Patapsco's PacketBand©TDM-RL-4

Technical Specification

NOTE: See also the single port RL-1 and other versions of PacketBand which have additional features and capabilities.

1. Connectivity Overview

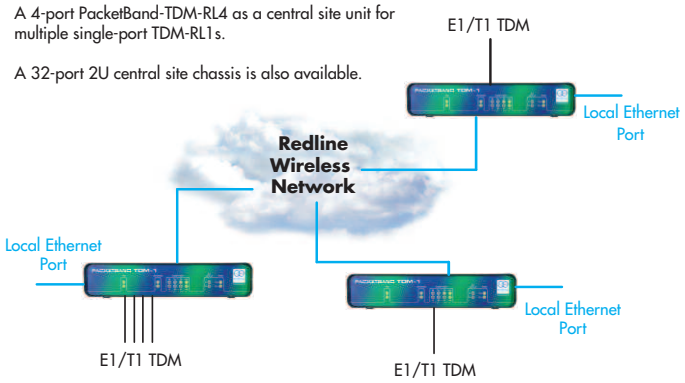
The PacketBand-TDM-RL-4 (TDM-RL-4) supplies clock-locked clear channel or structured E1 or T1 circuit over a wide range of Redline wireless systems.

It supports up to four E1/T1s and can be used in pairs or with other members of the PacketBand range and can be used with the 4-port RL-4 and the 8/16/32 port chassis. X.21 and V.35 versions of PacketBand are also available.

DIAGRAM 1

A 4-port PacketBand-TDM-RL4 as a central site unit for multiple single-port TDM-RL1s.

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



2. Interfaces

- 2 or 4 port E1/T1 versions available (user switchable between E1 and T1 in any combination)
  RJ45 120O hm or 75O hm (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 UTP Ethernet port
- 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-RL-4 delivers high quality, completely transparent, E1/T1 circuits across different types of packet networks and is specifically optimised and focused on Redline Communication Inc's range of wireless systems.

- Highly-accurate and stable clock recovery processes
- G.823 levels of accuracy achievable
- "Tuneable" to different network or wireless types and traffic loadings
- Robust, reliable and professional quality
- Excellent management, statistics and diagnostics
- Inter-works with other PacketBand family members

PacketBand excels in delivering stable and accurately-clocked E1/T1 "leased lines" over Redline's wireless networks.

See also the Temperature Extended version.

3. Clocking

Clock recovery, accuracy and stability is key to many TDM applications. This clock recovery performance **must** be maintained when migrating to an unclocked 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 and loading.

3.1 Clock Algorithms

The TDM-RL-4 supports three base algorithms designed for different network profiles, 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 Traffic mask and on quality links can meet the much more challenging Synchronous mask. 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

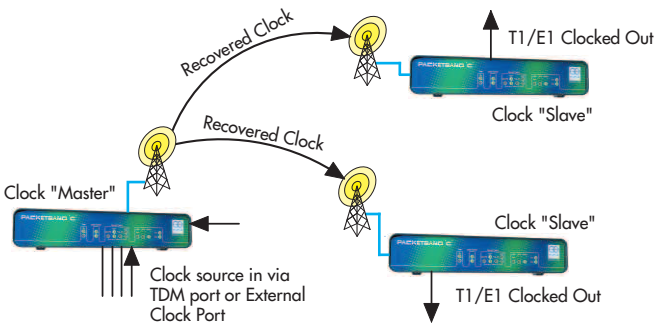
Although easy to use and configure, PacketBand offers customers a number of solutions for different clocking scenarios as briefly described below. Most situations will use the first two options shown, however some applications, devices and networks will benefit from the others. The PacketBand's advantage 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 heirachy is configurable and the PacketBand automatically switches between sources and generates an Alarm.

The RL-4 will be locked to one clock source so all E1s are clocked together. If all E1s need to be separately clocked, specify the Multi Clock option.

- 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

DIAGRAM 2



TDM port. This allows the "Slave" TDM-RL-4 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-RL-4s can be set to clock from this local source.
- Internal
  If no external quality clock is available, the TDM-RL-4 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 wireless 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-RL-4 maintain this hold-over clock to within15ppb.

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-RL-4 is fitted as standard with a temperature stabilised stratum 3 Enhanced TCXO oscillator which is ideal for all but the very 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.

The equipment is optionally available with an oven stabilised oscillator (OCXO) which may be relevant in environments where the temperature varies considerably.

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)

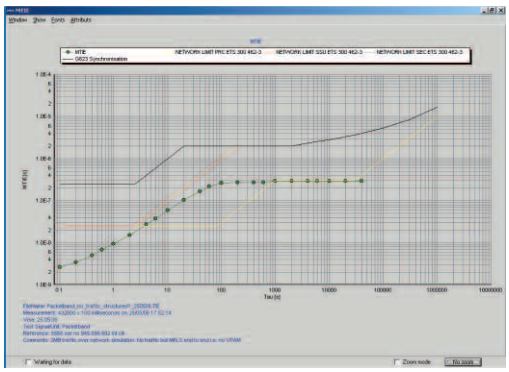
The PacketBand-TDM-RL-4 supports up to 400mseconds of PDV or jitter depending upon configuration parameters. This is normally far in excess of the PDV experienced on Redline wirelesses.

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 10/100Mbps.

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)

Available on other PacketBand units.

5.4 Rapid Spanning Tree Protocol (RSTP)

Available on other PacketBand units.

5.5 Link Fall-Back

System for PacketBand to automatically switch between 2 separate Ethernet/Wireless links require no network intelligence or special capabilities.

5.6 Asymmetrical Packetisation

Enables packet sizes to be configured so that "beating" against the wireless 8KHz clock is avoided. Available on other PacketBand units.

5.7 Rate Limiting

Individual packet ports can have the traffic capacity restricted in various ways, even though the access is 10/100. 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 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 though 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.

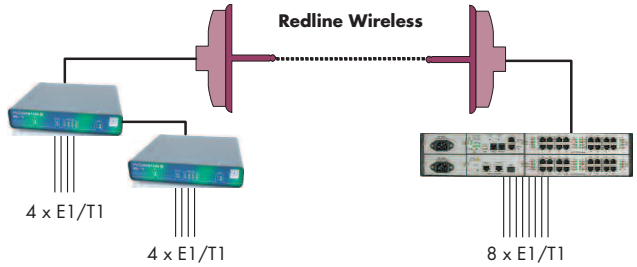
7.4 Transit Delay

All IP networks have different average transit delays. These vary depending upon a large number of criteria, including the number of "hops" and data loadings. Typically, transit delay across a Redline wireless network is very low. Please contact your Redline supplier.

Summary: between any pair of PacketBands the most significant element contributing to latency is size of the Jitter Buffer (which is user configurable). This is directly dependant on the performance and loadings of the wireless and its settings is outside the control of PacketBand.

DIAGRAM 3

Two close-coupled 4-port units deliver 8 E1s and communicate with the 8/16/32 port chassis



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 cuircuit 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.

Both the 2 and 4 port versions support 1 Logical Link as standard. An option to upgrade to 16 and 32 Logical 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).

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

11. Management

11.1 Overview

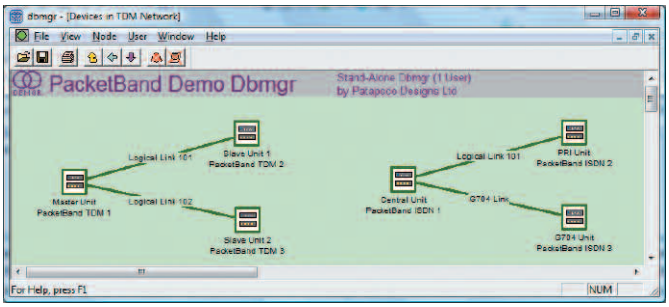
PacketBand can be locally or remotely configured using Patapsco's easy-to-use high functionality DbManager GUI software.

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.

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.



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

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-volitile memory.

DHCP is supported.

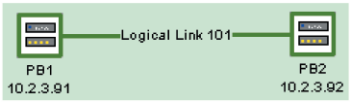
The TDM-RL-4 benefits from a batttery-backed Real Time Clock which provides time-stamps for configuration changes and other Events and Alarms.

11.3 Management Tools

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

11.3.1 Alarms/Events

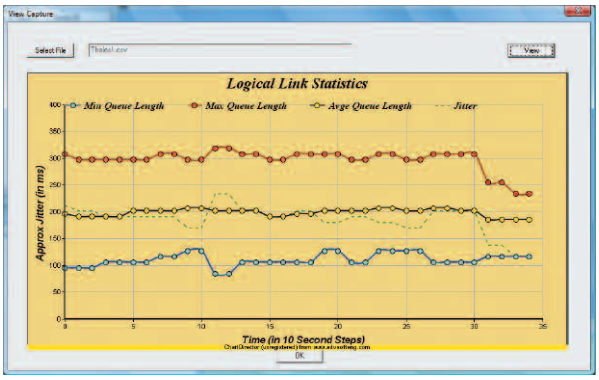
All Alarms are reported back to the DbManager and presented in a dedicated window with descriptor.



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

11.3.2 Graphs

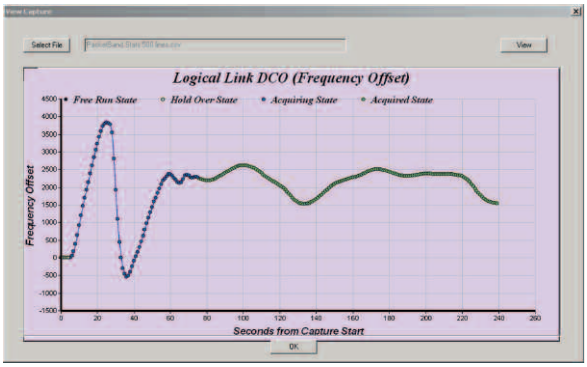
DbManager and PacketBand provide several network monitoring tools available with graphical out-put:



- 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 off-line 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.

Patapsco's PacketBand©-TDM-RL-4
Technical Specification

Specifications

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

B. TDM port (E1)
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)
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
Auto-sensing or manual

E. Oscillator Performance*

Standard	
Hold-over 24hrs	15ppb
Aging per day	10ppb
Temperature Stability	12ppb
Standard (from March '09)	
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-volitile 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

For ordering infomation, see separate document

K. Power (DC)
1. Nominal -48VDC
   4mm terminal block
   -33VDC to -75VDC
   0.35A max
   MTBF 1,790,000hrs
2. 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 +50°C
See also Temperature Extended version
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

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