



# ***IMUX 2000***

## ***T1/E1 Multiplexer***

### ***with Common Logic Redundancy***



## ***The Fifth Generation Multiplexer designed to meet the needs of your Telecommunications Network***

Designed for harsh environments, the new IMUX 2000 T1/E1 Multiplexer creates a new class of Intelligent Multiplexer with features such as *Redundant Common Logic Module*, *built in CSU functionality*, *DS0 squelching capability* and *Fast Reframing Channel*.

The unit provides full featured, Drop-and-Insert capability for each voice frequency circuit or any signal that can be transmitted in a DS0 channel. The multiplexer has electrical and a wide variety of optical fiber (both singlemode and multimode) interfaces to simplify system configuration. Channel cards are available for voice, data, telemetry, tele-protection, video and ethernet applications. When combined with our IMUX 2000 8-Port DACS-R, the IMUX 2000

T1/E1 Multiplexer supports many types of network layouts such as Spur, Hot Standby and Ring topologies. The IMUX 2000 is both hardware and software configurable. The unit offers the ultimate network management system. It operates in a Windows™ point-and-click environment and provides network visibility from any node which allows for remote provisioning, monitoring and alarm reporting.

The IMUX 2000 T1/E1 Multiplexer is compact, modular in design and compatible with previous generations of RFL Multiplexers. For a product that meets and exceeds your telecommunication needs, advance into this new class of hardened multiplexer and make the Intelligent choice, the IMUX 2000 Intelligent T1/E1 Multiplexer.



## Key Features and Benefits

- **Substation Hardened**

The IMUX 2000 T1/E1 Multiplexer is designed for harsh environments and has a wide temperature range of -20°C to +65°C (-4°F to +149°F). It meets the IEEE/ANSI standards C.37.90-1989, C.37.90.1 and C.37.90.2 for SWC, fast transient and EMI. It is CE approved and has been tested to BS EN 5002:1995. It is also FCC part 15 Class A approved.

- **Reliability**

The IMUX 2000 provides enhanced reliability by offering optional redundant power supplies and common logic modules.

- **Speed**

The IMUX 2000 is designed to handle time sensitive applications such as Protective Relaying. The Drop-and-Insert through-channel delay is less than 25 microseconds. The IMUX 2000 has an average reframe time of less than 25 milliseconds and also has the ability to enable a Fast Reframing Channel (FRC) for less than 1 millisecond reframing.

- **DS0 Squelching**

The IMUX 2000 T1/E1 Multiplexer has the ability to squelch (turn off) the output of a channel module in the Multiplexer upon loss of synchronization. This feature provides security against false tripping on 4-wire analog transfer trip channels and older digital equipment (with limited error checking) during loss of sync and protects against 'pink' noise conditions, which result from cross-talk or the frame search. This feature is ideal for preventing false tripping due to system malfunction.

- **CSU Functionality**

The IMUX 2000 offers a built in CSU functionality that meets applicable standards for protection including FCC Part 68 approval for direct connection into the Public Switched Telephone Network (PSTN). When enabled, the unit will respond to generated loopback codes compliant to either ANSI T1.403 or AT&T TR 54016. It will also maintain and allow local and remote retrieval of performance measurements in accordance with either ANSI T1.403 or AT&T TR 54016.

- **Modular Design**

The IMUX 2000 incorporates a midplane motherboard design. Channel modules plug into the front of the unit, and matching module adapter for I/O connections plug into the rear. This eliminates the need for internal chassis wiring when adding new channel cards, simplifying the upgrade.

- **Fiber Optic or Electric Interfaces**

The IMUX 2000 can be equipped with either electrical T1/E1 interfaces or Optical Interface Adapters (OIA's). The electrical T1 interface is equipped with Line Build-Out (LBO) networks for operation of up to 6,000 feet from the DSX. The OIA's are available in a wide range of multimode, single-mode, LED or laser combinations to accommodate 1300nm and 1550nm wavelengths.

- **Channel Interfaces**

A wide range of interfaces unique to the utility and the transportation market is offered. It also offers a wide range of Voice and Data, Status, Telemetry, Ethernet, Transfer Trip and Video channel interfaces to meet most communications requirements.

- **Fast Restoration**

When applied to diverse communication routes, such as Ring or Hot-Standby networks, the IMUX 2000 is capable of switch times programmable down to 1 millisecond.

- **Diverse Networks**

The IMUX 2000 supports many types of network layouts such as Linear, Spurs, Hot-Standby and Ring topologies. It is also designed for operation over SONET/SDH networks taking into consideration the critical time-delay issues associated with Protective Relaying.

- **SONET and SDH Applications**

Protective Relaying can finally be applied over non-proprietary SONET/SDH equipment. With emphasis placed on rapid break healing, the IMUX 2000 addresses the critical time issues associated with Protective Relaying making it the ideal and Intelligent choice when interfacing to SONET/SDH networks. The IMUX 2000 bridges the gap between SONET and substations providing DS0 gateways onto the network. Also, through its own switching techniques, can overcome the longer switch times and unequal channel delay issues associated with SONET.

- **Automation**

The IMUX 2000 offers the ultimate GUI Network Management system which operates in a Windows™ point-and-click environment. The optional SNMP based management reporting software can be used when integrated as part of a larger enterprise system. Network visibility is available from any node which allows remote provisioning, monitoring and alarm reporting.



## Telecommunication Solutions

### Electric Power Utilities

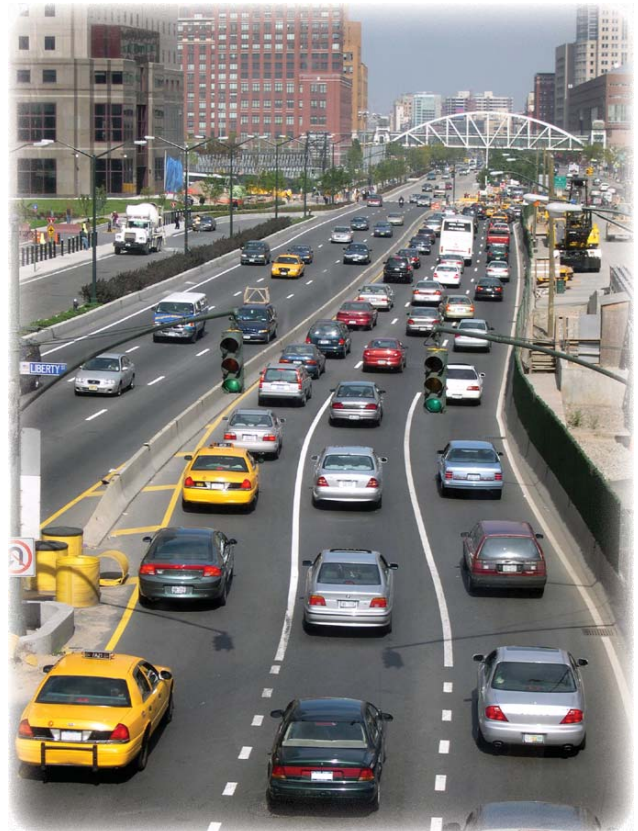


Designed specifically for the unique need of the harsh substation environments, the IMUX 2000 T1/E1 Multiplexer incorporates special design characteristics which allow it to meet ANSI / IEEE / IEC standards for operation in harsh environments (RFI, SWC, EMI and Fast Transient). The Drop-and-Insert through delay is less than 25 microseconds, including the fiber heads (excluding the communications medium). Along with the minimal through delay, a software programmable Fast Reframing channel is available to allow the multiplexer to reframe in less than 1 millisecond. The DS0 squelching (patent pending) capability allows the Common Logic Module to squelch (turn off) the output of a channel module in the Multiplexer upon loss of synchronization. This feature provides security against false tripping on 4-wire analog transfer trip channels and older digital equipment (with limited error checking). These features in the IMUX 2000 T1/E1 Multiplexer, address the critical time issues associated with protective relaying, making it ideal to be used in the electric power utilities industry. In addition, the multiplexer has the Transfer Trip and Current Differential interfaces required for the utility market.

### Transportation Industry

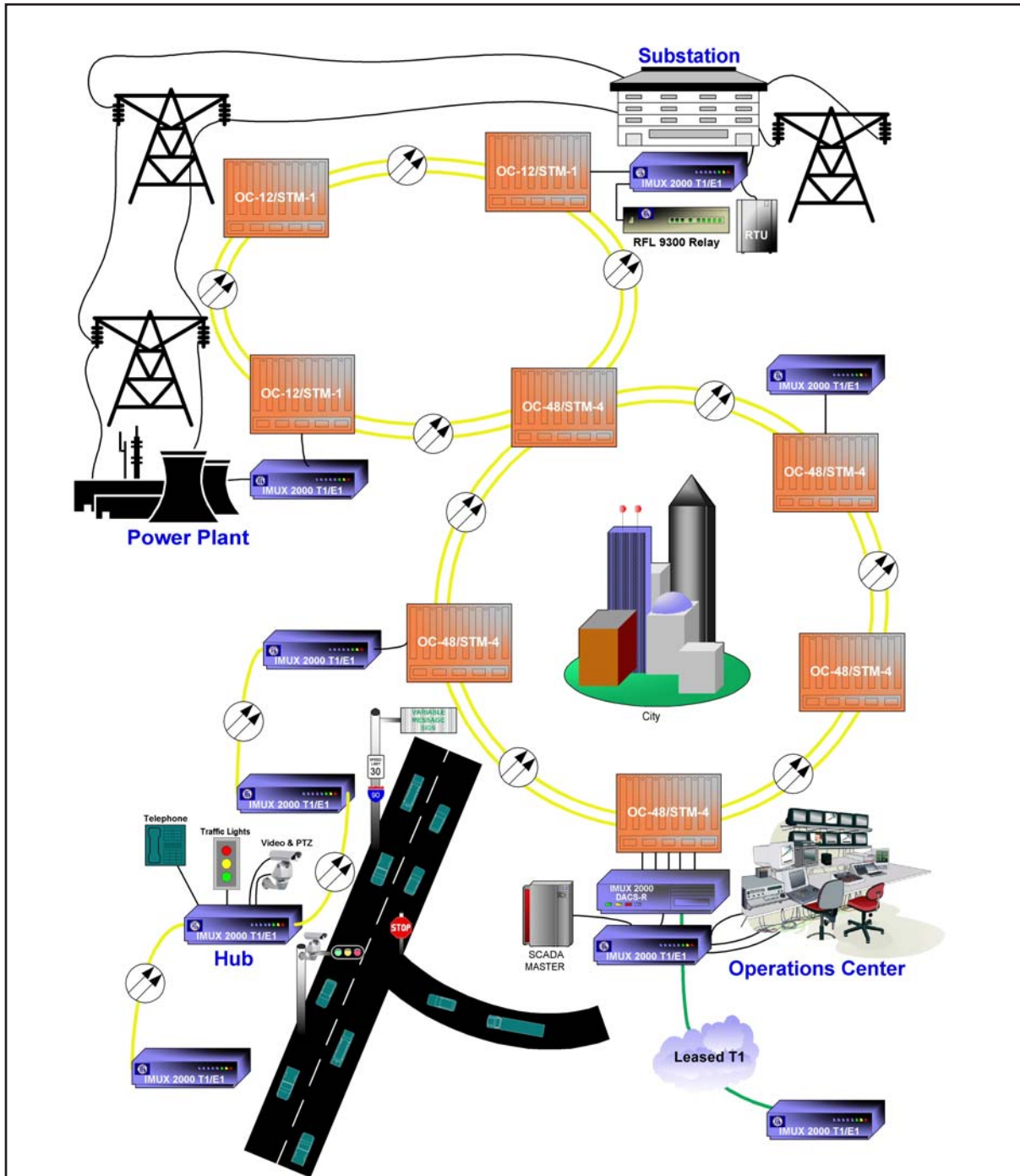
With the increasing demand for faster, more efficient ways to manage the flow of traffic, customers need a communication infrastructure that allows the system to advance as the technology develops. That is why the IMUX 2000 T1/E1 Multiplexer, with its unique harsh environments design, is the preferred choice of communication for the Transportation Industry. The IMUX 2000 T1/E1 multiplexer is designed to be used as part of a large traffic management system working in conjunction with higher bandwidth SONET/SDH networks or in stand-alone T1/E1 networks.

Applications for the product include: roadside signal acquisition and transmission from vehicle loop detectors, compressed digital video, camera control, toll collection, status and alarm reporting, tunnel ventilation control, and voice and data traffic signal control systems. The compact and robust design and the ability to work under harsh conditions makes the IMUX 2000 T1/E1 multiplexer the best multiplexer for transportation applications. The network management software provides ease of maintenance with Windows™ based GUI software. The optional SNMP based management reporting software can be used when integrated as part of a larger enterprise system.





## Application Solutions



Above is an example of a typical utility / traffic system solution. It is made up of two SONET/SDH rings as the communications backbone. The IMUX 2000 T1/E1 Multiplexers are configured to work in a Point-to-Point, Star and Stand-Alone Linear topology over the SONET/SDH system.

The IMUX 2000 carries RTU and phone circuits from several substations to the operations center. It also carries current differential relay data between substations.

The IMUX 2000 carries roadside signals, transmission data from vehicle loop detectors, compressed digital video, camera control, toll collection information, status and alarm reporting, voice and data traffic signal controls back to the operations center.



# Technical Specifications

## T1 INTERFACE

### Interface:

DSX-1 interface per ANSI T1.102-1993

### Rate:

1.544 Mbps per ANSI T1.102-1993  
(Transmit  $\pm$  30 PPM using internal timing)

### Transmit Pulse Shape:

Per ANSI T1.102-1993

### Formats:

Extended Superframe (ESF) per AT&T 62411, D4/  
Superframe (SF) per AT&T 43801

### Line Codes:

Bipolar with 8 Zero Substitution (B8ZS) & Alternate  
Mark Inversion (AMI)

### Output Impedance:

100 Ohms nominal per ANSI-T1.102-1993

### Reframe Time:

Without Fast Reframing Channel (FRC) enabled: Less  
than 25 milliseconds. With Fast Reframing channel  
(FRC) enabled: Less than 1ms.

## TIMING

### Primary Timing:

Internal, External, Loop or Through

### Fallback:

Automatically enabled in case of primary timing failure.

### Timing Output:

T1: 1.544 Mbps, (RJ11 connector)  
E1: 2.048 Mbps, G.703 (RJ11 connector)

## ENVIRONMENTAL

### Temperature:

-20°C to +65°C (-4°F to +149°F) operating

### SWC & Fast Transient:

Power supply, alarm contacts, pilot wire interface &  
transfer trip interface meet the requirements of ANSI  
C.37.90-1989 & ANSI C.37.90.1. IEC 1000-4-2:1995,  
IEC 1000-4-3:1997, IEC 1000-4-4:1995, IEC 1000-4-  
6:1996, IEC 1000-4-8:1994, DD ENV 50204:1996.

### EMI:

The chassis & modules meet ANSI C.37.90.2.

### FCC Compliance:

FCC Part 15 class A

### Humidity:

0-95% Non-condensing

### Shock & Vibration:

The chassis and channel modules shall meet require-  
ments of IEC 255-21-2 and IEC 255-21-1.

## E1 INTERFACE

### Interface:

Conforms to ITU G.703

### Rate:

2.048 Mbps  $\pm$  50 PPM input and output

### Jitter Tolerance:

Exceeds ITU G.823

### Attenuation:

Greater than 18 dB at 40Hz

### Formats:

Frame format per ITU G.704 in 30-channel and 31-  
channel modes.

### Line Codes:

HDB3 (High Density Bipolar, Order 3) per ITU  
G.703, or AMI (Alternate Mark Inversion)

### Connection:

75/100 ohm BNC connector or DB-15 connector  
for twisted pair.

### Frame Synchronization:

Average reframe time non-signaling DS0's:  
0.3 ms with fast reframe  
0.6 ms without fast reframe  
Multi-frame based signals (Signaling): 5ms

## PHYSICAL

### Dimensions:

Height: 5.25" (144 mm)  
Width: 19" (483 mm per EIA RS-310)  
Depth: 14.50" (370 mm)  
Available in 23" width mounting.

### Weight:

15 lbs (6.8 kg). for typical fully loaded shelf.

## USER INTERFACE

### Functionality:

Remote monitoring, configuration and alarm reporting.

### Local access:

Switch settings

### Remote Access:

RS-232C port  
Optional 10 BaseT Ethernet Interface



## Technical Specifications

### POWER REQUIREMENTS

All shelves can be equipped with a secondary plug-in power supply for redundancy.

#### Input Voltage:

24 Vdc  
48/125 Vdc  
250 Vdc  
120 Vac  
220 Vac

#### Range:

19 to 29.0 Vdc  
38 to 150 Vdc  
200 to 300 Vdc  
90 to 130 Vac  
180 to 265 Vac

### OPTICAL INTERFACE ADAPTERS (OIA)

Emitter	Wavelength	Fiber	System Gain
LED	1300 nm	MM	25dB (12mi; 19km)
LED	1300 nm	SM	18dB (17mi; 27km)
Laser	1300 nm	SM	36dB (37mi; 62km)
Laser	1550 nm	SM	30dB (56mi; 90km)
Laser 2mw	1550nm	SM	39d (70mi; 113km)

### ALARMS AND DIAGNOSTICS

#### Status Monitoring:

- Constant monitoring of equipment with alarm reporting.

#### Alarm Types:

- Alert, cautionary conditions that do not prevent multiplexer operation.
- Alarm, conditions that directly affect multiplexer operation.

#### Interface:

- Front panel indicators and alphanumeric display
- RS-232 port for remote access and interrogation
- Form C relays for shelf alarm and alert

#### Loopbacks:

- T1: Line, Equipment and Payload
- E1: Line and Equipment

### DS0 CHANNEL MODULE FUNCTIONALITY

#### Voice Units:

##### 2W VF

- Type I, II, III & V E & M signaling

##### 2W Foreign Exchange

- Loop or ground start signaling
- Automatic ring down option

##### 4W VF

- Type I, II, III & V E & M signaling
- Point-to-point and multi-point
- 4W FXO and FXS
- Channel addressing for added protection
- 2713Hz detection loop-back mode
- Optional SWC rated connection for analog teleprotection

#### Orderwire:

- 2W party line voice circuit over a 64 kbps channel
- DTMF signaling
- Uses a regular 2W phone

#### Data Units:

##### Low Speed Data

- RS-232 interface Async. and Synchronous
- RS-422 interface
- RS-485 interface 2 or 4 wire
- Sub-rate multiplexing
- Point-to-point and multi-point

##### High Speed Data (56/64 kbps rates)

- RS-449, V.35, X.21 and G.703
- Channel addressing for added protection
- ANSI C37.94 optical interface

##### High Speed Data (N x 64 kbps Rates)

- N = 1 to 24 64 kbps
- RS-449 & V.35 interfaces
- ANSI C37.94 optical interface

##### Office Channel Unit Data Port (OCUDP)

- ANSI T1.410



# Technical Specifications

## DSO CHANNEL MODULE FUNCTIONALITY

### Status:

- Contact Input/Output
- 16 input
- 16 output
- 8 input / 8 output

### Teleprotection Units:

#### Modular Teleprotection System

- Application: DTT, POTT, PUTT, DCB & DCU
- Four independent bidirectional function
- Solid state or relay output
- Channel delay measurements
- Sequence of events log
- Channel addressing for added protection
- Optional I-RIG B synchronization module

#### Current Differential

- Pilot wire relay interfaces
- HCB, HCB-1, MBCI & CPD

#### Analog Telemetry

- Transport of telemetry voltage or current
- Bus voltage remote synchronizing application

### Ethernet:

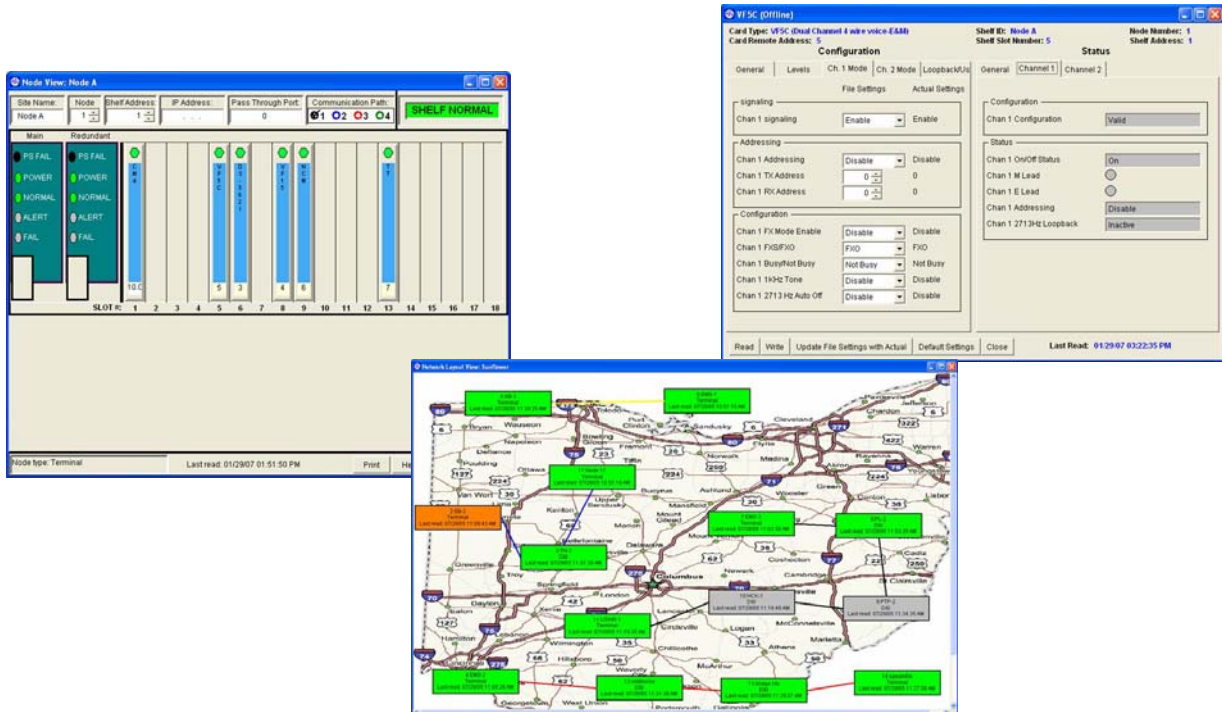
- IP connectivity
- LAN / WAN interconnect
- 10 BaseT Ethernet learning bridge
- Support half or full duplex
- IEEE 802.3

### Video:

- NTSC or PAL analog video signal transport
- ITU H.261 compression algorithm
- 1-20 frames/second
- 64 to 1536 Kbps bandwidth
- 352 x 288 resolution

## NETWORK MANAGEMENT

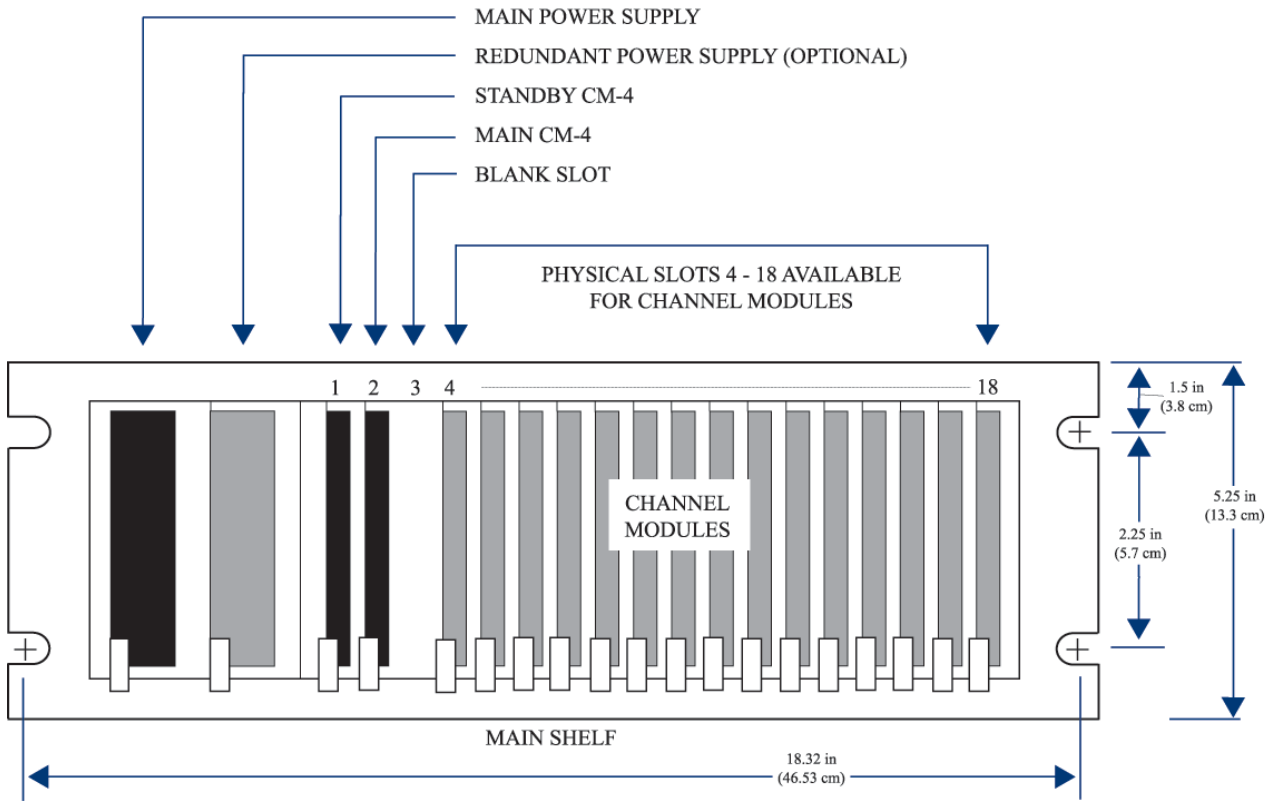
- Windows™ based PC NMS
- 3 User Level Password
- Access from any node for full system provisioning, monitoring and diagnostics
- Alarm logging and time stamping
- RS-232 craft interface
- Optional faster NMS communication using a single 64 kbps channel
- Optional 10 BaseT Ethernet Interface
- Optional interface for SNMP manager
- Network password protection for added security



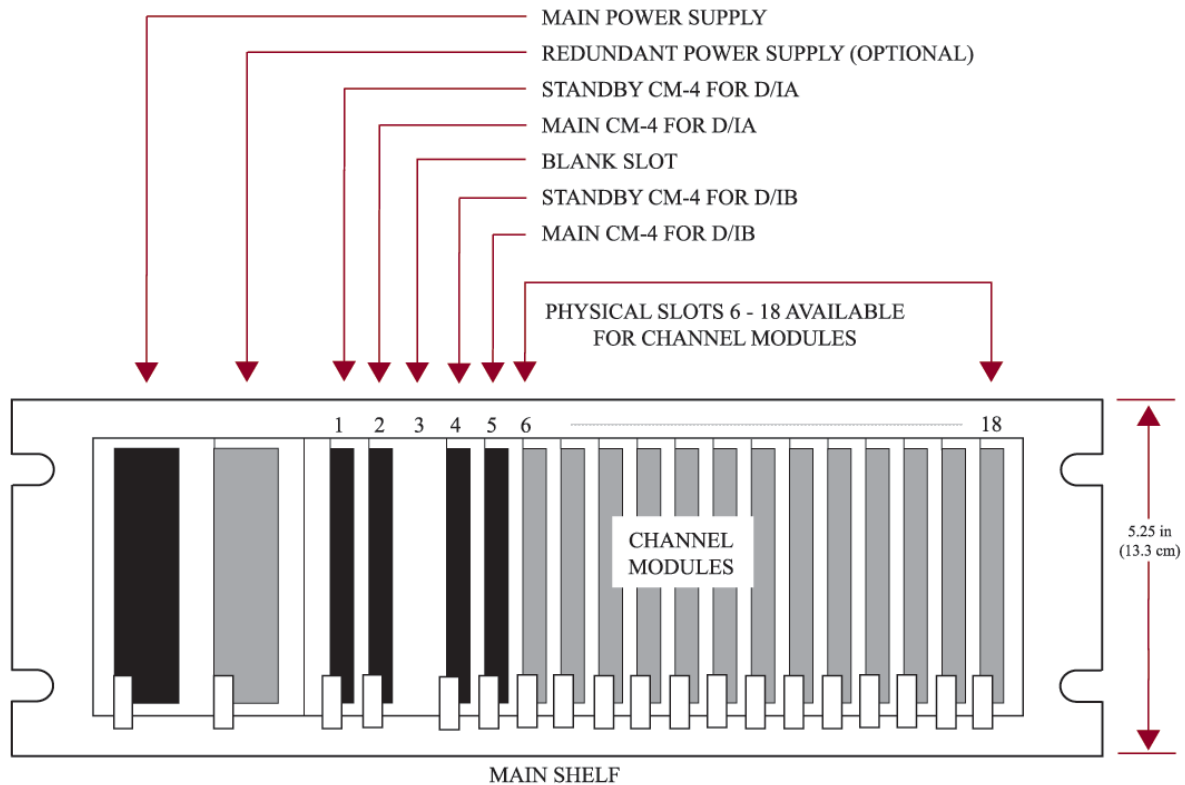
Typical Network Management Screens



# Layout and Dimensions



**a. Terminal**



**b. Drop and Insert**