RXT-6200 Module

100G Universal Test Module

100G Ethernet
32G Fibre Channel
24G CPRI
25G eCPRI
112G OTN
10G SDH/SONET
PDH/DSn

Now supporting CFP4, QSFP28, QSFP+, SFP28, SFP+ and SFP

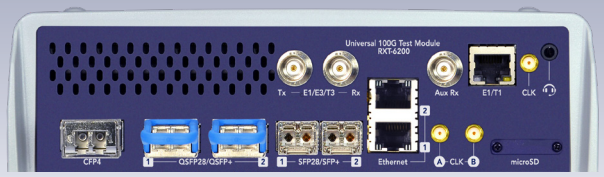
NEW

RXT-1200

Modular Test Platform

Enhanced Universal Test Module for 5G/4G Mobile Front/Backhaul, Carrier Ethernet & Transport

VeEX® RXT is the industry's most flexible, compact, and future-proof hand-held test solution for core, metro and access. The RXT-6200 module adds Ethernet, 5G/4G Mobile Backhaul and Fronthaul, Storage Area Networks, OTN, SDH/SONET, PDH/T-Carrier links and services testing, from 1.5/2 Mbps up to 100 Gbps.



Platform Highlights

The RXT modular test platform offers a full range of link and service testing capabilities, from Core to Access, from Lab to Field and from 64k to 100G, with a complete range of communication technologies, including eCPRI, CPRI/OBSAI, OTN, SDH/SONET, PDH/DSn, Carrier Ethernet, SyncE, 1588v2 PTP, Fibre Channel, OTDR, OSA, CaTV, QAM/DOCSIS. All supported by a single rugged hand-held test platform.

- Optional built-in GPS for One Way Delay (OWD) and Timing (Phase) measurement
- Optional built-in high-precision Atomic Clock reference
- Extended Sleep Mode (standby) with frequency and phase holdover
- Flexible Remote Access and Remote Control via ReVeal software, web browser, VNC® and SCPI commands
- Fast test results transfer via USB memory stick
- Built-in VeExpress client for asset management, software updates and licenses. Buy, rent or share licenses
- Built-in R300 Server client for test results upload
- Intuitive graphical user interface for easy operation
- 7" color LCD with touch screen
- Ultra high capacity field-exchangeable Li-ion battery pack offers over 1.5 hours of continuous operation at 100GE rate
- Smallest and lightest 100GE test platform, weighing 3 kg (6.7 lb) including its high-capacity Li-ion battery

Module Highlights

The RXT-6200 is the most complete and flexible portable 100G test set in the market. Equipped with most common transceiver form-factor ports and optional legacy test interfaces, this module is a perfect complement to the RXT Platform, extending its testing range to 100 Gbps and offering up to two simultaneous 100GE tests. Installation, commissioning, monitoring and maintenance tasks are simplified thanks to a combination of intuitive features and powerful test functions. Novice users benefit from the easy-to-use GUI, while experienced users will appreciate an array of advanced features such as OTL/PCS, CAUI-4/XLAUI Lane BERT, overhead monitor/control, Tandem Connection Monitoring, Service Disruption, Protocol Capture/Decode, BERT, Throughput test, and much more.

General

- Independent Dual-Port testing, up to 2x 112G
- CFP4 (LR4 & SR4) and QSFP28 interfaces for 100GE, OTU4 and 50GE applications
- Supports IEEE 802.3bj Clause 91 RS-FEC as required for SR4
- QSFP+ for 40GE, OTU3
- SFP28 interface for 25GE, 32/16G FC, 24G CPRI 10 and 25G eCPRI Layer 4 with RS-FEC
- SFP+ for 100Base-FX, 1000Base-X, 10GEBase-X, OTU2/2e/1e/1, STM-64/16/4/1/0, OC192/48/12/3/1, Fibre Channel 16/10/8/4/2/1G, CPRI up to 12G, and 10G eCPRI
- RJ45 for 10/100/1000Base-T applications

Module Highlights *cont'd*

Ethernet Testing

- Optical 100 Mbps to 100 Gbps Ethernet testing, including 25GE and 50GE
- Electrical 10/100/1000 Mbps Ethernet testing
- Dual-port testing capabilities
- Optical Lane BERT and CAUI-4/XLAUI Lane BERT
- PCS Layer Testing with Skew generation/monitoring
- Multi-stream testing up to 32 independent streams
- IEEE 802.3ah, ITU-T Y.1731, IEEE 802.1ag, and MPLS-TP OAM support
- RS-FEC support for SR4 and SR10 transceivers
- Q in Q (VLAN stacking), MPLS, MPLS-TP, PBB, EoE support
- MAC flooding
- RFC2544 and V-SAM (Y.1564) testing
- IPv4 and IPv6 traffic generation
- BERT and Throughput testing at Layer 2 and Layer 3
- Smart Loopback mode for Layer 2 and Layer 3
- One-Way-Delay latency measurement (GPS assisted)
- Line rate packet capture with Wireshark™ decode
- Error and Alarm Injection

CPRI Testing

- Common Public Radio Interface standard (CPRI) link performance verification
- Supports all Rate Options up to CPRI 10 (from 614.4 Mbps to 24.33 Gbps) per CPRI Specification v7.0
- Layer 2 Framed BER testing with PRBS stress patterns
- REC/BBU (master) and RE/RRH (slave) emulation
- Latency measurements
- Dual-port operation and bi-directional monitoring mode
- CPRI Hyperframe Capture

eCPRI Testing

- 25G/10G eCPRI
- Dual-port testing capabilities
- RS-FEC support
- Multi-stream testing up to 32 independant streams
- Throughput testing at Layer 2 and Layer 4
- IPv4 and IPv6 support
- Q in Q (VLAN stacking) and MPLS support
- High accuracy One-Way-Delay latency measurement (GPS assisted)
- Line rate packet capture

Fibre Channel

- Storage Area Networks (SAN) testing for 1G, 2G, 4G, 8G, 10G, 16G and 32G interfaces
- BERT and Throughput test
- RFC2544: Throughput, latency, frame loss, back to back tests Layer 1 and layer 2 loopbacks

OTN Testing

- OTN testing for OTU1, OTU2, OTU1e, OTU2e, OTU3 and OTU4
- Complete multi-stage Mapping/Multiplexing
- Advanced multi-step Map/Mux with SDH/SONET/PDH/DSn test payloads*
- Ethernet over OTN (EoOTN)
- ODUflex into ODU2, ODU3 and ODU4 with Bulk payload
- Service Disruption Time (SDT)
- Tandem Connection Monitoring
- Overhead monitoring and generation
- Terminate, Payload Through and Line Through test modes
- Per-lane optical power and frequency measurements
- External clock reference interface
- Histogram Analysis

SDH/SONET Testing

- Available as Line Rate or mapped into OTN payloads
- STM-0 to STM-64 and STS-1/OC-1 to OC-192
- Advanced multi-step Map/Mux with PDH/DSn test payloads
- Test payload multiplexing down to VC11/VT1.5 and internally generated PDH/DSn tributaries

PDH/T-Carrier Testing

The test set provides optional legacy SDH/SONET/PDH and DSn test interface capabilities and sub-rates from 155M (STS3/STM1), 55M, (STS1/STM0), 140 Mbps (E4), 34 Mbps (E3), 2 Mbps, 45Mbps (DS3), 1.5 Mbps (DS1), and G.703 64k codirectional.

Applications

Auto Scripting

The Auto Scripting feature is the perfect tool for the lab environment where multiple short-term or long-term test configurations are required to stress the network equipment and/or network under test, in order to measure and qualify the performance capabilities. The feature is also important in field operations, not only to speed-up service turn-up times, but also to facilitate the entire workforce the same test profiles and test procedures for day-to-day operations.

The Auto Scripting application is an automated sequence of tests that can be carried out by selecting previously configured Throughput or BERT profiles. The profiles can be created with ReVeal and then loaded to the unit or created directly on the unit in the Throughput and BERT applications. Users can select up to ten profiles, each profile configured with its own duration. The duration can be in seconds, minutes, hours, or days. The test sequence will begin with the first profile configured with its corresponding duration, followed by each profile after that. At the end of each profile tested a results file will be stored automatically before the test sequence continues to the next profile. Users have the option to continue or stop the auto scripting test if errors or alarms are detected.

Packet Capture and Decode

Configurable capture filters

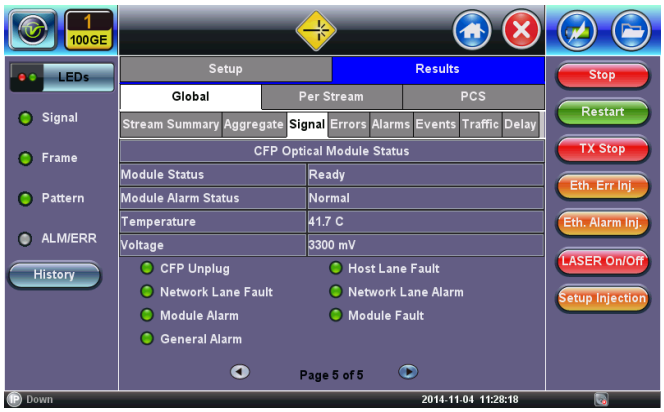
- MAC and IP
- UDP and/or TCP
- Multicast, Broadcast, IP Checksum error, UDP/TCP Checksum Error events

Integrated Wireshark™ packet decode

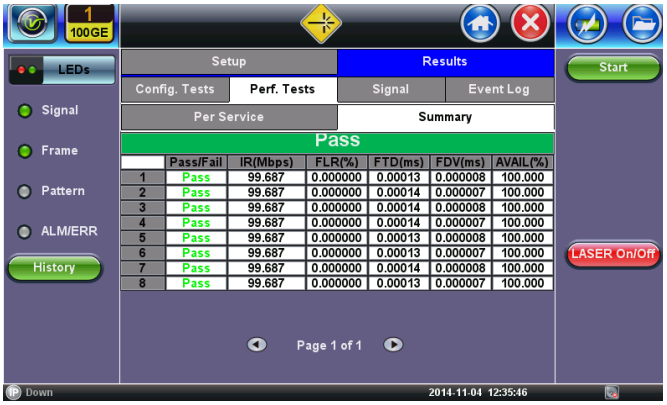
Packet captures can be saved and exported PCAP capture format, compatible with Wireshark

Application Examples

Transceiver Health - Module temperature, alarm and failure information display



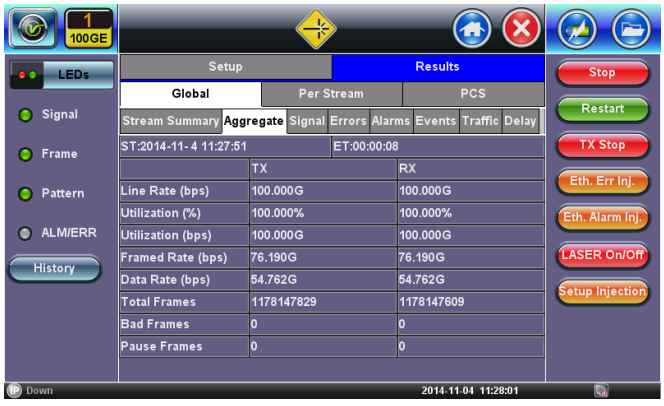
100GE V-SAM test results with 8 services. RXT-6200 is able to perform up to 32 services



Receive Optical Power per lane

PCS analysis for alarms and errors

Example of 100GE Layer 2 100% throughput test result display



PCS, CAUI-4, Virtual lane and skew control setup

Test Interfaces

Optical Ports

CFP4
- 100GE
- OTU4

QSFP28
- 100GE
- 50GE
- OTU4

QSFP+
- 40GE
- OTU3

SFP28/SFP+/SFP
- 25G, 10G, 1G, 100M Ethernet
- OTU2e, OTU1e, OTU2, OTU1
- STM-64/16/4/1/0, OC-192/48/12/3/1
- 32G, 16G, 10G, 8G, 4G, 2G, 1G Fibre Channel
- 24.33G, 12.17G, 10.14G, 9.83G, 8.11G, 6.14G, 4.92G, 3.07G, 2.46G, 1.23G, 614.4M CPRI
- 25G eCPRI

Electrical Ports

RJ45
- 10/100/1000Base-T

BNC and RJ48 (factory-installed option)
- E1, E3, E4, STM-0, STM-1, T1, T3, STS1, STS3

Physical Layer

RX Optical Power Measurements
- Per-lane input power measurement
- ± 2 dB accuracy, 0.01 dB resolution
- Aggregated (total) power in dBm
- LOS and Saturation indication

TX Optical Power Monitoring
- Per-lane output power in dBm
- Aggregated (total) power in dBm

RX Frequency Measurements
- RX Frequency (1 kHz resolution)
- Offset (ppm): Current, Minimum, Maximum

Optical Pluggable Modules*

Pluggable Module Information
- Power Class, Vendor, P/N, Serial Number, MSA HW revision, MSA MIS revision, Control 1 Register (IEEE), Expected Ability (supported rates)

Pluggable Module Status (CFP4/QSFP28/QSFP+/SFP28/SFP+ dependent)
- Module status, Alarm status, Internal Temperature, Voltage
- Transceiver unplugged
- Host Lane Fault, Network Lane Fault, Module Fault
- Network Lane Alarm, Module Alarm, General Alarm

Automatic initialization and laser safety reset (OFF) after hot swap

Operating temperature range: 0˚C to 45˚C

CFP4, QSFP28, QSFP+, SFP28, SFP+ and SFP transceivers conforming to Multi Source Agreement (MSA) specifications

Safety: Class 1 Laser Product. Comply with FDA/CDRH 21 CFR 1040.10 and 1040.11, EN (IEC) 60825 eye safety regulations

ROHS compliant and Lead Free per Directive 2002/95/EC

Note: Certain 100GE/OTU4 pluggable optics types may not guarantee error free pre-FEC lane transmission. For module-specific pre-FEC BER performance, please refer to the optical transceiver's specification."

**Dependent on module form factor and type*

TX Clock Source

Internal: Quartz, ≤ ± 3.5 ppm

Tx Frequency Offset
- ±150 ppm
- Steps of 0.1 ppm

Recovered: from incoming RX signal

External Clock Inputs (SMA)
- 2.048 MHz, 1.544 MHz, 10 MHz
- 1.544 Mbps, 2.048 Mbps (AMI, HDB3, B8ZS)
- 1 PPS
- independent clock for port group 1 (A) and group 2 (B)

System's High-precision 1 PPS and 10 MHz Clocks
- GNSS/GPS clock (RXT-1200 platform option)
- Atomic Clock (RXT-1200 platform option)
- Atomic clock can be disciplined by the GPS if both options are present. Check RXT-1200 Platform datasheet for details.

Measurement Clock Reference

Internal: Quartz, ≤ ± 3.5 ppm

From RXT-1200 Platform (optional):
- Atomic 10MHz (disciplined or free-run)
- Atomic 1PPS (disciplined)
- GNSS/GPS 1PPS

External clock sources via SMA ports (A and B)

Ethernet Testing

Reliability, Scalability and Quality of Service are the attributes needed for Ethernet to turn into Carrier-grade Ethernet. With standard features including RFC2544, VSAM, Throughput, MPLS and VLAN support, this test set has all the tools necessary to truly ensure end-to-end carrier-grade Ethernet services.

Key Features

- Transmit frequency offset to stress the network up to ±150 ppm
- Optical Lane BERT
- CAUI-4/XLAUI Lane BERT
- FEC Layer Testing with Skew generation/monitoring
- PCS Layer Testing with Skew generation/monitoring
- Throughput, latency, jitter, frame loss, and back-to-back measurements per industry-standard RFC2544
- Multi-stream testing with up to 32 fully independent and configurable streams
- IPv4 and IPv6 traffic generation
- MAC Flooding
- Q-in-Q (VLAN stacking) and multiple MPLS tag support
- BER testing at Layer 2 and Layer 3 with or without VLAN and MPLS tags
- Smart Loop mode for Layer 2, Layer 3, and Layer 4 with all key measurements on received traffic provided on the loopback port
- One-way latency measurement between remote devices (with GPS synchronization)
- Line rate packet capture with Wireshark™ decode

Interfaces

100GE/40GE Compliant with IEEE 802.3ba
MSA compliant transceiver interfaces
CFP4 Interface bit rates
- 100GBase-R 103.125 Gbps

QSFP28
- 100GBase-R 103.125 Gbps
- 50GEBase-R 51.56 Gbps

QSFP+
- 40GBase-R 41.25 Gbps

SFP/SFP+/SFP28
- 25GBase-R 25.78 Gbps
- 10GBase-X 9.95/10 Gbps
- 1000Base-X 1 Gbps
- 100Base-FX 100 Mbps

RJ45
- 10/100/1000Base-T

Frequency offset: +/- 150 ppm (0.1 ppm step)
External reference clock input: 2.048 Mbps, 2.048 MHz, 1.544 Mbps, 1.544 MHz, 10 MHz, Received signal

Operating Modes

Terminate
Loopback
Passthrough Monitor

100G FEC Layer Testing

FEC lane mapping; default, manually defined, shift
FEC Skew generation per lane pair (0 to 160000 bits)
RX Skew tolerance up to 4000 bits
RX FEC lane monitoring: skew measurements (bits and ps) and lane mapping
FEC Error/Alarm injection per lane or all lanes
FEC Error/Alarm injection: Corrected FEC, Uncorrected FEC, Invalid Transcoded Block errors, LOAMPS alarm
FEC Aggregate Error Counters: UFEC, CFEC, Invalid Transcoded Block (count and rate)
FEC Lane Error Counters: CFEC (count and rate)
FEC Aggregate Alarm Counters: HiSER, LOA, LOAMPS, FEC Lane Swap (seconds), LOA event and LOAMPS event (count and rate)
FEC Lane Alarm Counters: LOAMP (secs), LOAMP events (count and rate)

100G/40G PCS Layer Testing

PCS lane mapping: default, manually defined, random or shift
PCS Skew generation per lane pair (0 to 16000 bits)
Configurable Skew alarm threshold
RX Skew tolerance up to 4000 bits
RX PCS lane monitoring: skew measurement (bits and ps) and lane mapping
PCS Error/Alarm injection per lane or all lanes
PCS Error injection (single, burst or rate): Invalid Sync Header, Invalid Alignment Marker, BIP error
PCS Alarm injection (continuous): Loss of Alignment Marker Lock, Loss of Block Lock, High BER
PCS Lane Error counters (aggregate and per lane): Invalid Sync Header, Invalid Alignment Marker, BIP error
PCS Lane Alarm: Loss of Alignment, Loss of block label, High-BER

Lane BERT

Per CAUI-4/XLAUI lane or optical lane unframed BERT
PRBS pattern: 2^{31}-1, 2^{23}-1, 2^{15}-1, 2^{7}-1
Error injection (single or burst) per lane or multiple lanes: Bit error
Alarm injection per optical lane or multiple optical lanes: Optical LOS
Per lane and aggregate Bit error count and rate and Pattern loss

Optical Power Measurement

Per wavelength TX and RX power measurements
CFP2 vendor's detailed register display: Vendor, part number, Serial number, standard compliance
Optical module status: Temperature, Voltage, Alarm status

Framed Ethernet Traffic Generation

Layer 2, Layer 3, and Layer 4 traffic
Test Frame Header
- IEEE 802.3 and Ethernet II (DIX) frames
- Configurable Source and Destination MAC and Ethernet Type
- VLAN stacking up to 3 VLAN tags w/configurable priority & type
- MPLS-TP label with configurable LSP, PW and CW fields
- Provider Backbone Bridge (PBB) support with configurable Backbone MAC Source & Destination, I-SID, PBB-VLAN ID and priority
- EoE (Ethernet over Ethernet) support with configurable EoE MAC Source and Destination, Ethernet Type, EoE VLAN ID and Priority, TTL and EID
- Fully configurable IPv4 or IPv6 header
- MPLS up to 3 labels with configurable Label/S/CoS and TTL

Frame generation in fixed, random, increment, decrement modes
- Frame sizes from 64 to 1518 bytes and jumbo frames up to 16000 bytes

MAC flooding feature generates test frames with up to 4096 incremental Source and/or Destination MAC addresses
Traffic Pattern: Constant, Ramp, Multi Bursts, Single Burst
Ethernet Error Injection: Bit, CRC, Pause, IP Checksum, runt (60 bytes)
FEC Error and Alarm Injection: Corrected FEC, Uncorrected FEC,

Invalid Transcoded Block errors, LOAMPS alarm
PCS Error Injection (per lane or multiple lanes): Invalid Sync Header, Invalid Alignment Marker, BIP error
Ethernet Alarm Injection: Local Fault, Remote Fault, Optical LOS
PCS Alarm Injection: Loss of Alignment Marker Lock, Loss of Block Lock, High BER

Key Measurements

Error Measurements: Bit/BER (BERT and single stream Throughput Test), CRC, PCS Errored Blocks, IP checksum, jabber frames, runt frames, Frame loss (count and %), OSS
Alarm Detection: LOS, Local and Remote Fault
FEC Aggregate Error Counters: UFEC, CFEC, Invalid Transcoded Block (count and rate)
FEC Lane Error Counters: CFEC (count and rate)
FEC Aggregate Alarm Counters: HiSER, LOA, LOAMPS, FEC Lane Swap (seconds), LOA event and LOAMPS event (count and rate)
FEC Lane Alarm Counters: LOAMP (secs), LOAMP events (count and rate)
PCS Alarms and Errors: Loss of Alignment, Loss of block label, High-BER, Invalid Sync Header, Invalid Alignment Marker, BIP error
Frame/Packet Statistics: Multicast, broadcast, unicast, pause frames, frame size distribution
Rates (min, max, average and current): frame rate, bandwidth utilization, frame rate, line rate, data rate
Delay (min, max, average and current): round trip delay, inter frame gap, jitter, one-way delay between remote devices with GPS synchronization

Multiple Streams Throughput Testing

Up to 32 independent traffic streams generation and analysis, with configurable filters on 40GE and 100GE interfaces
Up to 10 independent traffic streams generation and analysis, with configurable filters on 10GE interface
Up to 8 independent traffic streams generation and analysis, with configurable filters on 1GE interface
Each stream can be set with independent frame size, bandwidth, traffic profile, and QoS levels
MAC flooding feature: generates test frames with up to 4096 incrementing Source and/or Destination MAC addresses
Test Patterns: PRBS: 2^{31}-1, 2^{23}-1, 2^{15}-1, 2^{11}-1, normal and inverted patterns, All 0s, All 1s and User Defined
Error Measurements: Bit/BER (Single Stream only), FCS/CRC, Jabber/Runt frames, IP Checksum, TCP/UDP Checksum, Frame Loss (count and %), Out of Sequence
Alarm Detection

- 10GE: LOS, LOSync, Service disruption (current, total, last, min/max, # of occurrences), Local Fault, Remote Fault, PCS-HI-BER, PCS-LOBL, WAN SONET Alarms: LOF, AIS-L and RDI-L WAN SDH Alarms: LOF, MS-AIS, MS-RDI
- 1GE: LOS, LOSync, Service disruption (current, total, last, min/max, # of occurrences)

Frame/Packet Statistics

- Multicast, broadcast, unicast, pause frames, frame size distribution

Rates (min, max, average and current): frame rate, bandwidth utilization, frame rate, line rate, data rate

- Frame arrival time (min, max, average and current), Frame Delay Variation
- Round Trip delay or One-Way Delay OWD* (min, max, average and current) and Histogram distribution with configurable sampling period and threshold

RFC2544 Compliance Testing

Automated tests compliant with RFC2544 with configurable threshold values and maximum transmit bandwidth settings
Throughput, Latency, Jitter, Frame Loss, and Back-to-Back (burst) tests
Frame sizes: 64, 128, 256, 512, 1024, 1280, and 1518 bytes including 2 user configurable frames

Loopback Mode

Layer 2: all incoming traffic is looped back with MAC source and destination addresses swapped
Layer 3: all incoming traffic is looped back with MAC and IP source and destination addresses swapped
Layer 4: all incoming unicast traffic is looped back with the MAC, IP, and UDP/TCP ports swapped.

Loopback traffic filters with all MAC/VLAN/IP parameters configurable
All key measurements on received traffic provided on the loopback port

IP Test Suite

IP Configuration and validation (IPv4, IPv6, Static, DHCP, PPPoE)
MAC address (configurable or default)
Ping and trace-route tests (IP address or URL)
Network discovery/ARP wizard

IPv6

IPv6 compliant test traffic generation and analysis for all test applications (Y.1564 V-SAM, RFC2544, BERT and Multi-stream Throughput)
IPv6 Loopback capability
IPv6 Static or Stateless Auto Configuration and Ping function
Fibre Channel
Total Data Transfer time
FTP Throughput rates
Compatible with Linux and Windows FTP servers

**Requires GPS option*

Layer 4-7 Features

V-PERF Test

TCP Throughput Compliant with RFC6349
Stateful TCP Test at line rate
TCP Client and Server modes
Compatible with iPerf Client/Server
MTU search per RFC4821
Round Trip Time Measurement
Configurable TCP Window sizes
Multi-Window size tests
Measurements: TCP Throughput rate (min, max, average), Transfer file size and duration, Transfer time ratio, TCP Efficiency %, Buffer Delay %

V-TEST HTTP Test

HTTP Throughput
Full line rate
HTTP client mode
Connection time to server
Total Data Transfer time
HTTP Throughput rates
Requires VeTest Server

FTP Throughput Test

FTP Throughput
Full line rate
FTP client mode
Connection time to server
Total Data Transfer time
FTP Throughput rates
Compatible with Linux and Windows FTP servers

V-FTP and V-TEST Throughput Test

FTP Throughput (V-FTP) and V-TEST features provide additional Layer 4-7 testing. The V-FTP Throughput feature allows the user to test up to full line rate FTP protocol performance to any FTP Server by uploading and downloading files. The V-TEST feature qualifies network TCP/HTTP protocol performance by testing against a V-TEST HTTP server. Both features can test up to the full line rate depending on the server specifications and limitations. Connection time to the server, data transfer time, line rate throughput rates, and protocol (FTP and HTTP) throughput rates key metrics are reported during the tests.

In VeEX Managed mode, the customer's servers are added to a customer server list that is maintained and managed by VeEX for the end-user's ease of use and convenience. The full list of server IP addresses or URLs are provided to VeEX. Once added, all the user has to do is select the server from their company list and initiate the test to the selected server.

In User Managed mode, the user is allowed to enter the server IP/URL and save it to a server list that they can maintain and manage on their own.

Synchronous Network Features

Synchronization Messages Capture

Message capture and decode for SyncE ESMC/SSM and IEEE 1588v2 messages. Captures in pcap format for further analysis using built-in or external protocol analyzers.

Recovered Clocks

Master clock emulation: Offers recovered clock output (clock translation) for external analysis or to provide timing to other devices

Slave clock emulation: Offers recovered clock output (clock translation) for external analysis or to provide timing to other devices

Recovered Clock Output (Clock Translation)

- 1PPS, 2.048 Mbps, 2.048 MHz, 10 MHz, 25 MHz, 125 MHz

Reference Clock

Reference Clock (Master Emulation and Wander/Phase Measurements)

- Internal, GNSS 1PPS (Raw), Atomic 1PPS, Atomic 10 MHz
- External: 1PPS, 1.544 Mbps, 1.544 MHz, 2.048 Mbps, 2.048 MHz, 10 MHz, 25 MHz, 125 MHz

Clock Wander & Phase Measurements

This option compares two physical clock sources and measures TIE (wander) or Timing Error (absolute phase error) differences between the signal present at the RX1 (BNC) test port and the external reference connected to the CLK (SMA) port or the optional internal free-running or GNSS-disciplined Atomic clock. Reports current, minimum, maximum and average phase differences

- Phase Error vs. Time on-screen graph (monitor the last 600s)
- Wander Resolution: 0.2 ns
- Phase Error Resolution: 1 ns
- Phase Accuracy: ± 3.2 ns

Signals Under Test

- Frequency: 1.544, 2.048 and 10 MHz (sine or square)
- Data: 1544 and 2.048 Mbit/s
- Phase/Timing: 1PPS

Clock References

- Frequency: 1.544, 2.048, 10 MHz, internal Atomic 10 MHz
- Data: 1.544 and 2.048 Mbit/s
- Phase: External 1PPS, internal Atomic 1PPS and GNSS 1PPS

Recovered Clock Wander Measurements

These options measure the wander characteristics of the data clock recovered by the test set slave emulation, against an external reference connected to the CLK (SMA) port or the optional internal free-running or GNSS-disciplined Atomic clock.

Signals Under Test (recovered clock)

- T1, T3, E1, E3, STM-1o, OC-3
- SyncE Slave
- 1588 V2/PTP slave (raw clock)

Clock References

- Frequency: 1.544, 2.048, 10 MHz, internal Atomic 10 MHz
- Data: 1.544 and 2.048 Mbit/s
- Wander Resolution: 0.2 ns

Real-time Wander & Phase Data Logging

This option exports real-time TIE or Phase measurements to a USB memory for further post-processing using the built-in or PC-based MTIE & TDEV Wander Analysis applications.

Modes: E1, E3, DS1, DS3, STM-1o, OC-3, SyncE, IEEE 1588v2, external clock signals

Sampling rates: 1/s, 5/s, 10/s, and 30/s

Recording Time: Limited only by the size of the USB memory

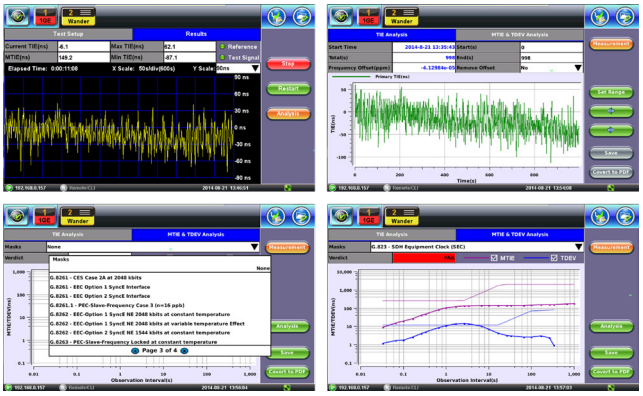
File formats

- VeEX's native TIE and Phase (TE)
- Open CSV TIE and Phase (TE)

Built-in MTIE/TDEV Wander Analysis

This option enables the test set to analyze up to three days' worth of wander measurement data and compare it against standard masks for a PASS/FAIL assessment, without the need for a PC. The analysis can be performed while the test is still running for run-time verification.

- Provides further post-processing of clock stability data, such as MTIE and TDEV
- Real-time or post analysis modes
- Frequency offset calculation and removal for relative TIE analysis
- Standard MTIE and TDEV masks
- MTIE and TDEV results and mask export to CSV
- Direct PDF report generation to USB



VeEX MTIE/TDEV Wander Analysis PC software

- Provides further post-processing of clock stability data, such as MTIE and TDEV for long-term tests
- Frequency offset calculation and removal for relative TIE analysis
- Partial offset calculation based on display range
- Standard and user-programmable masks
- PDF report generation
- Fully resizable window, to accommodate any screen size and provide detailed zoom levels
- Compact stand-alone Windows® software. It can be carried in the same USB memory as the TIE data. No installation is necessary
- Compatible with VeEX native and CSV formats

Precision Timing References

The test platform offers two internal, accurate and stable clock reference options:

- GNSS receiver
- Chip-scale Atomic Clock

They provide precise timing to test applications. These physical clocks can be used as a reference for frequency, phase and wander measurements, or other time sensitive tests like one-way-delay (symmetry) measurements.

Disciplining and holdover: Combining the long-term accuracy of the GNSS option, the stability of the Atomic clock option and its battery operation, this test platform can offer precision clock references even in places where satellite signals are not available or can't be trusted (e.g. in-building or urban canyon applications).

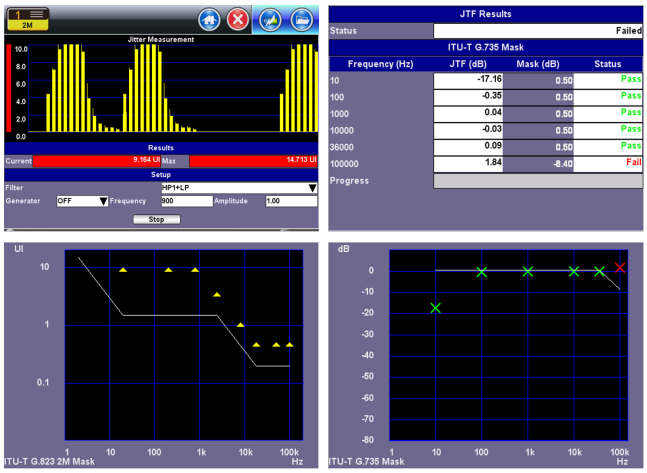
Jitter Measurement Options

Complete SDH/SONET and PDH/DSn Jitter Test Suite

- Jitter Measurements
- Jitter Generation
- Maximum Jitter Tolerance test
- Jitter Transfer Function test

Graphical and tabular results

Output jitter performance mandated by ITU-T 0.171/0.172 and Telcordia GR-499/253 standards is evaluated by measuring the recovered clock of the incoming signal (E1, E3, STM-1o and DS1, DS3, OC-3) traversing the network. In SDH/SONET networks there is a great potential for the accumulation of jitter to degrade network performance, thus it is imperative that components and the network as a whole be tested and screened regularly for jitter to ensure that optimum levels of quality can be maintained.



Jitter Measurements

HP1+LP (Wide-band Jitter) filter

- E1 (2M) 700 Hz to 100 kHz
- E1 (2M) 20 Hz to 100 kHz
- E3 (34M) 100 Hz to 800 kHz
- DS1 (1.5M) 10 Hz to 40 kHz
- DS3 (45M) 10 Hz to 400 kHz
- STM-1/OC-3 (155M Optical) 500 Hz to 1.3 MHz

HP2+LP (High-band Jitter) filter

- E1 (2M) 18 Hz to 100 kHz
- E3 (34M) 10 Hz to 800 kHz
- DS1 (1.5M) 18 Hz to 100 kHz
- DS3 (45M) 30 Hz to 400 kHz
- STM-1/OC-3 (155M Optical) 65 Hz to 1.3 MHz

Parameters: Current peak-peak, Maximum peak-peak
Color-coded Pass/Fail indication according to ITU-T limits
Standard Pass/Fail masks
Units: UI (Unit Interval)
Resolution: 0.01 UI
Accuracy: Per ITU-T O.171 and O.172
Graphical display of Jitter behavior over time
Test Duration: Continuous

Jitter Generation

Frequency: 10 Hz to 1.3 MHz (Wander: 1 Hz to 9 Hz)
Amplitude: 0.01 to 50 UIpp
Resolution: 1 Hz, 0.01 UI

Fibre Channel

Key Features

- SFP, SFP+ and/or SFP28 optical ports supporting 1.0625 Gbps, 2.125 Gbps, 4.25 Gbps, 8.5 Gbps, 10.52 Gbps, 14.025 Gbps and 28.05 Gbps
- Full line rate traffic generation and analysis
- Primitive Sequence Protocol support
- Flow control support with Buffer-to-Buffer credits
- FC-1 and FC-2 BERT and Throughput
- RFC2544: Throughput, Latency, Frame Loss, and Back-to-Back frames tests
- FC-2 Smart Loop mode
- Service Disruption Measurement
- FC-2 Frame Header configuration
- Test traffic shaping: constant, ramp, and burst
- Frame Length configuration up to 2148 bytes

Throughput and Bit Error Rate Test (BERT)

The Fibre Channel protocol specifies a maximum allowable Bit Error Rate (BER) of ≤ 1 x 10^{-12} that must be achieved. The test set allows the user to stress FC-1 and FC-2 network layers to ensure accurate benchmarking.

For FC-1, frequency fluctuations, transceiver noise and phase jumps are tested using CRPAT, CSPAT, and CJPAT patterns. Data dependency and behavior of network components are checked with PRBS patterns, sequence number tracking, and time stamping to calculate frame loss, round trip delay, and other performance metrics.

RFC2544 Benchmarking

Based on the Ethernet test methodology, the RFC2544 routine has been adapted to Fiber Channel circuits where flow-control and buffer verification is important. The feature checks throughput and round trip delay at various buffer sizes to verify optimal buffer size and best possible link performance.

Interfaces

Dual SFP28/SFP+/SFP

- 32GFC 28.050 Gbps
- 16GFC 14.025 Gbps
- 10GFC 10.519 Gbps
- 8GFC 8.500 Gbps
- 4GFC 4.250 Gbps
- 2GFC 2.125 Gbps
- 1GFC 1.062 Gbps

Optical Ports: LC connectors

Modes of Operation

Terminate, Loopback

Fibre Channel Topology

Point-to-Point

Primitive Sequence Protocols

Link initialization, link rest, link failure

Flow Control

Buffer-to-Buffer Credit Configuration: 1-65535

Traffic Generation

FC-1 (with SOF and EOF frame delimiters) and FC-2 Frames
Class 3 Service frames
Scrambling/Descrambling (8.5 Gbps only)
Configurable Header fields
Configurable EOF (EOF_t, EOF_n) and SOF (SOF_i3, SOF_n3, SOF_f)
Traffic Shaping: constant, ramp, burst
Frame Length Configuration: 2148 bytes maximum

RFC2544 Compliance Testing

Automated tests compliant with RFC2544 with configurable threshold values for Throughput and Round Trip Delay (Latency) and maximum transmit bandwidth settings
Throughput, Latency, Frame Loss, and Back-to-Back (burst) tests
Frame sizes: 64, 128, 256, 512, 1024, 1280, and 2000 bytes including 2 user configurable frames

Bit Error Rate Testing

NCITS-TR-25-1999 Patterns (FC-1): CRPAT, CSPAT, CJPAT
PRBS Patterns (FC-2): 2^{31}-1, 2^{23}-1, 2^{15}-1, 2^{11}-1, normal and inverted selections, and user defined patterns
Error Injection: Bit and CRC

Loopback Mode

FC-1
FC-2 (Layer 2): swaps the destination and source IDs (D-ID and S_ID)

Key Measurements

Optical power levels: transmit and receive optical levels in dBm
Error Measurements: Bit error count, BER, symbol, FCS/CRC, oversize, undersize, frame loss (count and %), out of sequence frame count
Alarm Detection: LOS, pattern loss, service disruption
Traffic Statistics: bandwidth utilization, data rate, frame count, byte count, frame size distribution, buffer-to-buffer credit count, RR_RDY count, frame loss count and round trip delay
Rates: line rate, framed rate, data rate, frames per second rate
Delay (min, max, avg, current): round trip delay, frame arrival delay

OTN Testing

The RXT-6200 Module offers full range of OTN testing capabilities for all standard OTN interfaces, including service-activation (Bringing-into-Service), performance verification, maintenance, and troubleshooting. It offers Multi-Layer testing from Physical layer (WDM), CAUI-4/XLAUI, OTL, OTUk/ODUk, to bulk payloads, and Ethernet traffic generation up to 100% rate.

OTN Functions

Test Interfaces

MSA compliant transceiver interfaces

CFP4, QSFP28 Interface bit rates

- OTU4 111.810 Gbps

QSFP+

- OTU3 43.108 Gbps

SFP/SFP+/ SFP28

- OTU2e 11.095 Gbps
- OTU1e 11.045 Gbps
- OTU2 10.709 Gbps
- OTU1 2.666 Gbps

Key Featuress

- Advanced Mapping/Multiplex Structures
- EoOTN testing with internally generated Ethernet payload mapped into OTU1e, OTU2e, OTU3 (up to 40 Gbps) or OTU4 (up to 100 Gbps)
- Up to two simultaneous and independent OTU4 tests, with 100G payloads at 100% throughput
- Internally generated SDH/SONET payloads
- OTU, ODU, OPU overhead manipulation and monitoring
- OTU, ODU, OPU layer alarms/errors generation and analysis
- OTU, ODU, TCMi trace messages
- Service Disruption monitoring
- Forward error correction (FEC)
- Tandem Connection Monitoring
- Frequency offset generation and measurement

Operating Modes

Normal (terminal)

- The instrument terminates the line, serving as source and sink for the generated traffic
- Offers full access to Overhead and Payload alarms and error generation and monitoring

Payload Through

- Instrument retransmits the received Payload and allows access to Overhead manipulation
- Offers full access to Overhead alarms and error generation as well as Payload monitoring

Line Through

- Instrument regenerates and retransmits the entire received signal
- Offers minimal interaction with the test signal
- Provides full access to Overhead and Payload alarms and error monitoring

OTN Mappings

Standards: ITU-T G.709, ITU-T G.798, ITU-T G.872

Mapping Procedures: AMP, BMP and GMP

Direct OTN Mapping Options

Single-step (direct) mapping options

- OTU4-ODU4-Bulk
- OTU4-ODU4-100GE
- OTU3-ODU3-Bulk
- OTU3-ODU3-STM256/OC768
- OTU3-ODU3-40GE
- OTU2e-ODU2e-Bulk
- OTU2e-ODU2e-10GE
- OTU1e-ODU1e-Bulk
- OTU1e-ODU1e-10GE
- OTU2-ODU2-Bulk
- OTU2-ODU2-STM64/OC192
- OTU1-ODU1-Bulk
- OTU1-ODU1-STM16/OC48

Test Setup

Test configuration, menus, and results are presented in VeEX's intuitive GUI, requiring little or no training for new or existing VePAL™ users, maintaining a consistent user experience from the lab to the field.

Layer-based graphical configuration interface allows users to build the test signal in a logical layer by layer sequence

- OTL Lanes
- OTN Signal
- ODUk (Mapping and Multiplexing)
- Payload (Bulk/PRBS, SDH/SONET or Ethernet)
- Test Pattern (CBR) or Traffic (Packets)

OTL Layer

OTL4.10 (OTU4)

OTL3.4 (OTU3)

TX Lane Mapping and Skew Generation

- Lane ID, Lane #, and Channel assignments

Lane Mappings

- Default (1 to 1)
- Random assignment
- Lane ID Shift

Skew Settings

- Skew Range: 0 to 64000 bits
- Adjustable Increment/Decrement steps (0 to 200 bits)
- Increase and Decrease control buttons and direct keypad entry
- Alarm Threshold (1 to 4000 bits)
- Enable/Disable RX MFAS Deskew

Per-Lane Alarm and Error Monitoring

- Alarms: OTL-LOL, OTL-OOL, OTL-LOF, OTL-OOF, OTL-LOR, OTL-OOR, OTL-OOLLM, OTL-OOMFAS, High Skew
- Errors: OTL-LLM, OTL-MFAS, OTL-FAS
- Soft LED overview and individual event counters
- Per-lane Skew measurements in bits and picoseconds
- Independent OTL events log with time stamp

OTU Layer

Alarm and Error Monitoring

- Alarms: LOM, OOM, SM-IAE, SM-BDI, SM-BIAE, SM-TIM
- Errors: MFAS, SM-BIP, SM-BEI, Correctable FEC, Uncorrectable FEC

ODU Layer

Alarm and Error Monitoring

- Alarms: AIS, OCI, LCK, PM-BDI, PM-TIM
- Errors: FAS, MFAS, PM-BIP, PM-BEI

OPU Layer

Payload Type (PT): Generates and displays received PT value
Expected Payload label setting
Enable/Disable PLM monitoring
Alarm and Error Monitoring

- Alarms: PLM, LO-OMFI, OO-OMFI
- Errors: OMFI (ODTU4.M)

GMP Stuffing

TX Settings

- Extended Offset support (Enable/Disable)
- Effective Cm Value

TX Values

- Nominal Cm Value, Nominal Bit Rate (kbps), Effective Bit Rate (kbps), Offset (ppm)

Alarm and Error Monitoring

- Alarms: GMP Loss of Sync, GMP Cm=0; in seconds
- Errors: CRC-5, CRC-8; count and ratio

RX Statistics

- Effective Cm Value, Minimum Cm Value, Maximum Cm Value
- Nominal Bit Rate (kbps), Effective Bit Rate (kbps), Offset (ppm)
- No Change, Single Increments, Double Increments, Single Decrements, Double Decrements, New Values

AMP Stuffing

TX Settings

- Offset (ppm)
- Stuffing Method: +1/0/-1 (PJO2 not used), +2/0/-1 (PJO2 used)

RX Statistics

- Offset (ppm)
- Positive, Double Positive, Negative, Total

BER Test (Alarm and Error Monitoring)

- Alarms: LOP (Loss of Pattern)
- Errors: Bit (Test Sequence Error)

Test Patterns

Test sequence availability depends on selected data rate and/or test mode

- PRBS: 2^{31}-1 , 2^{23}-1, 2^{20}-1, 2^{15}-1, 2^{11}-1, 2^{9}-1, 2^{7}-1
- Legacy and Fixed: QRSS, NET55, OCT55, DALY, All 1, All 0, 1010, 1100, 1in8, 2in8, 3in24, user-defined 24-bit and 10 x 32-bit
- Normal or Inverted

Error Insertion

OTL Layer

- FAS, MFAS, LLM
- Affected Lanes: Single or Multiple
- Modes: Single, Single Burst, Rate

OTU/ODU/OPU

- MFAS, SM-BIP, SM-BEI, Correctable FEC, Uncorrectable FEC, ODU-FAS, ODU-MFAS, PM-BIP, PM-BEI, TCMi-BIP, TCMi-BEI, GMP CRC-5, GMP CRC-8, OMFI (ODTU.M)
- Modes: Single, Single Burst, Fixed Rate or Custom Rate

Payload

- Bit (Test Sequence Error)
- Modes: Single, Single Burst, Rate

Alarm Generation

Physical Layer

- LOS
- Affected Optical Lanes: Single or Multiple
- Modes: Continuous (manual)

OTL Layer

- LOF, OOF, OOLLM, OOMFAS
- Affected Lanes: Single or Multiple
- Modes: Continuous (manual), Single Burst (# of ON frames), Continuous Burst (# of ON frames and # of OFF frames)

OTU/ODU/OPU

- OTU-LOM, OTU-OOM, SM-IAE, SM-BDI, SM-BIAE, SM-TIM, ODU-AIS, ODU-OCI, ODU-LCK, ODU-LOF, ODU-OOF, PM-BDI, PM-TIM, TCMi-AIS, TCMi-OCI, TCMi-LCK, TCMi-BDI, TCMi-TIM, TCMi-BIAE, TCMi-LTC, OPU-PLM, GMP LO-Sync, GMP Cm=0
- ODTU4.M: LO-OMFI, OO-OMFI
- Modes: Continuous (manual), Single Burst (# of ON frames), Continuous Burst (# of ON frames and # of OFF frames)

OTN Overhead Analysis and Generation

Multi-stage support: Provides access to OTU and ODUk overheads for all the layers present in complex mapping/multiplex structures

- OTU4, ODU4, ODUk, OPUk
- OTU3, ODU3, ODUk, OPUk
- OTU2, ODU2, ODUk, OPUk
- OTU1, ODU1, OPUk

Analysis – Decode and Display

Multiframe selection modes

- Display bytes can be locked to specific multi-fame (0 to 255)
- Free running

Byte Decoding

- On-screen Decode of all bytes and strings
- Byte Capture (raw data): 256 bytes (Hex)

ODUk bytes in hexadecimal, binary or ASCII formats

- SM-TTI (SAPI, DAPI, User), SM-BIP, SM-BEI (BEI/BIAE, BDI, IAE)
- PM-TTI (SAPI, DAPI, User), PM-BIP, PM-BEI (BEI/BIAE, BDI, IAE)
- TC, TCMi-TTI (SAPI, DAPI, User), TCMi-BIP, TCMi-BEI (BEI/BIAE, BDI, IAE)
- GCC0, CCC1, GCC2 bytes
- PCC/APS bytes
- FTFL bytes (forward and backward faults)
- Reserved bytes

OPUk bytes in hexadecimal and binary formats

- JC1, JC2, JC3, JC4, JC5, JC6, PSI, NJO/OMFI

Generation - Programmable Bytes and sequences

OTU and ODU Trace Generation

- SAPI (15 characters)
- DAPI (15 characters)
- User (31 characters)

TCMi Trace Generation

- SAPI (15 characters)
- DAPI (15 characters)
- User (31 characters)

Set TCMi Status

- No source TC, In use without IAE, In use with IAE, Reserved, ODUk-LCK, ODUk-OCI, ODUk-AIS
- Enable/Disable TC monitoring

OTU/ODU Trace Analysis and Generation
- Programmable Transmit and Expected OTU and ODUk Traces
- OTU and ODU SAPI, DAPI, and User
- Enable/Disable OTU/ODU TIM monitoring

GCC Channel BERT
- BER test on GCC0, GCC1 and GCC2 with PRBS
- Rount Trip Delay measurement

Tandem Connection Monitoring (TCM)

TCMi Monitoring (1 through 6)
- Alarms: AIS, OCI, LCK, BDI, BIAE, LTC, TIM
- Errors: BIP, BEI

Trace Identifier Monitoring and Generation
- Programmable Transmit and Expected SAPI, DAPI and User traces
- Copy trace from RX
- Enable/Disable TIM monitoring

Ethernet over OTN Testing

Internally generated Ethernet Payloads into ODU4, ODU3, ODU2e, ODU1e, ODU0
- Layer 2
- Layer 3 (IPv4 and IPv6)
- VLAN: Up to 3 tags
- MPLS: Up to 3 tags

Ethernet Testing
- BERT
- Throughput

Traffic Flows
- Programmable test bandwidth up to 100%
- Constant Bandwidth
- Ramp (Start BW, Stop BW, BW steps, Ramp time, Repetitions)
- Burst (Two traffic levels - Burst 1 BW, Burst 2 BW, Burst 1 time, Bust 2 time)
- Single Burst (1 to 10000 frames)
- Unless otherwise specified, traffic (BW) values can be entered in % of line rate, # of IPG Bytes, Frames per Second, and Mbit/s

Test Patterns (payload)
- PRBS: 2^{31}-1, 2^{23}-1, 2^{20}-1, 2^{15}-1, 2^{9}-1
- Normal, Inverted OR Live traffic

Test Traffic RX Filter
- MAC Source, MAC Destination, Frame Type, DSCP, Protocol Type, IP Source, IP Destination

Events Log

Date and time stamped record of all events occurred during a test, presented in tabular format

Includes event name, time, duration and count/severity

Individual event logs for OTL, OTN, BERT and Ethernet

Soft LED Indicators

Fixed OTN indicators for Signal, Framing, Pattern and Errors/Alarms

Expanded, layer by layer, detailed status summary

Display historical events and conditions

History reset function
- Clears the LED reminder without affecting the measurement counters

**Refer to the Ethernet Testing section for more details on Ethernet test results.*

SDH/SONET Testing

SDH/SONET signals can be used as physical layer or as OTU1/OTU2/OTU3/OTU4 payloads, and can contain multiplexed SDH/SONET or PDH/DSn clients, providing all the flexibility to address complex test scenarios.

Test Interfaces

SFP/SFP+/SFP28
- STM-64/OC-192 9.953 Gbps
- STM-16/OC-48 2.448 Gbps
- STM-4/OC-12 622 Mbps
- STM-1/OC-3 155 Mbps
- STM-0/OC-1 52 Mbps

BNC (with PDH/DSn hardware option)
- STM-1e/STS-3 155 Mbps
- STM-0e/STS-1 52 Mbps

Key Features

- Bulk VC/STS/VT, PDH/DSn and multiplexed payloads
- Overhead manipulation and monitoring
- Alarms/errors generation and analysis
- Round Trip Delay
- Tributary Scan
- Tandem Connection Monitoring
- Pointer Test Sequences

Operating Modes

Normal (terminal)
- The instrument terminates the line, serving as source and sink for the generated traffic
- Offers full access to Overhead and Payload alarms and error generation and monitoring

Payload Through (intrusive)
- Instrument retransmits the received Payload and allows access to Overhead manipulation
- Offers access to Overhead alarms and error generation as well as Payload monitoring

Line Through (Transparent)
- Instrument regenerates and retransmits the entire received signal
- Offers minimal interaction with the test signal
- Provides full access to Overhead and Payload alarms and error monitoring

SDH Mappings

(According to ITU-T G.707)
- C-11 (Bulk/PRBS, unframed or framed DS1)
- C-12 (Bulk/PRBS, unframed or framed E1)
- C-3 (Bulk/PRBS, unframed, framed or channelized E3 or DS3) via AU-3 or AU-4
- C-4 (Bulk/PRBS, unframed or framed E4)
- C-4-4c (Bulk/PRBS)
- C-4-16c (Bulk/PRBS)

SONET Mappings

(According to Telcordia GR-253/ANSI T1.105)

- VT-2 (unstructured or framed E1)
- VT-1.5 (unstructured or framed DS1)
- STS-1 SPE (unstructured or framed E3 or DS3)
- STS-3c SPE (unstructured or framed E4)
- STS-12c SPE (Bulk)
- STS-48c SPE (Bulk)
- STS-192c SPE (Bulk)

Test Patterns

The following test patterns can be generated

- PRBS: 2^{31}-1 , 2^{23}-1, 2^{20}-1, 2^{15}-1, 2^{11}-1 , 2^{9}-1, 2^{7}-1, QRSS
- Fixed: 0000, 1111, 1010, 1100, 1in8, 2in8, 3in24, DALY, NET55 and OCT55
- User defined: Ten 32-bit and one 24-Bit Programmable sequences
- Mode: Normal or Inverted

Errors

Insertion

- SDH: FAS, B1, B2, MS-REI, B3, HP-REI, LP-REI, LP-BIP, and bit errors
- SONET: FAS, B1, B2, REI-L, B3, REI-P, REI-V, BIP-V, and bit errors
- Modes: Single, Count (# of errors), Fixed Rates (1E-9 to 1E-3)

Detection

- SDH: FAS, B1, B2, MS-REI, B3, HP-REI, LP-BIP, LP-REI, slips and bit errors
- SONET: FAS, B1, B2, REI-L, B3, REI-P, REI-V, BIP-V, slips and bit errors

Alarms

Generation

- SDH: LOS, LOF, MS-AIS, MS-RDI, RS-TIM, AU-LOP, AU-AIS, HPUNEQ, HP-PLM, HP-RDI, HP-TIM, TU-LOM, TU-LOP, TU-AIS, LPUNEQ, LP-PLM, LP-RDI, LP-RFI, LP-TIM, 2M AIS, 2M LOF, 2M RDI
- SONET: LOS, LOF, AIS-S, RDI-S, TIM-P, LOP-P, AIS-P, UNEQ-P, PLM-P, RDI-P, LOM-V, LOP-V, AIS-V, UNEQ-V, PLM-V, RDI-V, RFI-V, TIM-V, DS1-AIS, DS1-LOF, 2M-AIS, 2M-LOF, 2M-RDI, 45M-AIS, 45M-LOF
- Modes: Continuous (manual), Count (0.1, 1, 10, 100 seconds)

Monitoring and Detection

- SDH: LOS, LOF, OOF, RS-TIM, MS-AIS, MS-RDI, AU-AIS, AU-LOP, HP-UNEQ, HP-PLM, HP-TIM, HP-RDI, TU-LOM, TU-AIS, TU-LOP, LP-UNEQ, LP-PLM, LP-TIM, LP-RDI, LP-RFI
- SONET: LOS, LOF, OOF, AIS-S, RDI-S, TIM-P, LOP-P, AIS-P,
- UNEQ-P, PLM-P, RDI-P, LOM-V, LOP-V, AIS-V, UNEQ-V, PLM-V, RDI-V, RFI-V, TIM-V

Other Tests

- Service Disruption Testing (SDT) with events log and concurrent with BERT
- Round Trip Delay (RTD)
- APS Signaling Monitor and Decode (K1, K2)

SDH Overhead Analysis and Generation

Network Architectures supported

- Linear (per ITU-T G.783)
- Ring (per ITU-T G.841)

Analysis – Decode and Display SOH/POH bytes in hexadecimal, binary or ASCII formats

- S1 synchronization status
- C2 HP/STS signal label
- J0 trace identifier (1, 16 or 64 bytes) in ASCII format
- J1 trace identifier (16 or 64 bytes) in ASCII format
- J2 trace identifier (16 or 64 bytes) in ASCII format
- K1, K2 APS Control
- V5 LP/VT signal label

Generation - Programmable Bytes RSOH/Section

- J0 trace: 1 byte hexadecimal, 16 byte ASCII with CRC-7 and 64 byte with CR+LF

MSOH/Line

- K1, K2 APS bytes per ITU-T G.783 and G.841
- S1 synchronization status message

HO-POH (VC-4, VC-3)/STS-POH (STS-N SPE, STS-1 SPE)

- J1 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- C2 signal label
- H4 Sequence/Multiframe Indicator
- G1 (bit 5): End-to-end path status (RDI generation)
- K3 (bits 1-4) APS signaling

LO-POH (VC-3)/STS-POH (STS-1 SPE)

- J1 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- C2 signal label
- G1 (bit 5): End-to-end path status (RDI generation)
- K3 (bits 1-4) APS signaling

LO-POH (VC-12, VC-11)/VT-POH (VT-1.5, VT-2)

- V5 (bits 5-7) LP/VT signal label
- J2 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- K4 (bits 3-4) LP/VT APS signaling

SONET Overhead Analysis and Generation

Network Architectures supported

- Linear (per ITU-T G.783)
- Ring (per ITU-T G.841)

Analysis – Decode and Display

SOH/POH bytes in hexadecimal, binary or ASCII formats

- S1 synchronization status
- C2 STS path signal label
- J0 trace identifier (1, 16 or 64) in ASCII format
- J1 trace identifier (16 or 64 bytes) in ASCII format
- J2 trace identifier (16 or 64 bytes) in ASCII format
- K1, K2 APS Control

Generation - Programmable Bytes

Section Overhead

- J0 trace: 1 byte hexadecimal, 16 byte ASCII with CRC-7 and 64 byte with CR+LF

Line Overhead

- K1, K2 APS bytes per ITU-T G.783 and G.841
- S1 synchronization status message

STS-POH (STS-N SPE, STS-1 SPE)

- J1 trace: 16-byte ASCII with CRC-7 or 64-byte ASCII sequences
- C2 signal label
- G1 (bit 5): End-to-end path status (RDI generation)
- K3 (bits 1-4) APS signaling

STS-POH (STS-1 SPE)
- J1 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- C2 signal label
- G1 (bit 5): End-to-end path status (RDI generation)
- K3 (bits 1-4) APS signaling

Tributary Scan
Automatically scans all VC-12, VC-11, VT-1.5 or VT-2 and reports alarms, errors, J2 trace and payload label

Pointer Analysis and G.783 Test Sequences
Pointer movements monitoring and generation for SDH and SONET

Monitor
- AU, TU, STS and VT pointer adjustments
- SS bits, LOP, New Data Flags (NDF)
- Current value, increments, decrements, sum, difference
- Tributary frequency offset (ppm of AU/TU or STS/VT)

Generation
- Pointer sequences: ITU-T G.783, Telcordia GR-253
- Pointer Types: AU, TU, STS, VT
- Single pointer, increment, decrement, or increment/decrement
- Sequence: Basic, Single Alternating, Regular Additive, Regular Cancel, Double Alternating, Burst, Transient Burst, 87/3, 87/3 Additive, 87/3 Cancel, Periodic Additive, Periodic Cancel
- Programming of SS bits
- Adjustments: Increment, Decrement, New Value
- Parameters: N, T1, T2, T3, T4

Tandem Connection Monitoring (TCM)
Generation and analysis of N1 (HP-TCM) and N2 (LP-TCM) bytes

Detection, display and analysis of events
- UNEQ, TC-AIS, TC-ODI, TC-IEC, TC-REI, TC-OEI, TC-LTC, TC-RDI

Common Functions & Measurements

Auto Configuration
Available for SDH and SONET signals

Identification of received signal - instrument configuration based on network type, bit rate, line coding, framing, mapping, and test pattern

Signal Level and Frequency Measurement
Available for Optical Interfaces

Signal level
- Optical power in dBm and Loss/Saturation graph

Frequency (Line and Payloads)
- Resolution: 1 bit/s (bps)

Frequency Offset
- Resolution: 0.1 ppm
- Current, Minimum and Maximum

Round Trip Delay
(Available for all interfaces & mappings)

Measurement Range: 1 µs to 10 seconds

Resolution: ±1 µs or 1 U.I.

Event Logging
Date and time stamped records of all error and alarm events occurred during a test, presented in tabular format

Histograms
(Available for OTU2, OTU1, SDH/SONET and PDH/DSn interfaces)

Histogram: Simultaneous display of Errors and Alarms versus time for sequence of events correlation

Bar Graph: Individual Error or Alarm severity versus time

Resolution: Seconds, minutes, hours and days

PDH/DSn Testing

The optional PDH and DSn (T-carrier) rates and features support legacy physical interfaces or internally-generated payloads within SDH/SONET/OTN. Their availability depends on configuration, multiplexing and/or mapings being used.

PDH/DSn Interfaces
Requires factory-installed SDH/PDH electrical interfaces module

Electrical

RJ-48 (120Ω) balanced
- Bantam (100Ω) planned*
- DS1, 1.544 Mbps, AMI & B8ZS, 100Ω balanced
- E1, 2.048 Mbps, HDB3 & AMI, 120Ω balanced
- G.703 Codirectional, 64 Kbps, 120Ω balanced

BNC (75Ω unbalanced)
- E1, 2.048 Mbps, HDB3 & AMI
- E3, 34.368 Mbps, HDB3
- DS3, 44.736 Mbps, B3ZS
- E4, 139.264 Mbps, CMI

Compliant to ITU-T G.703, G.823, G.824, G.772 and ANSI T1.102

Receiver Sensitivity

1.544 Mbps (DS1)
- Terminate: ≤ 26 dB (cable loss only) at 0 dB DSX TX
- Monitor (PMP): ≤ 26 dB (20 dB resistive, 6 dB cable loss)
- Bridge: ≤ 6 dB (cable loss only)
- Line Equalizer function provides increased dynamic range to support for LBO < -7.5 dB

2.048 Mbps (E1)
- Terminate: ≤ 6 dB (cable loss only)
- Monitor (PMP): ≤ 26 dB (20 dB resistive, 6 dB cable loss)
- Bridge: ≤ 6 dB (cable loss only)
- Line Equalizer function provides increased dynamic range to support for LBO < -7.5 dB

34.368 Mbps (E3)
- Terminate: ≤ 12 dB (cable loss only)
- Monitor (PMP): ≤ 26 dB (20 dB resistive, 6 dB cable loss)

44.736 Mbps (DS3)
- Terminate: ≤ 10 dB (cable loss only)
- Monitor (PMP): ≤ 26 dB (20 dB resistive, 6 dB cable loss)

139.264 Mbps (E4)
- Terminate: ≤ 12 dB (coaxial cable loss only)

Operating Modes
Terminate, Monitor, Bridge (E1 & DS1)

Signal Structure
1.544 Mbps (DS1)
- Unframed or Framed SF (D4), ESF per ANSI/Telcordia standards
- Fractional test signal in N x 64 kbps or N x 56 kbps, where N=1 to 24

2.048 Mbps (E1)
- Unframed or Framed with/without CRC per ITU-T G.704 (PCM30, PCM30C, PCM31, PCM31C)
- Fractional test signal in N x 64 kbps, where N=1 to 30/31

8.448 Mbps (E2)
- Unframed or Framed according to ITU-T G.742

34.368 Mbps (E3)
- Unframed or Framed according to ITU-T G.751

44.736 Mbps (DS3)
- Unframed or Framed M13 & C-Bit Parity per ITU-T G.752/G.704

139.264 Mbps (E4)
- Unframed or Framed per ITU-T G.751

Test Patterns

The following test patterns can be generated
- PRBS: 2^{31}-1 , 2^{23}-1, 2^{20}-1, 2^{15}-1, 2^{11}-1 , 2^{9}-1, 2^{7}-1, QRSS
- Fixed: 0000, 1111, 1010, 1100, 1in8, 2in8, 3in24, DALY, NET55 and OCT55
- User defined: Ten 32-bit and one 24-Bit Programmable sequences
- Mode: Normal or Inverted

Errors

Insertion
- 1.544 Mbps (DS1): Code, FAS, Bit, Frame, CRC
- 2.048 Mbps (E1): Code, FAS, CRC, EBIT, Bit errors
- 8.448 Mbps (E2): Code, 8M FAS, 2M FAS, 2M CRC, 2M RDI, Bit errors
- 34.368 Mbps (E3): Code, 34M FAS, 8M FAS, 2M FAS, 2M CRC, 2M RDI, Bit errors
- 44.736 Mbps (DS3): Code, FAS, MFAS, P/C-Parity, Bit errors
- 139.264 Mbps (E4): Code, FAS, Bit errors
- Modes: Single, Count (# of errors), Fixed Rates (1E-9 to 1E-3)

Measurement
- 1.544 Mbps (DS1): Code, FAS, Bit, Frame, CRC
- 2.048 Mbps (E1): Code, FAS, CRC, EBIT and Bit errors
- 8.448 Mbps (E2): Code, FAS, Bit errors
- 34.368 Mbps (E3): Code, FAS, Bit errors
- 44.736 Mbps (DS3): Code, FAS, MFAS, P/C-Parity, Bit errors
- 139.264 Mbps (E4): FAS

Alarms

Generation
- 1.544 Mbps (DS1): AIS, yellow, idle, LOS, LOF
- 2.048 Mbps (E1): LOS, AIS, LOF, RDI
- 8.448 Mbps (E2): 8M AIS, 8M LOF, 8M RDI, 2M AIS, 2M LOF, 2M RDI
- 34.368 Mbps (E3): 34M LOS, 34M AIS, 34M LOF, 34M RDI, 8M AIS, 8M LOF, 8M RDI, 2M AIS, 2M LOF, 2M RDI
- 44.736 Mbps (DS3): LOS, LOF, OOF, AIS, Parity
- 139.264 Mbps (E4): LOS, AIS, LOF, RDI

Measurement
- 1.544 Mbps (DS1): AIS, yellow, idle, LOS, LOF, LSS
- 2.048 Mbps (E1): LOS, AIS, LOF, LOMF, RDI, and LSS
- 8.448 Mbps (E2): LOS, AIS, LOF, RDI, and LSS
- 34.368 Mbps (E3): LOS, AIS, LOF, RDI, and LSS
- 44.736 Mbps (DS3): LOS, LOF, OOF, AIS, Parity, LSS
- 139.264 Mbps (E4): LOS, AIS, LOF, RDI
- Modes: Continuous (manual), Count (0.1, 1, 10, 100 seconds)

Measurement Functions

Test Results

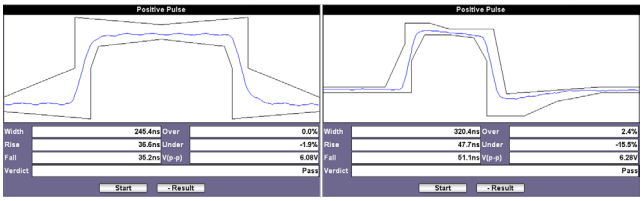
Error count, ES, %ES, SES, %SES, UAS, %UAS, EFS, %EFS, AS, %AS, and rate for all events: errors, alarms and pointer events

Performance Analysis

Measurements according to:
- ITU-T G.821: ES, EFS, SES and UAS with HRP 1% to 100%
- ITU-T G.826: EB, BBE, ES, EFS, SES, UAS; HRP of 1% to 100%
- In Service Measurement (ISM) using B1, B2, B3, FAS, CRC or Code (E1)
- Out of Service measurement (OOS) using bit errors (Test Sequence Error)
- ITU-T G.828: ES, EFS, SES, BBE, SEP, UAS with HRP 1% to 100%
- ITU-T G.829: ES, EFS, SES, BBE, UAS on RSOH (B1), MSOH (B2) or TSE
- ITU-T M.2100: ES, EFS, SES, UAS with HRP 1% to 100%
- User defined thresholds for Maintenance (MTCE) and Bringing into Service (BIS) objectives
- ITU-T M.2101: ES, EFS, SES, BBE, SEP, UAS with HRP 1% to 100%
- User defined thresholds for Maintenance (MTCE and Bringing into Service (BIS) objectives. In service measurements on both near and far ends of path using TSE, HP-BIP/P-BIP (B3), MS-BIP/L-BIP (B2), RS-BIP/S-BIP (B1) and LP-BIP/V-BIP (V5)

Pulse Mask Analysis

PDH/DSn signals may fail pulse shape requirements due to interference, excessive cable length, improper impedance, open cable branches or poor transmitter characteristics. In such cases, G.703 Pulse Mask compliance verification is very useful in diagnosing related physical layer problems.



PDH
- Bit rates: 2.048 Mbps (E1) and 34.368 Mbps (E3)
- Conformance Mask: ITU-T G.703

DSn
- Bit rates: 1.544 Mbps (DS1) and 44.736 Mbps (DS3)
- Conformance Masks: ITU-T G.703, ANSI T1.102, T1.403, T1.404

Mode: Non-Intrusive

Display: Pulse shape graph with Conformance mask verification (Pass/Fail)

Parameters: Width, Rise/Fall time, Overshoot/Undershoot

E1/DS1 VF Measurements Option*

The Voice Frequency (VF) option is a basic diagnostic tool to install, verify and troubleshoot voice circuits. Digital to analog conversion tests are performed by inserting/measuring tones with user defined frequency and level on selected sub-rate channels.

Codec: µ-Law or A-Law
Programmable ABCD
- Manual edit AB, ABCD or ON-HOOK, OFF-HOOK, WINK for DS1, and IDLE, SEIZE for E1

Independent Time Slot channel selection for TX and RX
- E1 channel: 1 -15, 17-31, 1 to 31
- DS1 channel: 1 to 24

Tone Generation and Measurement
- Transmit Frequency: 50 to 3950 Hz
- Transmit Level: -60 to 3 dBm

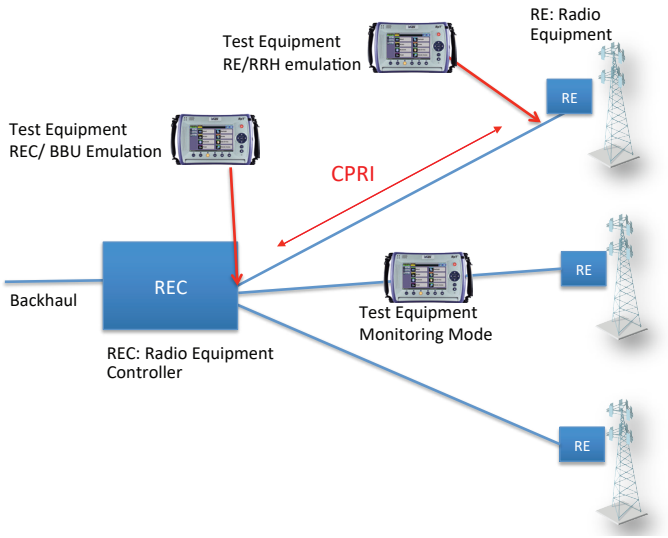
Results
- AB/ABCD bits monitor
- View Received Data in selected T/S
- Measure signal frequency and level in selected timeslot

CPRI Testing

Traditional deployment of the base station functions are co-located with the radio tower at the base of the antenna or basement of a tall building.

The Common Public Radio Interface (CPRI) protocols introduce a centralized model where one REC (Radio Equipment Controller) can manage many REs (Radio Equipment). The REC can be physically located far from radio towers in a centralized indoor and temperature controlled location. The CPRI/OBSAI optical link between REC and RE allows long distances without loss.

Simplified RE function makes field elements more compact, easier to install, and therefore increases the number of possible sites. Further Capex and Opex improvements are possible by having one REC manage many towers, and increased deployment flexibility to add new cell sites.



CPRI Layer 2 testing includes REC or RE emulation, BER traffic generation, control words decode and frame capture capabilities to troubleshoot interoperability, transport or RF performance issues.

Latency Measurement

Highly accurate latency measurements ensures that CPRI traffic between controller and the radio equipment stays below standard specifications.

CPRI Rates

- CPRI 10 24.3302 Gbps
- CPRI 9 12.1651 Gbps
- CPRI 8 10.137 Gbps
- CPRI 7 9.8304 Gbps
- CPRI 7A 8.110 Gbps
- CPRI 6 6.144 Gbps
- CPRI 5 4.9152 Gbps
- CPRI 4 3.072 Gbps
- CPRI 3 2.4576 Gbps
- CPRI 2 1.2288 Gbps
- CPRI 1 614.4 Mbps

CPRI Layer 2

Dual port operation
REC/BBU Emulation and RE/RRH Emulation
Error Injection: Bit, Code Violation
Alarm Injection: LOS, LOF, SDI, RAI, RLOS, RLOF
Error measurements: Bit, BER, CV, CV Rate, Pattern Loss
Alarms detection: LOS, LOF, HLOF, HLOF, BLOF,SDI, RAI, RLOS, RLOF
Latency measurement
Service Disruption Test
Frequency and Offset (current, min, max)
TX/RX Hyperframes and NodeB Frames counters
Configurable HDLC and Ethernet C&M channels
Control Words decode
CPRI Hyperframes capture

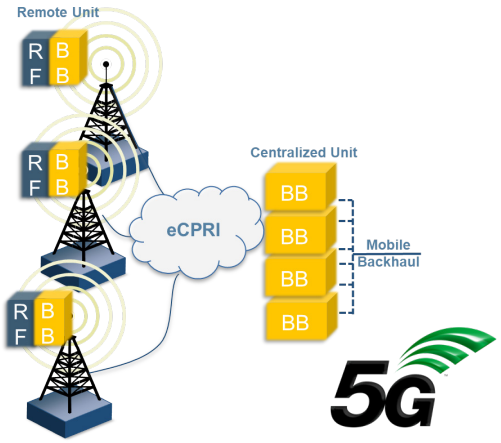
Bi-directional Monitor Mode

Bi-directional traffic analysis and monitoring between RE and REC, and hyperframe capture

eCPRI Testing

As current fronthaul solutions based on CPRI or OBSAI show limitations for future 5G deployments, the vendor consortium behind the CPRI protocol has released a new Ethernet based fronthaul protocol: eCPRI.
eCPRI is designed to comply with the more stringent requirements brought on by 5G standards:

- Increased bandwidth
- Bandwidth scalability and flexibility
- Low latency
- Flexibility in functional split options between Remote Unit (RU) and Centralized Unit (CU)



To ensure that 5G network's strict requirements are met in the fronthaul, the eCPRI Transport Network requirement document establishes classes of service for data and C&M traffic. With full line rate eCPRI traffic generation capabilities and high accuracy one-way latency measurements, the RXT6200 provides the tools necessary to ensure that the eCPRI transport network is ready for 5G deployments.

Test Interfaces

- 25GBase-R w/RS-FEC support
- 10GBase-X

Reference clock input: Atomic 1PPS*, 2.048 Mbps, 2.048 MHz, 1.544 Mbps, 1.544 MHz, 10 MHz, 1 PPS, GPS 1PPS**

*Requires Atomic Clock option
**Requires GPS option

Framed Ethernet Traffic Generation

Layer 2 or Layer 4 traffic
Test Frame Header

- IEEE 802.3 and Ethernet II (DIX) frames
- Configurable Source and Destination MAC
- Ethernet Type: AE-FE (eCPRI)
- eCPRI Header: Protocol Rev. 1, Configurable C field, Configurable message type
- VLAN stacking up to 3 VLAN tags w/configurable priority & type
- VLAN ID and priority
- Fully configurable IPv4 or IPv6 header
- MPLS up to 3 labels with configurable Label/S/CoS and TTL
- UDP Header configurable Source and Destination ports
- Up to 32 independent traffic streams generation and analysis, with configurable filters
- Each stream can be set with independent eCPRI header, frame size, bandwidth, traffic profile, and QoS levels
- Test Patterns: PRBS pattern: 2^{31}-1, 2^{23}-1, 2^{15}-1, 2^{11}-1 PRBS normal and inverted patterns, All 0s, All 1s, and User Defined
- Frame sizes from 64 to 1518 bytes and jumbo frames up to 16000 bytes (Layer 2 only)

Ethernet Error Injection: Bit, CRC, Pause, IP Checksum, UDP Checksum, OOS, Missing sequence
Ethernet Alarm Injection: Local Fault, Remote Fault, Optical LOS

Key Measurements

Error Measurements: Bit/BER (single stream only), CRC, IP checksum, jabber frames, runt frames, Frame loss (count and %), OSS, Duplicate Sequence
Alarm Detection: LOS, Local and Remote Fault
FEC Aggregate Error Counters: UFEC, CFEC, Invalid Transcoded Block (count and rate)
FEC Aggregate Alarm Counters: HiSER, LOA
Frame/Packet Statistics: Multicast, broadcast, unicast, pause frames, frame size distribution
Rates (min, max, average and current): frame rate, bandwidth utilization, frame rate, line rate, data rate
Frame arrival time (min, max, average and current), Frame Delay Variation
Round Trip delay or One-Way Delay OWD* (min, max, average and current) and Histogram distribution with configurable sampling period and threshold
Latency measurement resolution 1ns, 25G accuracy ±4 ns (typical), 10G ±8 ns (typical)

Packet Capture and Decode

Line rate packet capture
Full frame capture or truncated

Configurable capture filters

- MAC and IP
- UDP and/or TCP
- Multicast, Broadcast, IP Checksum error, UDP/TCP Checksum Error events
- Ethernet Type
- VLAN ID
- MPLS ID
- eCPRI: Layer 2, Layer 4, Message Type

Additional Functions

Test Results Management

Local and remote web-based interface provides easy access and manipulation to OTN and Ethernet Test Results
Save, View, Rename, Lock and Delete functions

Export results to USB
- PDF, CSV, TXT formats

File Organizer
- Filtering per test result type

File Sorting
- By Name, Port, Test Type, Date, Size, Locked/Unlocked

Screen capture: Screen shots in .bmp format

Test Profile Management & Auto Scripting

Save and Recall test profiles to internal memory
Auto Script uses up to 10 saved test profiles to run batch tests

Remote Access and Control

Compatible with VeEX SCPI Remote Client (optional)
Compatible with multi-platform VNC® clients
Web-based VNC® server (no PC client required)
ReVeal RXTS Data Management
Test results management
Advanced report generation with html, pdf, or csv formats, combine test results, add logos and comments
Test profiles management: Online or offline test profile creation, upload and download
Remote Control

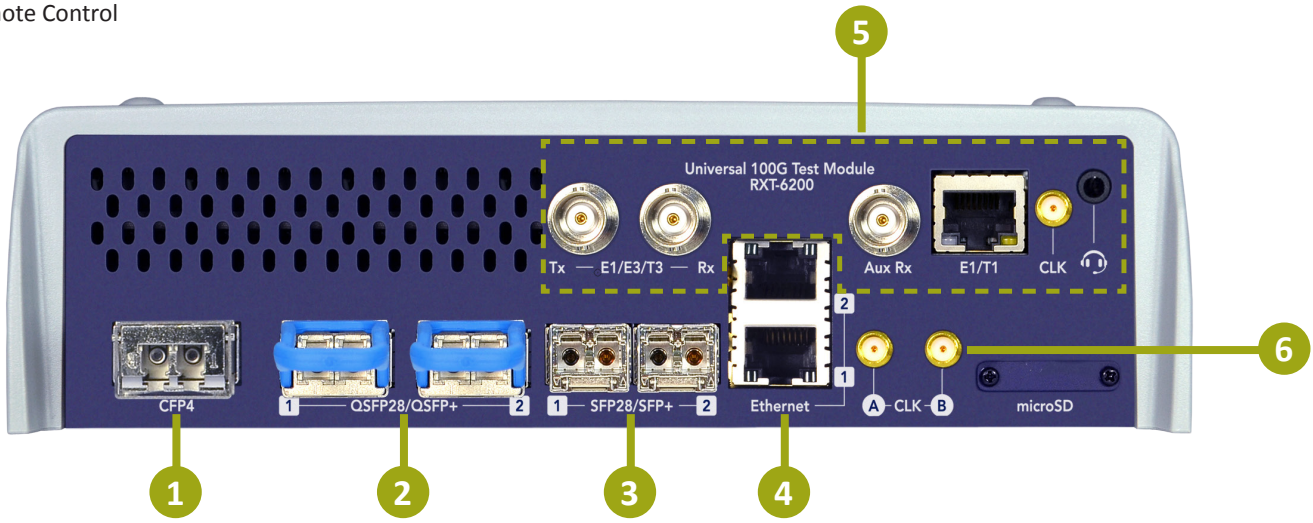
EZ Remote
On-demand remote control functionality that works over the internet through firewalls
Connect to VeEX test sets online anywhere in the world with any computer, tablet or smartphone, using standard web browser client
Functionalities: Screen-sharing, remote control and access to test results download

General

Power Consumption	
Active	90 watts (max)*
Environmental	
Operating temperature	0 to 45°C (32 to 113°F)
Storage temperature	-20 to 70°C (-4 to 158°F)
Humidity	5% to 90% non-condensing
Test Set Weight	3.27 kg (7.2 lb)
RXT-6200 module	1.4 kg (3.0 lb)
RXT-1200 platform	1.32 kg (2.9 lb)
9-cell Li-ion battery	0.55 kg (1.2 lb)

ROHS compliant and Lead Free per Directive 2002/95/EC

**requires A01-00-0136G AC/DC charger and B02-09-006G high-capacity battery pack*



1. **CFP2**: 100GE, OTU4
2. **QSFP28/QSFP+**: 100GE, 50GE, 40GE, OTU4, OTU3
3. **Dual SFP28/SFP+**: 32/16/10/8/4/2/1G FC, 25/10/1GE, 100Base-FX, OTU2/2e/1e/1, SONET/SDH, CPRI up to 24G
4. **Dual RJ45**: 10/100/1000Base-T
5. **BNC, RJ48/Bantam**: Legacy electrical STM-1e/STS-3, STM-0/STS-1, E4, E3, E1, T3, T1 (Optional HW*)
6. **SMA**: External Reference Clock Inputs

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