-pin Amp CHAMP)

6.4.5 Remote Terminal Controller

Description	Quantity/Specifications
Diagnostic Port	DB-9 (F), Front Panel
Mounting	Front, Slide-in Card
Indicators	Fault, Online/Standby
Indicators, Front Panel	2 LED's Power and Fault
Function and Capability	• Configure a Remote Chassis • Receive data from an interface card • Format data into minicells for transmission across the RF link • Insert network management messages into the outbound data system • Transfer the formatted data to the Remote modulator • Receive data from the RF demodulator • Extract network messages from the received data stream • Extract data packets from the received data stream • Transfer data to the interface card • Provide status information and allow control via the Local Site Manager • Allow software updates to the Cold-Fire processor via the LSM interface • Provide debug information via the debug serial port

6.4.6 Remote Terminal FDMA Modulator

Description	Quantity/Specifications
Modulation	QPSK 16-QAM 64QAM
FEC Encoding	
Type	Reed-Solomon
Rate	187/204
Constellation Encoding	Gray Coding
Interleaving	Programmable Depth 1 to 12
Randomization	Scrambling to insure symbol transitions for adequate clock recovery
Data Rate Range (10 MHz Channel)	
QPSK	7 T1
16-QAM	14 T1
64-QAM	16 T1
Mounting	Front, Slide-in Card
Indicators	Fault, Online/Standby

6.4.7 Remote Terminal Demodulator

Description	Quantity/Specifications
Modulation	QPSK 16-QAM 64QAM
FEC Encoding	
Type	Reed-Solomon
Rate	187/204
Constellation Encoding	Gray Coding
Interleaving	Programmable Depth 1 to 12
Randomization	Descrambling compatible with Modulator Channel Equalizer Feedback/Feedforward, Adaptive Decision
Data Rate Range (10 MHz Channel)	
QPSK	7 T1
16-QAM	14 T1
64-QAM	16 T1
Mounting	Front, Slide-in Card
Indicators	Fault, Online/Standby

6.4.8 User Interface Module (UIM)

Description	Quantity/Specifications
Physical Interface	6 x T1
Mounting	Front, Slide-in Card
Indicators	Fault, Online/Standby
Ports	50-pin Amp Telecom Connector
Framing	Super Frame, Extend Super Frame
Channel Description	Voice or Data
Line Codes	AMI, B8ZS
Transmitted Alarms	AIS (Blue)
Detected Signals	Loss of Signal, AIS, BPV
Jitter Attenuation	Receive path
Line Build Out	0-133, 133-266, 266-399, 399-533, 533-655 Ft
Local Site Manager Port	DB-9 (F) Front

6.4.9 Remote Terminal Power Supply

Description	Quantity/Specifications
Input Voltage	
AC	90-260 VAC, 47 - 63 Hz
DC	+20 to 56 VDC 3 Amp
Power	90 W, max

6.5 Environment Specifications

Description	Quantity/Specifications
Operational Temperature	
IDU	0°C to +40°C
ODU	-40°C to +60°C
Storage Temperature	
IDU	-40°C to +80°C
ODU	-40°C to +80°C
Altitude	
Operating	15,000 feet (4,500 meters)
Survival	40,000 feet (10,000 meters)
Vibration (5 to 500 Hz)	
ODU Operating	0.9 G, <1 Order of Magnitude degradation in Post-FEC BER, No Synch Loss
ODU Survival	2.4 G
Shock (10 mSec)	
IDU Operating	5 G, <1 Order of Magnitude degradation in Post-FEC BER, No Synch Loss
ODU Operating	10 G, <1 Order of Magnitude degradation in operation BER, No Synch Loss
ODU Survival	40 G
ODU Rain Fall	3 in/hr Max
ODU Solar Load	360 BTU/hr/m2

6.6 Certifications

Description	Quantity/Specifications
Safety	UL, ETSI
Emissions	FCC, CSA, ETSI

Glossary

AAU	Antenna Alignment Unit
AGC	Automatic Gain Control
AIS	Alarm Indicator Status
AMI	Alternate Mark Inversion
AMSL	Above Mean Sea Level
ASIC	Application Specific Integrated Circuit
B8ZS	Bipolar with Eight Zero Substitution
Base Station	The center of a cell where Sector Terminal(s) are installed.
BER	Bit Error Rate
BNC	Bayonet Nut Connector
BPV	Bipolar Violation
CAS	Channel Associated Signaling
CCS	Common Associated Signaling
CHAMP	Connector
CLAV	Cell Available
CPE	Customer Premise Equipment - Customer provided equipment that connects to the interface port(s) of the IDU.
CRC	Cyclic Redundancy Check
DBPSK	Differential Bi-Phase Shift Keyed
DFM	Drive Fault Monitor
DLL	Dynamic Link Library
Down Link	The RF communications path from a Base Station to the Remote Terminal
DQPSK	Differential Quandrature-Phase Shift Keyed
DSP	Digital Signal Processor
EIA	Electronics Industry Association
EIRP	Effective Isotropic Radiated Power
EPLD	Electronically Programmable Logic Device
ESF	Extended Super Frame Format
FCC	Federal Communications Commission
FDMA	Frequency Decision Multiple Access
FEC	Forward Error Correction
FPGA	Field Programmable Gate Array
FSK	Field Shift Keyed

FWA	Fixed Wireless Access .
HDB3	High Density Bipolar Order 3
IDU	Indoor Unit
IF	Intermediate Frequency
IFL	Interfacility Link
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LIU	Line Interface unit
LMCS	Local Multi-Point Communications Services
LMDS	Local Multi-Point Distribution Services
LNA	Low Noise Amplifier
LOS	Loss of Signal
LSM	Local Site Manager -Laptop or desktop PC using P-COM's Local Site Manager Windows application
MC	Modem Controller
MCF	Motorola Cold-Fire Processor
MIB	Management Information Base
NCO	Numerical Control Oscillator
NIC	Network Interface Card - Supports user interfaces, as well as signal monitoring and port statistics collection.
NMA	Network Management Agent
NMS	Network Management System
ODU	Outdoor Unit
OTA	Over the Air
PA	Power Amplifier
PA	Power Amplifier
PCB	Printed Circuit Board
PD	Pattern Detect
PMP	Point-to-Multipoint
POST	Power Up Self Test
PSN	Public Switched Network
PTN	Public Telephone Network
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keyed
RAM	Random Access Memory

RCS	Redundancy Control Switch
Remote IDU	Remote Terminal Indoor Unit chassis located at the remote location
Remote ODU	Remote Terminal Outdoor Unit located at the remote location, connected to a directional antenna pointed towards the Sector Terminal.
Remote Terminal	Consists of a Remote IDU, Remote ODU and Interfacility Link
RF	Radio Frequency
RMA	Return Material Authorization
ROM	Read Only Memory
RSSI	Receive Signal Strength Indicator
RU	Rack Unit
RX	Receive Signal
SAW	Surface Acoustic Wave
SCC	Serial Communication Controller
Sector	A geographic area radiating out from a Base Station. Typically referred to as the area covered by a Sector Antenna
Sector IDU	Sector Terminal Indoor Unit chassis located at the Base Station
Sector ODU	Sector Terminal Outdoor Unit chassis located at the Base Station location, connected to an antenna providing coverage over a sector.
Sector Terminal	Consists of one or more Sector IDUs connected to a common, or redundant, set of Hub IF Combiners and Sector ODU/Antenna assemblies
SF	Super Frame Format
SNMP	Simple Network Management Protocol
TAC	Technical Assistance Center
TDMA	Time Division Multiple Access
Tel-Link	Brand Name for P-COM Point to Multipoint equipment
TX	Transmit Signal
UIM	User Interface Module
Uplink	The RF Communications path from the Remote Terminals to the Base Station
VOM	Volt-Ohm-Meter
WLL	Wireless Local Loop

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January 1999

Reader Comment Form

We welcome your comments and suggestions for improving our manuals. Please record your suggestions below and FAX the completed form with your comments to (407) 674-3799.

NOTE

This form is for documentation comments only. Problems with hardware or software should be reported separately to the Technical Assistance Center at 1-877-674-3600

1. **Did you find any omissions or inaccuracies in the manual? If so, please specify the page and the problem. (It may help to include a marked up copy of the page along with this form.)**

2. **Did you find this manual understandable, usable, and well organized? Please make suggestions for improvement.**

3. **Is there sufficient documentation on the associated hardware or software required for your use of the Point to Multipoint System, as described in this manual? If not, specify the type of information you feel is missing.**

4. **Please indicate the type of user/reader that you most nearly represent:**

   _____System programmer/System Manager
   _____Maintenance Technician
   _____Process Engineer
   _____Other_____

5. **Please indicate the way(s) in which you use this manual:**

   _____Instructional Tool
   _____Other_____
   _____Reference Tool

Name _____ Title _____

Company_____ Division_____

Address_____ City _____

Telephone_____ State, Zip/Country _____

Date_____

Exhibit B:

L5X-PMP-01-000

Types of Emission

Section 2.1033

(C) Applications for equipment other than that operating under parts 15 and 18 of the rules shall be accompanied by a technical report containing the following information:

(4) Types of Emission

Intentional Radiator employing QPSK, 16-QAM or 64-QAM digital modulation.

Exhibit C:

L5X-PMP-01-000

Frequency Range of Operation: If and RF

This Exhibit provides a response to Section 2.1033 (c) (5).

Radio Frequency (RF) Bands Supported:

*38,600.00 to 40,000.00 MHz

Intermediate Frequencies (IF):

Transmit IF:	*490 MHz (±25 MHz)
Receive IF:	*205 MHz (±25 MHz)

*These frequencies are adjustable in 100 KHz increments.

Exhibit D:

L5X-PMP-01-000

Operational Power Levels and Control Methods

This Exhibit provides a response to Section 2.1033 (c) (6).

Range of operating power values or specific operating power levels and description of any means provided for variation of operating power.

Frequency	Output Power Range
36,400 to 40,000 MHz	* -20 to +20.0 dBm

*Output levels are based on measurements taken at the antenna flange and are maintained by automatic power control.

SECTOR TUNE-UP: Upon initial tune-up, Transmit Power Levels from the Sector ODU are manually configured to meet requirements necessary for link stability. Automatic Power Control (APC) capabilities are then enabled to maintain a constant transmit power level.

Exhibit E:

L5X-PMP-01-000

Maximum Operational Power Levels per FCC Rules

This Exhibit provides a response to Section 2.1033 (c) (7), based on the transmitter power limitations of Section 101.113.

The transmit power level limitation at 38.600 GHz to 40.000 GHz is +55 dBm

Each hub antenna has an elevation beamwidth of six degrees and an azimuth beamwidth of 90 degrees. The antennas with these beamwidths provide a Peak gain of 17.5 dBi as specified by the vendor. This gain applies to both frequency bands.

The power amplifiers in the 38 GHz band RF Unit have a P1dB of +25 dBm at the antenna interface. With no backoff the maximum EIRP of this system will be (17.5 + 25) or 42.5 dBm. In practice, this equipment will operate with a backoff of 7 dB that will provide a peak EIRP of 35.5 dBm.

The antennas are discussed in more detail in Exhibit N.

The above calculations indicate that the equipment will not exceed the maximum EIRP limitation of +55 dBW at any time.

Exhibit F:

L5X-PMP-01-000

DC Voltages and Current Requirements of PA

This Exhibit provides a response to Section 2.1033 (c) (8).

The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range.

Final frequency up-conversion and amplification takes place in the Outdoor Unit (ODU) which has been filed under a separate FCC application. The ODU has the following voltages and currents supplied:

Input Voltage	+44 VDC
Current	625 mA, max

Exhibit G:

L5X-PMP-01-000

Power Level Setting Alignment

This Exhibit provides a response to Section 2.1033 (c) (9).

Tune-up procedure over the power range, or at specific operating power levels.

SECTOR TUNE-UP: Upon initial tune-up, Transmit Power Levels from the Sector ODU are manually configured to meet requirements necessary for link stability. Automatic Power Control (APC) capabilities are then enabled to maintain a constant transmit power level.