



# PatapSCO's PacketBand<sup>®</sup>TDM-4D, -4E & -3MC Technical Specification



**NOTE:** All references to the PacketBand-TDM-4D are also relevant for the [TDM-4E](#) and the [TDM-3MC](#). The extra features on the TDM-4E and TDM-3MC are briefly identified within. See separate documents for details and the PacketBand-TDM Comparison chart.

See also the [8 port](#) and [16/32](#) port PacketBands and the low cost [single port](#) devices.

## 1. Connectivity Overview

The PacketBand-TDM-4D (TDM-4D) supplies clock-locked clear channel or structured E1/T1 circuits over Ethernet, IP, or MPLS networks.

It supports up to four E1/T1s and can be used in pairs or with other members of the PacketBand range.

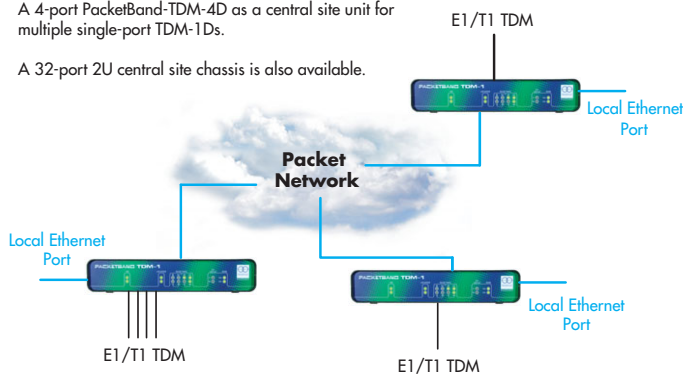
[A 3-port unit (PacketBand-TDM-3MC) supporting Multicast is also available and this has applications in larger networks where clocking is critical and in some vertical markets such as broadcasting].

[The TDM-4E version has a range of alternative clocking systems and support for RSTP and LACP.]

### DIAGRAM 1

A 4-port PacketBand-TDM-4D as a central site unit for multiple single-port TDM-1Ds.

A 32-port 2U central site chassis is also available.



## 2. Interfaces

- 1, 2 or 4 port E1/T1 versions available (user switchable between E1 and T1 in any combination)  
RJ45 120Ohm or 75Ohm (user switchable) via converter cable.  
Full E1/T1 or a fractional G.704
- 10/100/1GE UTP (Unshielded Twisted Pair RJ45) interface to the WAN
- A local 10/100/1GE UTP Ethernet port
- Optional SFP cage. Interfaces to a fibre network with the appropriate SFP module (not supplied)
- RJ12 management port (PacketBand is also manageable across the packet network)
- IEC connector for quality internal AC PSU (DC options available)

## Product Overview

The PacketBand-TDM-4D, TDM-4E and TDM-3MC deliver very high quality, completely transparent, E1/T1 circuits across different types of packet networks.

- Highly accurate and stable clock recovery processes
- G.823 Synchronisation levels of accuracy achievable
- On high quality networks clock recovery as close as 10ppb can be achieved
- “Tuneable” to different network types
- Robust, reliable and professional quality
- Excellent management, statistics and diagnostics
- Various clocking options for different network types and clock recovery requirements
- Inter-works with other PacketBand family members
- No available with [PoE](#) - see website

**PacketBand excels in delivering stable and accurately clocked E1/T1 “leased lines” over packet networks and benefit from PatapSCO’s excellent support.**

## 3. Clocking

Clock recovery, accuracy and stability is key to many TDM applications. This clock recovery performance **must** be maintained when migrating to an unlocked packet network solution.

Many types of equipment expect similar performance to that of traditional leased lines which are generally referenced to the G.823 Synchronous Interface mask. The PacketBand ranges are specifically designed and optimised to excel in this area and when used on high-quality networks can meet and exceed the G.823 requirements.

The clock recovery methods use a variety of mechanisms. These include sophisticated algorithms which allow users to “tune” the performance to match the network characteristics; after all, networks differ greatly – an extreme example being between the public Internet and a private managed networks supporting Quality of Service (QoS).

### 3.1 Clock Algorithms

The TDM-4D supports three advanced algorithms as standard. These are designed and optimised for different network types, broadly-speaking one for high quality managed networks with low jitter (PDV) and packet loss, one for networks with lower performance characteristics and one for applications where stability is paramount but the G.823 mask is not targeted. Within these options are two further settings allowing tighter optimisation if required.

This means PacketBand can be configured to extract the best possible service for any given network.

### 3.2 Clock stability

Clock frequency stability performance can exceed AT&T TR-62411, T1.403, G.824 and G.823 on quality networks for both Traffic and the much more demanding Synchronisation requirements. This is an important strength as many applications will either require very accurate synchronisation to run correctly (for example mobile backhaul), or there could be multiple clock sources within the network which all require aligning accurately to ensure error-free and reliable services.

PacketBand can deliver reliable services that clock as well as traditionally delivered leased lines.

PacketBand alarms to DbManager should the recovered clock's stability move outside of configured historic thresholds, giving immediate information should the clock deteriorate for any reason.

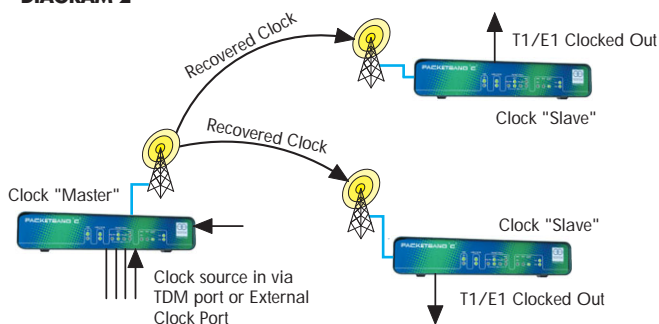
### 3.3 Clock Sources and Clocking

Although easy to use and configure, PacketBand offers customers a number of solutions for different clocking scenarios as briefly described below. Most situations will use the first two options shown, however some applications, devices and networks will benefit from the others. The PacketBand's advantage is not only very accurate clocking and reliability, but also the flexibility to work in different modes to suit a variety of situations and applications.

A clocking heirarchy is configurable and the PacketBand automatically switches between sources and generates an Alarm.

A document describing the [various clocking options](#) in detail is available.

DIAGRAM 2



- **TDM port**

Clock can be extracted from any of the attached user ports. This would normally be used at the "Master" end of a circuit with the remote "Slave" unit recovering clock across the packet network and clocking its attached equipment as described in "Adaptive" below.

- **Adaptive**

Using sophisticated recovery algorithms, clock can be derived from any of the in-coming packet streams from a remote "Master" PacketBand. The remote "Master" would generally have a high quality clock source presented on its TDM port. This allows the "Slave" TDM-4D to adaptively recover this clock very accurately across the packet network, in effect synchronising both devices to a common clock.

- **Loop-Timing**

In instances where both ends of the circuit have a good quality common clock source (for example ISDN clocks into PABXs) both TDM-4Ds can be set to clock from this local source.

- **Plesiosynchronous** - PacketBand-TDM-4E only

Plesiochronous (or plesiosynchronous) working means the TDM-4E can support multiple clocks and in different directions. This has two main applications.

1. Where the TDM links at both ends provide clock and these clocks may be slightly different.
2. Some locations need to receive TDM links from different devices (and/or different locations) which may have different clocks. The TDM-4E can provide different clocks on each G.703 TDM port.

These clocking capabilities open unique opportunities to network different clocks across packet networks and are covered in detail in the [TDM-4E](#) datasheet.

- **Asymmetrical Working** - PacketBand-TDM-4E only

When running in G.703 unstructured mode, PacketBand-4E is able to transmit and receive packets of different sizes and for the packets to be sized down to the individual byte level. This configuration is used in certain types of networks, mainly wireless, where the transport is clocked at the 64KHz level and where a phenomenon called "beating" would otherwise be experienced. Please see the [PacketBand-TDM-4E Application Overview](#) or contact [Patapsco](#) for more information.

- **Multicast** - PacketBand-TDM-3MC only

The PacketBand-TDM-3MC supports an innovative out-of-band clocking method via Multicast services. This has important advantages for larger networks and some vertical markets such as broadcasting. Clocks can be recovered extremely accurately across very large networks yet the bulk of the traffic load (the user data) can be given a low priority. See separate [TDM-3MC Application Overview](#).

- **Internal**

If no external quality clock is available, the TDM-4D can use its internal oscillator. Various oscillator options are available to deliver different levels of accuracy and stability (see below).

- **Clock Hold-Over**

Problems in the packet network, for example a sudden increase in jitter or an interruption in packet delivery, can cause an unwanted movement in the recovered clock. To avoid this PacketBand enters a "hold-over" state, maintaining the recovered clock at the last value prior to the problem. This means the clock is always stable irrespective of issues within the network. The mid range oscillator option and timing circuits within the TDM-4D maintain this hold-over clock to within 1.5ppb.

### 3.4 Oscillators

The quality of the oscillator when recovering the clock across the packet network is very important. The receive PacketBand running "Adaptive" clocking uses a variety of different information and many calculations to ascertain how to modify its on-board oscillator's output to match the clock of the remote or "master" end. It can be seen that the more stable the on-board oscillator, the more stable the recovered clock.

TDM-4D is fitted as standard with a 0.5ppm TCXO oscillator with a low cost upgrade option to a high quality Temperature Stabilised Enhanced Stratum3 TCXO oscillator which is ideal for all but the very most exacting applications. This delivers +/-12ppb over the full temperature range and typically in "Hold-Over" better than +/-15ppb in a 24 hour period with the unit operating at ambient room temperature.

For even further improved stability, particularly in environments where the temperature can change rapidly, the TDM-4D is available to order with an oven-controlled OCXO oscillator. Please contact Patapsco or your supplier to discuss this area in more detail. Very few applications require the OCXO version as the mid range enhanced TCXO has such a high performance. See specification page at rear.

**Note** that the quoted figures are for the stability of the on-board oscillator itself, not the actual clock provided to attached devices. PacketBand adds/subtracts from this internal clock to derive the recovered clock which in the majority of instances is significantly superior to the base oscillator with zero wander/drift over a period of time.

Oscillators comply with G8261/Y.1361 and detailed specifications are available on request.

## 4. PDV (Packet Delay Variation or jitter)

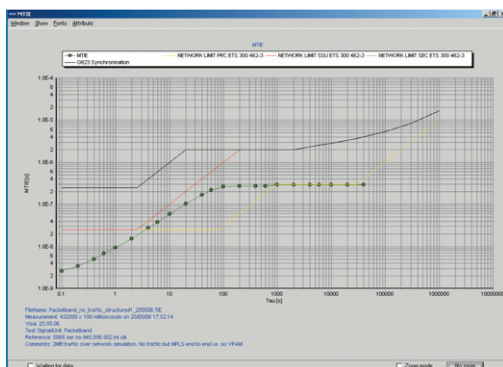
The PacketBand-TDM-4D supports up to 400mseconds of PDV or jitter depending upon configuration parameters. This is normally far in excess of the PDV experienced on private networks and many Internet connections.

The jitter buffer can be set in msec granularity and adjusted manually or automatically whilst the circuit is in place, overcoming 'skew' at start up time caused by the first packet in the buffer arriving later or earlier than average.

The buffer re-orders out of sequence packets. If packets are lost by the network the data to be transmitted to the attached device by PacketBand is user configurable.

Statistics are available to provide information on usage (see below).

Actual MTIE report from a customer's testing showing excellent adaptive clock results with PacketBand being close to the PRC reference source and significantly lower than the G.823 Synch mask.



## 5. Ethernet and Packet Handling

Support for 10/100/1GE.

Support for "Jumbo-packets" up to 10,240 bytes in size.

Single MAC and IP address, Default Gateway and SubNet Mask, support for DHCP. Disordered packets are reordered automatically.

### 5.1 Prioritisation

TDM packets can be assigned IP Diffserv (DSCP) or ToS and 802.1p CoS values.

Packetband supports full 802.1q tagging and the associated 802.1p CoS prioritisation levels.

All egress packets including TDM links can be prioritised across four output queues using CoS (802.1p) or Diffserv/ToS values.

### 5.2 VLAN Handling

PacketBand's powerful and latest-generation on-board packet switch offers advanced 802.1Q VLAN facilities such as multiple TAGing, TAG insertion/removal, port routing based on default TAG or a Global TAG table. Egress packets can be TAGed, have multiple TAGs or be stripped of TAGs according to configuration.

PacketBand also supports Provider Mode whereby customer packets are TAGed for transport across the network with the TAGs being removed before passing back to the customer at the far end.

### 5.3 Link Aggregation Control Protocol (LACP) – PacketBand-TDM-4E and TDM-3MC only

This powerful feature enables two or more Ethernet ports connected between PacketBand and the network switch to be aggregated together as defined in LACP IEEE 802.3-2005. This aggregation makes it appear as if the multiple links are acting as a single high capacity circuit. Furthermore, it adds a level of redundancy with automatic rerouting. See the TDM-4E and TDM-3MC Application Overviews for further information.

### 5.4 Rapid Spanning Tree Protocol (RSTP) – PacketBand-TDM-4E and TDM-3MC only

RSTP (as defined in IEEE 802.1D-2004) identifies the means to build an Ethernet network which contains physical loops between bridges. This facility enables PacketBands to be connected to more than one network switch via different circuits and to provide an automatic fall-back in the case of a link failure. This is covered in more detail in the Packetband-TDM-4E and TDM-3MC Application Overviews.

### 5.5 Rate Limiting

Individual packet ports can have the traffic capacity restricted in various ways, even though the access is 10/100/1GE. This is particularly useful on the second Ethernet port when connected to user LANs where the main link to the network could be "swamped" by data from attached devices.

## 6. Overheads

In order to transport TDM data over the packet network, there is some overhead caused by encapsulating the data inside the packet network protocol.

### 6.1 The Protocol

PacketBand supports a number of different packet network protocols. The user's choice of a particular network will affect the overall size of packet headers.

### 6.2 Size of Packet

PacketBand supports a configurable packet size per Logical Link. There is a trade off between transmitting small packets at a fast rate (low latency, larger overhead due to protocol headers) and transmitting larger packets at a slower rate (bigger latency, smaller overhead).

Typical overheads are in the 5% to 10% range. Patapsco have a spreadsheet available which identifies overheads based on a number of different parameters. Contact Patapsco or your supplier.

## 7. Latency

The total end-to-end latency experienced between two devices using PacketBands is made up of four elements:

### 7.1 Processing Delay

The latency or processing delay through each PacketBand is optimised to be as low as possible. Typical processing delay is less than 1msec.

### 7.2 Transmit Delay

This is the time necessary to wait for sufficient incoming data to arrive from the attached device so a packet of the configured size can be built and transmitted over the network. This is typically around the 1msec range. See also 6.2 above.

### 7.3 Jitter

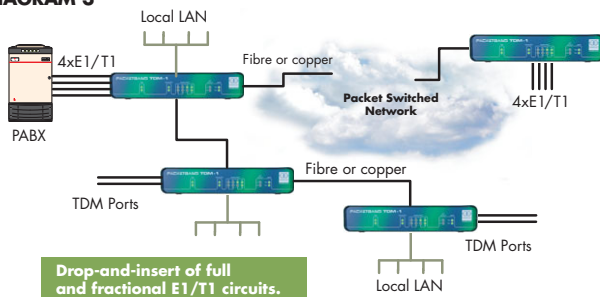
Packet networks differ in how consistently packets pass through them; some packets take more or less time than the average. PacketBand provides a synchronous clocked circuit to the attached devices and therefore has to have data ready and available for the relevant clock pulse. PacketBand buffers the fast packets so as to ensure the slow ones can arrive in time to be used. The amount of buffering is user-configurable and will depend upon the performance of the network. Note that this buffering is only required on the PacketBand receive data path and the amount of buffering needed (which equates to latency) is a result of the network, not PacketBand.

### 7.4 Transit Delay

All IP networks have different average transit delays. These vary depending upon a large number of criteria, including the number of "hops" and whether satellites are involved. Typically, domestic links are very fast, inter-continental around 60msec and a satellite can add 250msecs. Please consult your network supplier.

**Summary:** between any pair of PacketBands on a terrestrial network, the most significant element contributing to latency is size of the Jitter Buffer (which is user configurable). This is directly dependant on the performance of the network and outside the control of PacketBand.

**DIAGRAM 3**



## 8. CESoP Modes

PacketBand supports both "Structure Aware" and "Structure Agnostic" modes.

Complies with ITU-T recommendation Y.1413, IETF PWE3 draft standards CESoPSN, SAToP and CES draft IAs from MEF and MFA.

## 9. "Logical Links" and "Grooming"

A Logical Link is the emulated circuit over the packet network between a pair of PacketBand devices.

If running G.703 or G.704 between end points each circuit requires 1 Logical Link.

If "grooming" multiple time slots from many remote destinations into a single G.704, every individual link between PacketBands (irrespective of speed) requires 1 Logical Link.

The single port version of the TDM-4D supports 32 Logical Links and the 2 and 4 port versions 64 Logical Links. An option to upgrade to 128 Links is available.

The IP ToS or Diff Serv and Ethernet VLAN Tagging is configurable on a per-Logical Link basis.

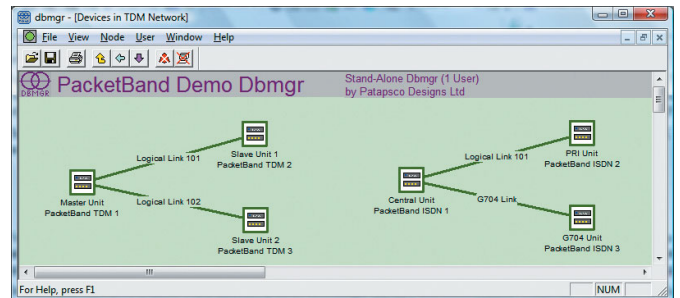
## 10. Approvals

All approvals completed in a UK Accredited laboratory. Reports available. CE marked.

Safety and Emissions (EMC) approvals (CE and FCC).

Telecoms approvals for connection to carrier leased lines is optionally available.

PacketBand TDM-4D is RoHS compliant without the use of "exceptions".



## 11. Management

### 11.1 Overview

PacketBand can be locally or remotely configured using Patapsco's easy-to-use high functionality DbManager GUI software.

DbLite is supplied free with each unit.

Optionally available are different versions to support requirements for larger or more integrated networks. It is sophisticated but simple to use via an intuitive Graphical User Interface (GUI) which controls, configures and monitors individual Patapsco units and complete networks, currently Microsoft-based, it can also generate SNMP Traps and Alarms.

The DbManager supplied with PacketBand (DbLite) allows control and visibility of a single PacketBand at any one time via a single PC. Other options support multiple real-time work-stations, a network of PacketBands and links, and have additional capabilities such as SNMP Traps & Alarms and continuous polling of devices. A document identifying the differences between [DbLite](#) and other versions is available. A [movie](#) is also available.

Used by various organisations with different network sizes - up to and including carriers - versions of DbManager deliver a network-wide view of all PacketBands and links via a 4-layer "tree-structured" overview. The status of all PacketBands and links are easy to identify with Alarms being colour coded and passed up the tree. Separate windows provide Event and Alarm information with the ability for operators to add comments etc. Different access levels and passwords provide operators with appropriate capabilities within the program.

An option to encrypt the management traffic across the packet network is available, together with key management/update system.

Demonstration software is available which illustrates both the DbManager and the PacketBand features. Please ask for information. Movies are available at [www.patapSCO.co.uk](http://www.patapSCO.co.uk)

## 11.2. Configuration Changes

Configuration changes on PacketBand are made via the DbManager. All configurations can be stored on DbManager. Installations require little or no expertise in the field as most configurations (other than IP address) can be performed remotely.

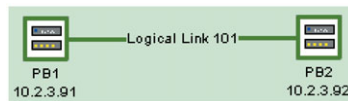
Configurations are held in non-volatile memory.

DHCP is supported.

The TDM-4D benefits from a battery-backed Real Time Clock which provides time-stamps for configuration changes and other Events and Alarms.

## 11.3 Management Tools

A wide number of statistics are available for the E1/T1 circuit and Ethernet port.

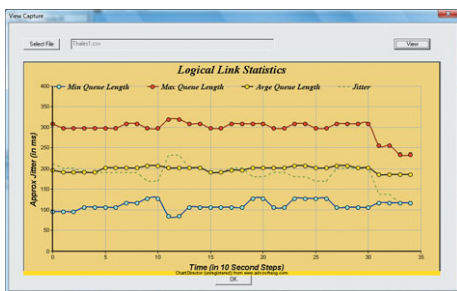


### 11.3.1 Alarms/Events

All Alarms are reported back to the DbManager and presented in a dedicated window with descriptor.

Events and Alarms are held within non-volatile memory locally in the TDM-4D for access via DbManager.

A dry contact alarm relay is available in the RJ12 port.



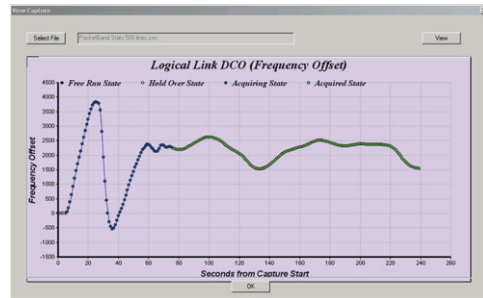
### 11.3.2 Graphs

DbManager and PacketBand provide several network monitoring tools available with graphical output:

- Maximum, minimum and average jitter buffer usage over time. This useful screen shows how the network and link are performing. Particularly useful information includes Lost and Late packets and jitter buffer usage figures.

- Average network jitter over time  
A graphical representation showing Minimum, Maximum and average buffer usage which provides important information on network performance.
- Recovered clock movement over time This graph shows frequency stability and the status of the acquiring clock.

These are invaluable tools for optimising PacketBand and for acquiring information on network performance.



These statistics, which are updated for each Logical Link every 10 seconds, gives accurate and invaluable information on the performance of the network and are vital when installing. The information also identifies whether the jitter buffer settings are correct and if the jitter buffer can be reduced to remove any unnecessary latency.

### 11.3.3 "Sniffer" port

The second Packet port on PacketBand can be configured as a "sniffer" port duplicating TX and/or RX packets on the network Packet Port. This is a very useful diagnostic tool.

### 11.3.4 Loop-Backs

Loops can be placed on the TDM port in either direction and at the Ethernet level.

### 11.3.5 Pings

PacketBand generates Ping/Trace Route and responds to Ping and UDP Echo requests.

### 11.3.6 Boot Test

Internal test on power-up with results visible via DbManager.

## 11.4 Software/Firmware Updates

New software can be loaded via the DbManager to PacketBand-TDM-4. New software is loaded to the offline sector of Flash and is confirmed via a CRC. Users can switch to the new software at any time. DbManager can load new code to multiple PacketBands simultaneously.

## 12. Power

### 12.1 Internal High-Quality AC supply

Auto-sensing, standard IEC input.

### 12.2 Optional DC Supplies 48VDC or 24VDC (nominal)

Replaces AC supply. Specify when ordering.

### 12.3 PoE Option available

Meets [IEEE 802.3af](http://www.ieee.org) see website



## Specifications

### A. Clock Recovery

Advanced algorithms tunable for different network characteristics as standard. Capable of exceeding G.823 Synchronous Interface requirements (subject to network performance)

### B. TDM port (E1)

1, 2 and 4 port versions  
 User switchable E1/T1  
 RJ45 connector  
 Presents as DCE (crossed cable for DTE)  
 120 Ohm  
 75 Ohm user-selectable via converter cable  
 G.703 unstructured  
 G.704 channelised  
 ITU G.706  
 Selectable CRC4/non-CRC4  
 HDB3  
 Transparent to user signaling

### C. TDM port (T1)

1, 2 and 4 port versions  
 User switchable T1/E1  
 RJ45 connector  
 Presents as DCE (crossed cable for DTE)  
 100 Ohm  
 Unframed 1.544Mbps  
 Framed 1.536Mbps (robbed-bit)  
 ESF or D4 selectable  
 B8ZS or AMI selectable  
 Transparent to user signaling

### D. Ethernet Interfaces

2 x RJ45 UTP  
 10/100/1GE  
 Auto-sensing or manual  
 Optional SFP cage (module not supplied) for various fibre modes  
 1 network and 1 or 2 user ports  
 (2nd port using SFP)



### E. Oscillator Performance\*

Standard		
Hold-over 24hrs	15ppb	
Aging per day	10ppb	
Temperature Stability	12ppb	
Enhanced		
Hold-over 24hrs	4ppb	
Aging per day	0.5ppb	
Temperature Stability	14ppb	
Oven		
Hold-over 24hrs	10ppb	
Aging per day	0.3ppb	
Temperature Stability	10ppb	

\* Figures based on typical parts and performances. Individual oscillators may vary slightly either way. Temperature Stability range -5DegC to +70DegC assumes 20 minutes from power on. Aging and hold-over at constant temperature

### F. Local Management Port

RJ12  
 Asynchronous  
 Auto-sensing to 115kbps  
 Also remote access via packet network  
 Dry contact alarm relay pins 4, 5, 6

### G. IP & MAC Address

Single MAC address, IP address, subnet mask and default gateway  
 Support for DHCP

### H. Configuration

Held in non-volatile memory

### I. Realtime Clock

For time-stamping Events and Alarms

### J. Power (AC)

Internal via IEC connector  
 Auto-sensing 96VAC-240VAC  
 Max consumption 0.2Amps RMS @230VAC  
 MTBF 400,000hrs

### K. Power (DC)

- Nominal -48VDC  
 4mm terminal block  
 -33VDC to -75VDC  
 0.35A max  
 MTBF 1,790,000hrs  
 PoE option
- Nominal -24VDC  
 4mm terminal block  
 -18VDC to -75VDC  
 0.55A max  
 MTBF 800,000hrs

### L. Dimensions & Environment

Metal chassis and front/rear panels  
 W – 225; D – 200; H – 44mm  
 Weight – 0.9Kg/2lb  
 Optional 19" rack-mount kit; 1 unit per 1U, or 2 units side-by-side per 1U  
 Operating Temperature -20°C to +55°C  
 Humidity 10-90% non-condensing

### M. Maintenance

There are no serviceable parts or maintenance required.

Real-time battery-backed clock life in excess of 7 years.

### N. Approvals

EMC  
 EN55022:1988  
 EN55014:1988  
 EN61000-3-2/3:1995  
 AS/NZ CISPR22:2000  
 FCC Part 15(B)  
 RoSH Compliant without the use of exceptions

### O. Safety

EC EN60950-1:2002  
 ACA TS001:1997  
 ACS/NZ60950:2000  
 AS/NZS3260:1993  
 IEC950

### P. Telecomms (optional)

TBR12/TBR13  
 TBR4/TBR3  
 TIA/E1A-1S/968  
 TNA117  
 AS-ACIF S006/S016

**For ordering information, see separate document**

All details subject to change without notification E&OE

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