

# IPmux-24

## TDM Pseudowire Access Gateway



### TDM circuit emulation over packet-switched networks

- Comprehensive support for pseudowire/circuit emulation standards including TDMoIP, CESoPSN, SAToP and HDLCoPSN
- Industry-leading adaptive clock recovery mechanism suitable for cellular backhaul over packet-based networks
- Carrier-class/environmentally hardened device
- Extensive OAM and performance monitoring capabilities
- Three auto-detecting Gigabit or Fast Ethernet SFP- or UTP-based ports, and one, two or four TDM service ports



IPmux<sup>®</sup>-24 provides legacy services over packet networks. The device converts the data stream from its user E1/T1 ports into packets for transmission over the network. The frame format of these packets is IP or MPLS. These packets are transmitted via the IPmux-24 Ethernet network port to the PSN. A remote pseudowire device converts the packets back to the original user traffic format.

#### PSEUDOWIRE FUNCTIONALITY

The ASIC-based architecture provides a robust and high performance pseudowire solution with minimal processing delay.

The unit supports various legacy over packet transport types, including TDMoIP, CESoPSN, SAToP, HDLCoPSN.

Proper balance between PSN throughput and delay is achieved via configurable packet size.

A jitter buffer compensates for packet delay variation (jitter) of up to 180 msec in the network.

#### PSEUDOWIRE QoS/CoS

Ethernet networks – outgoing pseudowire packets are assigned a dedicated VLAN ID according to 802.1Q and marked for priority using 802.1p bits.



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IP networks – outgoing pseudowire packets are marked for priority using DSCP, ToS, or Diffserv bits.

MPLS networks – outgoing pseudowire packets are assigned to a specific MPLS tunnel and marked for priority using EXP bits.

### PSEUDOWIRE TIMING

End-to-end synchronization between circuits is maintained by deploying advanced clock recovery mechanisms.

Clock recovery conforms to G.823 and G.824 traffic interface using G.8261-defined scenarios.

Advanced clock recovery conforms to G.823 synchronization interface using G.8261-defined scenarios and achieves 16 ppb clock accuracy.

The system clock ensures a single clock source for all TDM links. The system clock uses master and fallback timing sources for clock redundancy. IPmux-24 also provides system clock input and output via an optional external clock port.

### TDM INTERFACE

One, two or four E1 or T1 ports provide connectivity to any standard E1 or T1 device.

The E1 and T1 interfaces support:

- Integral LTU/CSU for long haul applications
- G.703 unframed and G.704 framed modes
- CAS and CRC-4 bit generation (E1)
- D4/SF and ESF framing (T1)
- Robbed bit (T1).

### ETHERNET INTERFACE

IPmux-24 provides the following Ethernet ports:

- One network port
- One network/user port
- One user port.

The Ethernet ports accept a wide range of Gigabit and Fast Ethernet SFP-based fiber optic interfaces. One or two ports can be ordered with built-in 10/100BaseT interfaces.

The unit can also be ordered with Fast Ethernet interface only.

### ETHERNET CAPABILITIES

IPmux-24 features an internal bridge, operating in VLAN-aware and VLAN-unaware modes.

VLAN stacking can be used for traffic separation between different users or services, by defining a service provider VLAN ID per customer or service. When VLAN stacking is used, a service provider VLAN tag is added to the user traffic and removed from network traffic. Both service provider VLAN ID and service provider VLAN priority can be defined.

IPmux-24 provides four priority queues for each port or pseudowire traffic. User traffic can be prioritized according to the VLAN priority, DSCP, IP Precedence or per port basis.

Ingress and egress rate limitation can be activated per user and network port. The rate limitation is configured per packet types.

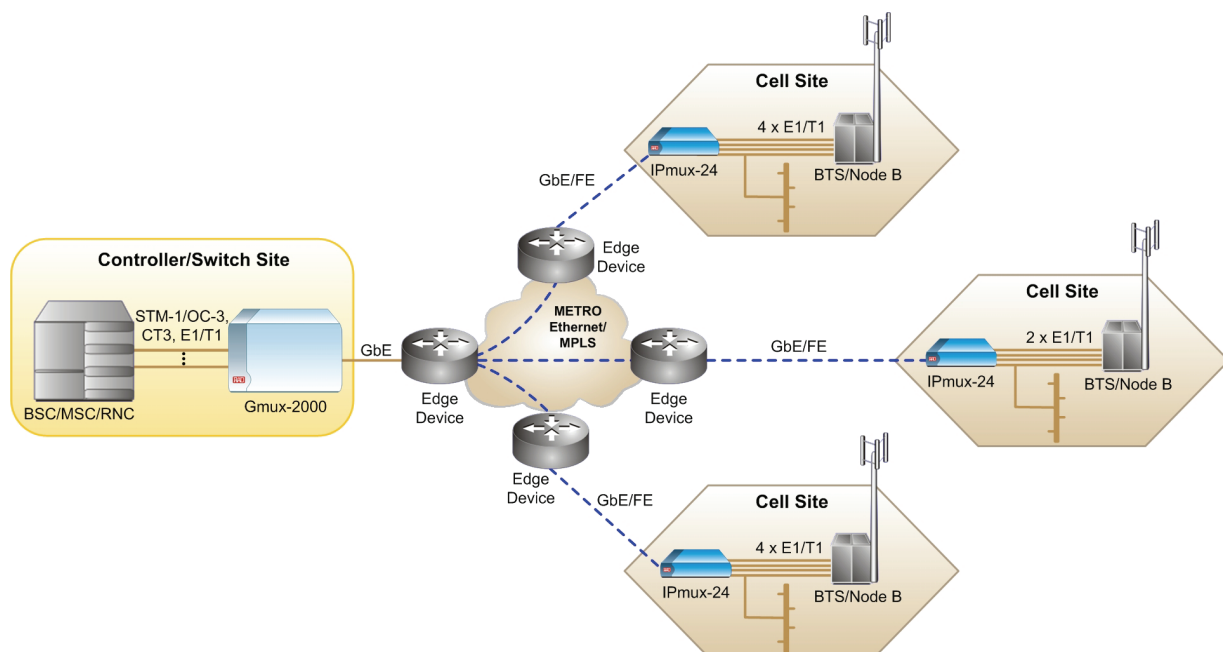


Figure 1. 2G/3G Cellular Backhaul

## MANAGEMENT

IPmux-24 can be configured and monitored locally via an ASCII terminal, or remotely via Telnet/SSH, Web browser or RADview.

Management traffic can run over a dedicated VLAN.

The RADview Service Center and Element Manager packages control and monitor TDM over IP (TDMoIP) devices and circuits. The Service Center's intuitive GUI, "point and-click" functionality and easy-to-follow wizards increase the efficiency and accuracy of the service provisioning process.

IPmux-24 performs RADIUS client authentication. Using SSH and SSL encryption protocols allows secure communication over potentially insecure IP-based networks.

Software download is supported via the local terminal, using XMODEM, or remotely, using TFTP. After downloading a new software version, IPmux-24 automatically saves the previous version in non-volatile memory for backup purposes. Similarly, copies of the configuration file may be downloaded and uploaded to a remote workstation for backup and restore purposes.

## OAM AND DIAGNOSTICS

The following RFC-2495 E1/T1 physical layer performance statistics are available: LOS, LOF, LCV, RAI, AIS, FEBE, BES, DM, ES, SES, UAS and LOMF.

IPmux-24 performs an internal built-in test (BIT) after power-up. The results of the test are visible via the local terminal.

LAN and IP layer network condition statistics, such as packet loss and packet delay variation (jitter) are monitored and stored by the device.

Fault isolation, statistics and event logging are available.

Fault propagation initiates service port alarms, e.g. E1/T1 LOS, to reflect packet network fault conditions. Alarms detected at service ports are propagated to the remote pseudowire device via the packet network.

Diagnostic loopbacks can be activated inband.

Performance monitoring is provided by Ethernet and IP-layer network condition statistics, such as packet sequence errors (loss or misorder) and packet delay variation (jitter), which are monitored and stored by the device.

RAD's TDM PW OAM mechanism ensures connectivity verification, round trip delay measurement and pseudowire configuration mismatch prevention.

The carrier-class version of IPmux-24 includes an alarm relay mechanism. The minor and major alarms are forwarded to a remote alarm device via dedicated pins of the external clock RJ-45 connector.

## ENVIRONMENT

IPmux-24/H is an environmentally hardened version intended for street-cabinet and cellular-tower installations.

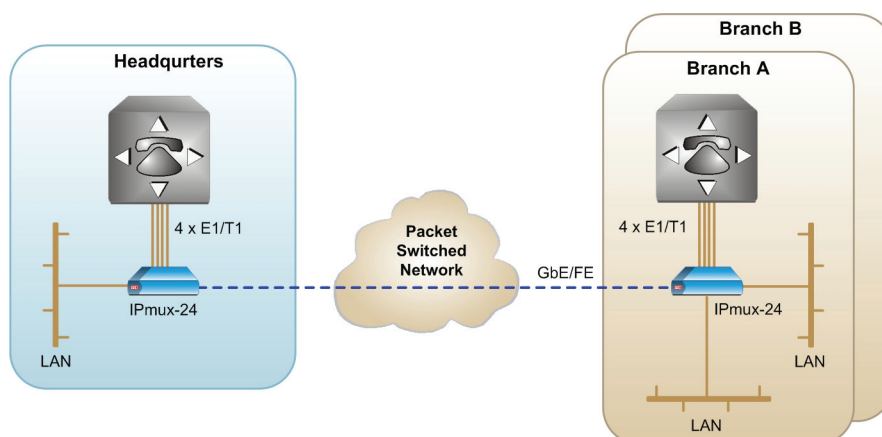


Figure 2. Private or Leased Line over PSN

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## TDM Pseudowire Access Gateway

### Specifications

#### E1 INTERFACE

##### Number of Ports

1, 2 or 4

##### Compliance

ITU-T Rec. G.703, G.704, G.706, G.732, G.823

##### Data Rate

2.048 Mbps

##### Line Code

HDB3

##### Framing

Unframed, framed, multiframe; with or without CRC-4

##### Signaling

CAS, CCS (transparent)

##### Line Impedance

120Ω, balanced

75Ω, unbalanced

##### Signal Levels

Receive:

0 to -36 dB with LTU (long haul)

0 to -10 dB without LTU (short haul)

Transmit balanced:  $\pm 3V \pm 10\%$

Transmit unbalanced:  $\pm 2.37V \pm 10\%$

##### Jitter and Wander Performance

Per AT&T TR-62411, ITU-T G.824 (for internal, loopback and external clock modes)

##### Connector

Balanced: RJ-45

Unbalanced: BNC (RJ-45 to BNC adapter cable is supplied)

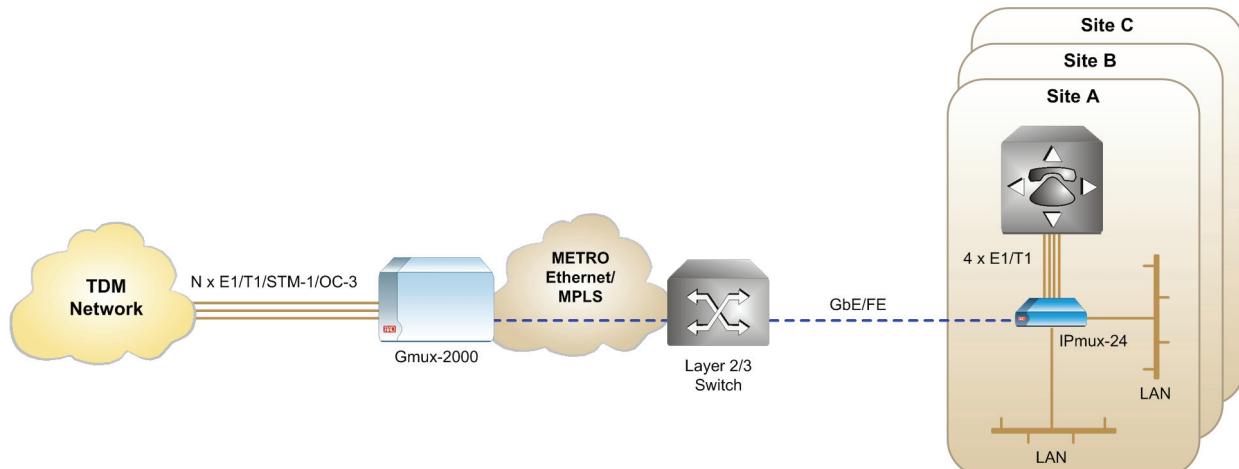


Figure 3. Providing Ethernet and TDM Services in the First Mile

## T1 INTERFACE

### Number of Ports

1, 2 or 4

### Compliance

ANSI T1.403, ITU-T Rec. G.703, G.704, G.824

### Data Rate

1.544 Mbps

### Line Code

B8ZS, B7ZS, AMI

### Framing

Unframed, SF, ESF

### Signaling

CAS (bit robbing), CCS (transparent)

### Line Impedance

100Ω, balanced

### Signal Levels

Receive: 0 to -36 dB

Transmit pulse amplitude:

- $\pm 3V \pm 20\%$ ; 0 dB, -7.5 dB, 15 dB (CSU), user-selectable
- $\pm 2.7V \pm 10\%$ , 0 to 655 feet, (DSU), user-selectable

### Jitter and Wander Performance

Per AT&T TR-62411, ITU-T G.824 (for internal, loopback and external clock modes)

### Connector

RJ-45

## ETHERNET INTERFACE

### Standard Compliance

IEEE 802.3, 802.3u, 802.1p&Q

### Number of Ports

3, network or user

### Type

Gigabit Ethernet: fiber optic or electrical (via SFP)

Fast Ethernet: fiber optic (via SFP) or 10/100BaseT

### Port Combinations

3 fiber optic SFPs

2 fiber optic SFPs + 1 UTP

1 fiber optic SFP + 2 UTPs

3 UTPs (Fast Ethernet unit only)

### Type

SFP-based:

- Gigabit Ethernet – 1000BaseSx, 1000BaseLX10, 1000BaseBx10
- Fast Ethernet – 100BaseFx, 100BaseLX10, 100BaseBx10

### GbE SFPs Specifications and Ranges

SFP-5: 850 nm, 0.55 km (0.3 miles)

SFP-6: 1310 nm, 10 km (6.2 miles)

SFP-7: 1550 nm, 80 km (49.7 miles)

SFP-8: 1310 nm, 40 km (24.8 miles)

SFP-17a: Tx – 1310 nm, Rx – 1490 nm, single fiber, 10 km (6.2 miles)

SFP-17b: Tx – 1490 nm, Rx – 1310 nm, single fiber, 10 km (6.2 miles)

SFP-20: 1550 nm, 120 km (74.5 miles)

SFP-22a: Tx – 1490 nm Rx – 1570 nm, single fiber, 80 km (49.7 miles)

SFP-22b: Tx – 1570 nm, Rx – 1490 nm, single fiber, 80 km (49.7 miles)

### FE SFPs Specifications and Ranges

SFP-1: 1310 nm, 2 km (1.2 miles)

SFP-2: 1310 nm, 15 km (9.3 miles)

SFP-3: 1310 nm, 40 km (24.8 miles)

SFP-4: 1550 nm, 80 km (49.7 miles)

SFP-13: Tx/Rx, single fiber, 20 km (12.4 miles)

SFP-10a: Tx – 1310 nm, Rx – 1550 nm, single fiber, 20 km (12.4 miles)

SFP-10b: Tx – 1550 nm, Rx – 1310 nm, single fiber, 20 km (12.4 miles)

SFP-18A: Tx – 1310 nm, Rx – 1550 nm, single fiber, 40 km (24.8 miles)

SFP-18B: Tx – 1550 nm, Rx – 1310 nm, single fiber, 40 km (24.8 miles)

SFP-19a: Tx – 1490 nm Rx – 1570 nm, single fiber, 80 km (49.7 miles)

SFP-19b: Tx – 1570 nm, Rx – 1490 nm, single fiber, 80 km (49.7 miles)

**Note:** It is strongly recommended to order this device with **original RAD SFPs installed**. This will ensure that prior to shipping, RAD has performed comprehensive functional quality tests on the entire assembled unit, including the SFP devices. RAD cannot guarantee full compliance to product specifications for units using non-RAD SFPs. For detailed specifications of the SFP transceivers, see the SFP Transceivers data sheet.

### Connector

LC, SFP-13 – SC/APC

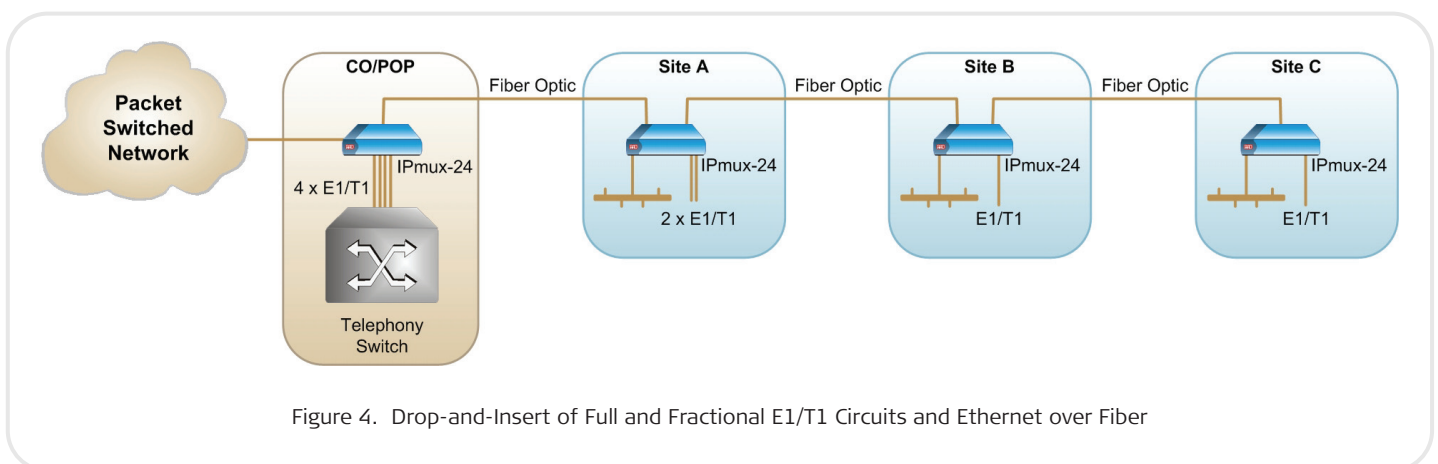


Figure 4. Drop-and-Insert of Full and Fractional E1/T1 Circuits and Ethernet over Fiber

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## TDM Pseudowire Access Gateway

### PSEUDOWIRE

#### Standard Compliance

IETF: RFC 4553 (SAToP), RFC 5087 (TDMoIP), RFC 5086 (CESoPSN)

ITU-T: Y.1413

MFA: IA 4.1, IA 8.0.0

#### Number of PW Connections

64

#### Jitter Buffer Size

0.5–180 msec (unframed) with 0.1 msec granularity

2.5–180 msec (framed) with 0.5 msec granularity

#### IPmux-24/A Adaptive Clock

Frequency accuracy:  $\pm 16$  ppb and G.823 synchronization interface requirements (clause 6), when locked to a PRC (stratum 1) or SSU (stratum 2) clock

Frequency accuracy in holdover:  $\pm 16$  ppb  $\pm 1$  ppb of aging per day

### GENERAL

#### Timing

Internal

Loopback

Adaptive

External input or output via optional dedicated RJ-45 port: E1/T1 or 2048/1544 kHz squarewave (RS-422 electrical levels)

#### Management

SNMPv1

Telnet

RADview Service Center TDMoIP (ordered separately)

ASCII terminal via V.24 (RS-232) DCE port

#### Diagnostics

E1/T1 local loopback

E1/T1 remote loopback

Facility Type 1 (FAC1) inband loopback

CSU loopback as per Telecordia GR-54

#### Statistics

E1/T1 (per G.826 and RFC 2495)

Ethernet (per RFC 2819)

Jitter buffer indication (overflow, underflow, sequence error)

#### Alarm Relay

Via pin 6, pin 7 and pin 8 of the EXT. CLK connector (RJ-45)

**Indicators**

PWR (green) – Power status

ALM (red/yellow) – Alarm status

E1/T1 SYNC (green/red) – E1/T1 synchronization status

LINK/ACT (green) – Ethernet link/activity status

EXT. CLK (red/green) – External clock status

**Power**

AC/DC: 100–240 VAC, 50/60 Hz or 40/60 VDC nominal (40 to 72 VDC)

DC: 24/48/60 VDC nominal (18–72 VDC)

**Power Consumption**

12W max

**Physical**

Height: 47 mm (1.8 in)

Width: 215 mm (8.4 in)

Depth: 147 mm (5.8 in)

Weight: 0.7 kg (1.5 lb)

**Environment**

Temperature:

IPmux-24, IPmux-24/A: 0 to 50°C  
(32 to 122°F)IPmux-24/H: -30 to 65°C  
(-22 to 149°F)

Humidity: Up to 90%, non-condensing

Table 1. IPmux Family Product Comparison

	IPmux-14 (Ver. 2.0)	IPmux-24 (Ver. 1.0)	IPmux-216 (Ver. 1.0)
TDM service ports	1, 2, 4	1, 2, 4	8, 16
Ethernet network ports	1 × FE network, 1 × FE network/user	1 × GbE/FE network, 1 × GbE/FE network/user	1 × GbE/FE network, 1 × GbE/FE network/user
Ethernet subscriber ports	1 × FE	1 × GbE/FE	1 × GbE/FE
Number of PWs	64	64	256
Multi-pseudowire	✓	✓	✓
jitter buffer size (msec)	0.5–180	0.5–180	0.5–180
Advanced clock recovery	✓	✓	✓
Redundant power supply	–	–	✓
External clock port	Optional	Optional	✓

## IPmux-24

## TDM Pseudowire Access Gateway

## Ordering

IPmux-24/#/!/?/~/\*/\$/+1/+2/+3

## Legend

# Ethernet interface type:

FE Fast Ethernet interface only

**Note:** By default the unit is supplied Fast and Gigabit Ethernet capabilities.

! Power supply type:

WRDC Wide range DC power supply

**Note:** By default the unit is supplied with the wide range AC/DC power supply.

? Temperature range:

H Environmentally hardened enclosure

**Note:** By default the unit is supplied in a regular enclosure.

~ Clock recovery:

A Advanced clock recovery mechanism per TDM port

**Note:** By default the unit is supplied with standard clock recovery mechanism.

\* Carrier-class package:

C Carrier-class package includes external clock, alarm relay and real-time clock

**Note:** By default the unit is supplied without the carrier-class package. Currently the package is supported by the IPmux-24 hardware only. Full functionality will be implemented in future software releases.

\$ TDM interface type:

1E1 Single balanced E1 interface

1E1CX Single unbalanced E1 interface

1T1 Single balanced T1 interface

2E1 2 balanced E1 interfaces

2E1CX 2 unbalanced E1 interfaces

2T1 2 balanced T1 interfaces

4E1 4 balanced E1 interfaces

4E1CX 4 unbalanced E1 interfaces

4T1 4 balanced T1 interfaces

**Note:** Unbalanced E1 interfaces are provided via RJ-45 to BNC adapter cables supplied with the product.

+1 Network interface type:

NULL SFP-ready slot

SFP-1 SFP-1 transceiver

SFP-2 SFP-2 transceiver

SFP-3 SFP-3 transceiver

SFP-4 SFP-4 transceiver

SFP-10A SFP-10A transceiver

SFP-10B SFP-10B transceiver

SFP-13 SFP-13 transceiver

SFP-18A SFP-18A transceiver

SFP-18B SFP-18B transceiver

SFP-19A SFP-19A transceiver

SFP-19B SFP-19B transceiver

SFP-5 SFP-5 transceiver

SFP-6 SFP-6 transceiver

SFP-7 SFP-7 transceiver

SFP-8 SFP-8 transceiver

SFP-17A SFP-17A transceiver

SFP-17B SFP-17B transceiver

SFP-20 SFP-20 transceiver

SFP-22A SFP-22A transceiver

SFP-22B SFP-22B transceiver

UTP 10/100BaseT

+2 Network/user interface type:

See the network interface ordering options above

+3 User interface type:

See the network interface ordering options above

## SUPPLIED ACCESSORIES

Power cord

AC/DC adapter plug

## CBL-RJ45/2BNC/E1/X

RJ-45 to BNC adapter cable (if an unbalanced E1 interface is ordered)

## OPTIONAL ACCESSORIES

## RM-35/@

Hardware kit for mounting one or two IPmux-24 units into a 19-inch rack

## Legend

@ Rack mounting kit type:

P1 Kit for mounting one unit

P2 Kit for mounting two units

## WM-35

Hardware kit for mounting one IPmux-24/A or IPmux-24/H unit on a wall

## CBL-DB9F-DB9M-STR

Control port cable

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