xGenius is a multi-technology Transmission / Synchronization tester equipped with an atomic Rubidium oscillator making it ideal to maintain Power Substations, 4G/5G Telecom, TV/Radio Broadcast, Finance and Air Traffic Control infrastructures.

Table 1.
Operation modes vs. Connection modes

<table>
<thead>
<tr>
<th>Connection</th>
<th>End-point</th>
<th>Monitor</th>
<th>Pass</th>
<th>Loop</th>
<th>MaxDmux</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eth</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Eth L1</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>T1/E1</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Analog</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Data</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Clock</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>ED</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>C37.94</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

Table 2.
Native Test Interfaces and Clock References

<table>
<thead>
<tr>
<th>Operation modes</th>
<th>10GE</th>
<th>1GE</th>
<th>T1/E1</th>
<th>Clk Monitor</th>
<th>Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>RJ45-A</td>
<td>Ethernet, IP</td>
<td>PTP, SyncE</td>
<td></td>
<td></td>
<td>Ethernet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RJ45-B</td>
<td>Ethernet, IP</td>
<td>PTP, SyncE</td>
<td></td>
<td></td>
<td>SyncE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFP-A</td>
<td>Ethernet, IP</td>
<td>PTP, SyncE</td>
<td></td>
<td></td>
<td>SyncE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFP-B</td>
<td>Ethernet, IP</td>
<td>PTP, SyncE</td>
<td></td>
<td></td>
<td>SyncE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFP+-A</td>
<td>Ethernet, IP</td>
<td>PTP, SyncE</td>
<td></td>
<td></td>
<td>SyncE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SFP+-B</td>
<td>Ethernet, IP</td>
<td>PTP, SyncE</td>
<td></td>
<td></td>
<td>SyncE</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMB-C</td>
<td>5/10 MHz</td>
<td>2448 kHz</td>
<td>1544 kHz</td>
<td>1 PPS/1 PP2S</td>
<td>ToD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMB-1</td>
<td>5/10 MHz</td>
<td>2048 kHz</td>
<td>1544 kHz</td>
<td>1 PPS/1 PP2S</td>
<td>ToD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMB-2</td>
<td>5/10 MHz</td>
<td>2048 kHz</td>
<td>1544 kHz</td>
<td>1 PPS/1 PP2S</td>
<td>ToD</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RJ45-C</td>
<td>5/10 MHz</td>
<td>2048 kHz</td>
<td>1544 kHz</td>
<td>1 PPS/1 PP2S</td>
<td>ToD</td>
</tr>
</tbody>
</table>

Figure 1. Ports and connectors
1.4 Internal Clock
- Rubidium better than ±5.0e-11
- OCXO better than ±0.1 ppm
- Internal time reference better than ±2.0 ppm

1.5 Rubidium features
**GNSS Locked**
- Time/Phase Accuracy to UTC: ±20 ns at 1σ after 24 hours lock
- Frequency Accuracy: 1e-11 (averaged over one week)

**Hold-over**
- Output freq. accuracy (after 24 h. locked): 1.5e-11 / 24 h
- Output time accuracy (after 24 h. locked): ±100 ns / 2h, ±1.0μs / 24 h

**Freerun**
- Output freq. accuracy (7.5 minutes warm up): ±1e-9
- Output freq. accuracy on shipment (24 h. warm up): ±5.0e-11
- Aging (1 day, 24 hours warm up): ±0.5e-11
- Aging (1 year): ±1e-9

1.6 Built-in GNSS receiver
- SMA connector
- GPS, Glonass, Beidou, Galileo support single / multiple selection
- Omnidirectional magnetic antenna
- Fixed position mode for GNSS references.
- Automatic setting of UTC-to-TAI offset (leap second count)
- 4V - 5V DC output in GNSS port to feed an external antenna
- Cable delay compensation

1.7 Clock reference Inputs
- 10 MHz, 5 MHz, 2048 kb/s, 2048 kHz, 1544 kb/s, 1544 kHz

1.8 Clock Reference Outputs
- 2048 kHz and 10 MHz unbalanced.
- 1 PPS, 1 PPS2, balanced and unbalanced compatible with standard ITU-T G.8271. To be balanced compatible with ITU-T G.8271, China Mobile and NMEA formats
- Ethernet through Port A and Port B (over any valid electrical / optical synchronous Ethernet interface)
- Custom delay compensation for phase and time inputs

2. Ethernet PHY

2.1 Interfaces
**SFP / SFP+ ports**
- 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-T, 1000BASE-SX, 1000BASE-LX, 1000BASE-ZX, 1000BASE-BX, 1000BASE-FX, 1000BASE-TX, 1000BASE-T

**RJ-45 ports**
- 10BASE-T, 100BASE-TX, 1000BASE-T
- On / Off laser control
- Insertion of code errors

**Auto-Negotiation**
- Bit rate: 10 Mb/s, 100 Mb/s, 1 Gb/s
- Master and Slave roles in the 1000BASE-T
- Disable auto-negotiation, force line settings

2.2 Synchronous Ethernet
**SFP / SFP+ ports**
- 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 1000BASE-T, 1000BASE-SX, 1000BASE-LX, 1000BASE-ZX, 1000BASE-BX, 1000BASE-TX

**RJ-45 ports**
- 100BASE-TX, 1000BASE-T

**Timing**
- Freq offset generation up to ±125 ppm (res. 0.001 ppm)
- Line freq (MHz), offset (ppm), drift (ppm/s)

**Synchronization**
- ESMC, SSN, QL generation, decoding, forwarding
- Sinusoidal wander generation on Ethernet interfaces (ITU-T O.174)

2.3 Power over Ethernet (PoE)
**Interfaces**
- 10BASE-T, 100BASE-T, 1000BASE-TX
- IEEE 802.3af-2003 and PoE+ (IEEE 802.3at-2009) detection
- PoE pass-through when configured in transparent mode
- Volts in pairs 1-2 / 3-6 and 4-5 / 7-8 in end-point mode
- Voltage / current in 1-2 / 3-6 and 4-5 / 7-8 in transparent mode

3. Ethernet MAC
**Formats**
- DIX, IEEE 802.1Q, IEEE 802.1ad
- Jumbo frames up to 10 kb
- Sour / Dest MAC address setting
- Type / Length Setting
- Enable / Disable VLAN and Q-in-Q modes
- VLAN VID / User Priority setting
- S-VLAN VID, DEI, PCP, C-VLAN VID, User Priority
- FCS error insertion

4. MPLS
**MPLS generation / analysis**
- Single/Double label stack support
- TTL, Exp, Label fields edition

5. IP
**IPv4**
- Sour / Dest edition
5.2 Protocols
- ARP
- DHCP
- DNS
- Ping
- Traceroute

6. Traffic Generation
- Generation over 8 independent streams
- Two independent traffic generators over A / B ports

6.1 Bandwidth Profile
**Generation modes**
- Continuous
- Periodic burst
- Ramp
- Random

6.2 Test Patterns and Payloads
**Layer 1**
- HE, LE, MF, Long/Short continuous random, PRBS 23, A-seed, B-seed

**Layer 2-4**
- PRBS 11, PRBS 15, PRBS 20, PRBS 23, PRBS 31, all 0, all 1
- SLA payload
- Insertion of TSE: single, rate, random

7. Filters
- Up to 8 simultaneous
- Selection by Ethernet, IP, TCP/UDP fields
- Generic filter by using 16 bit mask and arbitrary offset

7.1 Ethernet Selection
- MAC Address: Source and Destination
- Type / Length value with selection mask
- C-VID and S-VID with selection mask
- Service and Customer priority codepoint

7.2 MPLS Selection
- Top and Bottom MPLS headers
- Label value
- Exp field

7.3 IPv4 Selection
- IPv4 source / dest address
- IPv4 protocol
- DSCP field

7.4 IPv6 Selection
- IPv6 source / dest address
- IPv6 flow label
- IPv6 "next header"
- DSCP field

7.5 UDP Selection
- Selection by UDP port

8. PHY Results
8.1 Cable Tests
- Inactive links: Open, Short, Distance to fault
- Active links MDI / MDIX Status, Polarities, Pair Skew
- Optical power (over compatible SFP/SFP+)

8.2 Auto-Negotiation
- Bit rate and duplex mode
- 1000BASE-T role indication

8.3 Synchronous Ethernet
- Frequency (MHz), offset (ppm), drift (ppm/s)
- TIE / MTIE / TDEV on Ethernet (ITU-T G.8266)
- Decoding of the QL transported in SSM
- Resolution of TIE, MTIE and TDEV results: 100 ps

9. Frame Analysis
9.1 Statistics
**Frame Counts**
- Ethernet, VLAN, IEEE 802.1ad, Q-in-Q, Control, Pause, PTP
- Unicast, multicast, broadcast
- FCS errors, Undersized, Oversized, Fragments, Jabbers

**Frame Sizes**
- < 65, 65-255, 256-511, 512-1023 1024-1518
- 1519-1522, 1523-1526 and 1527 MTU bytes

9.2 MPLS Statistics
- Single / Double label

9.3 IP Statistics
**Packet Counts**
- IPv4 / IPv6
- Unicast, Multicast, Broadcast
- TCP, UDP, ICMP
- IPv4 / IPv6 / UDP / TCP checksum errors

9.4 Bandwidth Statistics
- Current, max, min, avg in b/s, f/s, %
- Unicast, multicast, broadcast in %
- IPv4 and IPv6 in b/s, f/s, %
- UDP in b/s, f/s, %

9.5 SLA Statistics
- Simultaneous per stream and port
- Delay (FTD): current, min, max, mean
- Delay variation (FDV or jitter): current, min, max, mean
- Reordering: Out-of-order, Duplicated count and ratio
- Loss (FLR): count, ratio
- Availability: SES count, PEU, PEA

9.6 Service Disruption Test
- 1 ms resolution
- Total, avg, min, max time
- Time in the last disruption event

9.7 Bit Error
- Count, Errored sec, BER
- Pattern loss secs at layer 1-4

9.8 Network Exploration
- Top MAC / IPv4 / IPv6 talkers
- Top C-VID and S-VID tags
- Automatic 8 filtering blocks

10. PTP (IEEE 1588) testing
10.1 Operation
- Generation / Decoding of PTP - IEEE 1588-2008
- Master / Slave operations, ability to force master or slave roles
- 1-step and 2-step mechanism synchronization
- PTP pass-through monitoring
- Peer-to-peer and end-to-end delay
- Encapsulations: PTP over UDP / IPv4, PTP over Ethernet
- Unicast, multicast and hybrid addressing mechanisms
- Compatible with IEEE 1588-2008 default profiles
- Compatible with ITU-T G.8265.1, G.8275.1, G.8275.2 Telecom profiles
- Compatible with IEEE C37.238 Power profile and IEC 61850-9-3 Utility profile
10.2 Protocol state results
- Port, best master clock, master identity
- Grandmaster identity, BMC priorities, clock class, accuracy, variance, time source, master IP or Ethernet address

10.3 Counts & statistics
- PTP message counts: Sync, Delay request, Delay response Peer delay request, Peer delay response, follow up, Peer delay response follow up, Announce, Signaling, Management
- Sync delay: current, max, min, avg, standard deviation, range
- Sync delay variation: current, max, avg
- Sync inter arrival time: min, avg, max, current
- Delay request: current, max, min, avg, standard deviation, range
- Round trip delay: current, mean
- Correction field: current, max, avg
- PDV metrics (Sync / Delay Request latency) captures 1s resolution

10.4 Floor Delay metrics
- Floor delay packet population, ratio/percentage/count
- Count (FPC), Rate (FPR), Percent (FPP)
- Configurable Pass / Fail threshold

10.5 Wander metrics
- TIE (ITU-T G.8260 pktfilteredTIE)
- MTIE (ITU-T G.8260 pktfilteredMTIE)
- TDEV (ITU-T G.8260 pktfilteredTDEV)
- Tables and Graphs

10.6 Time Error (TE) test
- Two-way TE and max [TE]
- Low frequency TE as the cTE + d^TE components (ITU-T G.8271.1)
- High frequency TE (ITU-T G.8271.1 d^TE)

10.7 Path Delay Asymmetry
- Between PTP master clock and client clocks

11. Automatic Tests
- Configurable PASS/FAIL objectives
- RFC 2544, ITU-T Y.11564, RFC 6349 and Synchronization tests (Sync/E)

11.1 RFC 2544
- Throughput, Frame-loss, Latency, Back-to-back, Recovery
- Symmetric and Asymmetric test modes

11.2 eSAM (ITU-T Y.1564)
- Ethernet service activation
- Four / eight services (color and color) defined by CIR, EIR
- FTD, FDV, FLR, availability objectives
- Symmetric and Asymmetric test modes

Test Phases
- Phase 1: steps, step duration
- Phase 2: duration, bandwidth profile (deterministic, random)

11.3 TCP test - RFC 6349
- Modes: active (client), passive (server)
- ALBEDO / IPerf3 endpoints in client mode
- Configurable MTU and MSS
- Configurable Bottleneck Bandwidth (BB) in B/s, %
- Round-Trip Time (RTT)
- Window Sweep at 25 / 50 / 75 / 100/% of BDP size
- Transfer Time Ratio, TCP Efficiency, Buffer Delay

12. Port Loopback
- Layer 1-4 loop-back with Filtering conditions
- MPLS loop control
- Loop controls for broadcast and ICMP

13. ICMP Processor
- Generation of ICMP echo request (RFC 792)
- Analysis of ICMP reply (RFC 792) with Round Trip Time and Lost packets
- Analysis of ICMP Time-To-Live Exceeded and Port unreachable replies received in the traceroute test

14. T1 (ANSI T1.102)

14.1 Connectors
- Balanced (RI-48) 120 Ω

14.2 Line
- Configurable impedance: nominal, PMP 20, 25, 30 dB, high (> 1000 Ω)
- Configurable output freq. offset ±25,000 ppm
- Line codes: B825, AMI
- Input Level: From 0 dB to -45 dB
- Line attenuation (dB)
- Pulse mask compliance (ANSI T1.102-1999, ITU G.703)
- Custom transmission clock: recovered or synthesized

14.3 Frame
- 1544 kb/s unframed, SF (D4) and ESF (ANSI T1.403-1999, ITU-T G.704)
- Nx64 and Nx56 kb/s in contiguous / non-contiguous time slots
- Optional ‘robbed bit’ signaling
- CAS A, B, C, D bit generation for each voice channel
- Generation of custom FDL word (ESF frame format)
- Custom Synchronization Status Message (SSM) generation

14.4 Patterns
- PRBS 6, PRBS 7, PRBS 9 (ITU-T G.105, 0.153), PRBS 11 (ITU-T G.105, 0.152, 0.153), PRBS 15 (ITU-T G.105, 0.151), PRBS 20 (ITU-T G.105, 0.153), PRBS 23 (ITU-T G.105, 0.151), PRBS 6 inverted, PRBS 7 inverted, PRBS 9 inverted, PRBS 11 inverted, PRBS 15 inverted, PRBS 20 inverted, PRBS 23 inverted, QRSS, QRSS inverted, QR / FO, all 0, all 1
- User configurable 32 bit word
- Tone (from 10 Hz to 4000 Hz, from +6 dBm to -60 dBm)

14.5 Line Analysis
- Line attenuation (dB).
- Frequency (Hz), frequency deviation (ppm)
- Custom pass / fail indications

14.6 Pulse mask
- Frequency (Hz), frequency deviation (ppm)
- Operation modes: Eye diagram or continuous run
- Display of positive, negative and positive / negative pulse
- Width, rise / fall time, level, overshoot / undershoot (± pulse)
- Pass / Fail compliance with ANSI T1.101-1999 T1 mask

14.7 Frame and Pattern Analysis
- Defects: LOS, LOF, AIS, RDI, LSS, All 0, All 1, Slip
- Anomalies: Code, FAS error, CRC error, TSE
- Channel map: time slot in hex/bin, level, freq. (ITU-T G.711 Law)
- Anomalies: Code, FAS error, CRC error, TSE
- Channel map: time slot in hex/bin, level, freq. (ITU-T G.711 Law)
- Display of positive, negative and positive / negative pulse
- Width, rise / fall time, level, overshoot / undershoot (± pulse)
- Pass / Fail compliance with ANSI T1.101-1999 T1 mask

14.8 Performance
- Results and PASS/FAIL indication
- G.821: ES, SES, UAS, DM
- G.826: ES, SES, UAS, BBE (near / far-end)
- M.2100: ES, SES, UAS, BBE (near / far-end)

14.9 Event Insertion
- Physical: AIS, LOS
- Frame: FAS error, CRC error, LOF, RDI
- Pattern: TSE, Slip, LSS, All 0, All 1

14.10 Latency
- Modes
- Two way delay

www.albedotelecom.com
Communication Technologies
info.telecom@albedo.biz
in Test we Trust
14. Jitter / Wander Generation

- Waveform: sinusoidal
- Range: 1 μHz to 100 kHz
- Resolution: 0.1 Hz (jitter), 1 μHz (wander)
- Amplitude: 0–1000 Uipp. max depends on modulation freq
- Resolution: 1 mUipp or 1/10^4 configured value
- Accuracy: better than 0.172
- Intrinsic jitter < 10 mUipp

14.11 Jitter Analysis

- Modulation range: 1 to 100 kHz (locking time 10 s), 1 to 100 kHz (locking time 1 s), 10 to 100 kHz (locking time < 1 s)
- Amplitude: 0 to 1000 Uipp
- Resolution: 1 mUipp or 1/10^4
- Accuracy: better than ITU-T 0.172

14.12 Jitter Results

- Peak to peak, RMS, jitter, hits detection and count
- Observation time: 1, 10, 60 s

14.13 Wander Analysis

- Range: 1 μHz to 10 Hz
- Sampling: 50 Hz
- Amplitude: 0 to ±2 s (single range)
- Accuracy: 2 ns

15.1 Connectors

- 2 x Unbalanced (BNC) 75 Ω
- Balanced (RI-48) 120 Ω

15.2 Line

- Configurable impedance: nominal, PMP 20 / 25 / 30 dB, high (> 1000 Ω)
- Recovered or synthesized clock
- Configurable output freq. offset ±25,000 ppm
- Line codes: HD81, AMI
- Input Level: from 0 dB to -45 dB
- Pulse mask compliance: ITU-T G.703
- Jitter compliance: ITU-T G.823

15.3 Line Analysis

- Line attenuation (dB)
- Frequency (Hz), frequency deviation (ppm)
- Custom pass / fail indications

15.4 Pulse mask

- Frequency (Hz), frequency deviation (ppm)
- Operation modes: Eye diagram or continuous run
- Display of positive, negative and positive / negative pulse
- Width, Rise/Fall time, Level, Overshoot and Undershoot
- Pulse mask compliance ITU G.703

15.5 Frame

- 2048 kb/s unframed (ITU-T G.704, G.704 CRC / CAS / CRC+CAS)
- Nx4 in contiguous / non-contiguous time slots
- Custom NFAS generation (ITU-T G.704 with CRC-4 multi-frame)
- CAS A, B, C, D bit generation for each voice channel

15.6 Patterns and Signals

- PRBS 6, PRBS 7, PRBS 9 (ITU-T 0.150, 0.153), PRBS 11 (ITU-T 0.150, 0.152, 0.153), PRBS 15 (ITU-T 0.150, 0.151), PRBS 20 (ITU-T 0.150, 0.153), PRBS 23 (ITU-T 0.150, 0.151), PRBS 6 inverted, PRBS 7 inverted, PRBS 9 inverted, PRBS 11 inverted, PRBS 15 inverted, PRBS 20 inverted, PRBS 23 inverted, QRSS, QRSS inverted, QBF / FOX, all 0, all 1
- User configurable 32 bit word
- Tone (from 10 Hz to 4000 Hz, from +6 dBm to -60 dBm)

15.7 Frame and Pattern Analysis

- Defects: LOS, LOF, AIS, RDI, CRC-LOM, CAS-LOM, MAIS, MRDI, LSS, All 0, All 1, Slip
- Anomalies: Code, CAS, CRC error, REBE, MFAS error, TSE, TSBE
- Channel map: time slot in hex/bin, level, freq. (ITU-T G.711 A law)
- CAS A, B, C, D bit analysis
- FAS / NFAS word analysis

15.8 Performance

- Results and PASS/FAIL indication
- Operation modes: Eye diagram or continuous run
- Frequency (Hz), frequency deviation (ppm)
- Range: 0–1000 Uipp
- Amplitude: 0 to ±1000 Uipp (max depends on modulation freq)
- Resolution: 0.1 Hz (jitter), 1 μHz (wander)
- Accuracy: better than ITU-T 0.172
- Intrinsic jitter < 10 mUipp

15.9 Event Insertion

- Physical: Code, AIS, LOS
- Frame: FAS/CRC/MFAS error, REBE, LOF, MAIS, CAS-LOM, RDI, MRDI, CRC-LOM
- Pattern: TSE, Slip, LSS, All 0, All 1
- Modes
- Anomalies: single, rate
- Defects: continuous, burst of M, M out of N

15.10 Latency

- Modes: Two way delay
- One way assisted with GNSS or ToD and remote-end identification
- Results
- Round Trip Delay (RTD)
- One way Forward / Reverse Path delay
- Asymmetry with min. / max. records
- Patch cord delay compensation
- Pass / Fail indication

15.11 Jitter / Wander Generation

- Waveform: sinusoidal
- Range: 1 μHz to 100 kHz
- Resolution: 0.1 Hz (jitter), 1 μHz (wander)
- Amplitude: 0–1000 Uipp. max depends on modulation freq
- Resolution: 1 mUipp or 1/10^4 configured value
- Accuracy: better than 0.172
- Intrinsic jitter < 10 mUipp

15.12 Jitter Analysis

- Modulation range: 1 to 100 kHz (locking time 10 s), 1 to 100 kHz (locking time < 1 s)
- Amplitude: 0 to 1000 Uipp (max. depends on modulation freq.)
- Resolution: 1 mUipp or 1/10^4
- Accuracy: better than ITU-T 0.172

15.13 Jitter Results

- Peak to peak, RMS, jitter, hits detection and count
- Observation time: 1, 10, 60 s

15.51 Connectors

- 2 x Unbalanced (BNC) 75 Ω
- Balanced (RI-48) 120 Ω

15.2 Line

- Configurable impedance: nominal, PMP 20 / 25 / 30 dB, high (> 1000 Ω)
- Recovered or synthesized clock
- Configurable output freq. offset ±25,000 ppm
- Line codes: HD81, AMI
- Input Level: from 0 dB to -45 dB
- Pulse mask compliance: ITU-T G.703
- Jitter compliance: ITU-T G.823

15.3 Line Analysis

- Line attenuation (dB)
- Frequency (Hz), frequency deviation (ppm)
- Custom pass / fail indications

15.4 Pulse mask

- Frequency (Hz), frequency deviation (ppm)
- Operation modes: Eye diagram or continuous run
- Display of positive, negative and positive / negative pulse
- Width, Rise/Fall time, Level, Overshoot and Undershoot
- Pulse mask compliance ITU G.703

15.5 Frame

- 2048 kb/s unframed (ITU-T G.704, G.704 CRC / CAS / CRC+CAS)
- Nx4 in contiguous / non-contiguous time slots
- Custom NFAS generation (ITU-T G.704 with CRC-4 multi-frame)
- CAS A, B, C, D bit generation for each voice channel

15.6 Patterns and Signals

- PRBS 6, PRBS 7, PRBS 9 (ITU-T 0.150, 0.153), PRBS 11 (ITU-T 0.150, 0.152, 0.153), PRBS 15 (ITU-T 0.150, 0.151), PRBS 20 (ITU-T 0.150, 0.153), PRBS 23 (ITU-T 0.150, 0.151), PRBS 6 inverted, PRBS 7 inverted, PRBS 9 inverted, PRBS 11 inverted, PRBS 15 inverted, PRBS 20 inverted, PRBS 23 inverted, QRSS, QRSS inverted, QBF / FOX, all 0, all 1
- User configurable 32 bit word
- Tone (from 10 Hz to 4000 Hz, from +6 dBm to -60 dBm)

15.7 Frame and Pattern Analysis

- Defects: LOS, LOF, AIS, RDI, CRC-LOM, CAS-LOM, MAIS, MRDI, LSS, All 0, All 1, Slip
- Anomalies: Code, CAS, CRC error, REBE, MFAS error, TSE, TSBE
- Channel map: time slot in hex/bin, level, freq. (ITU-T G.711 A law)
- CAS A, B, C, D bit analysis
- FAS / NFAS word analysis

15.8 Performance

- Results and PASS/FAIL indication
- Operation modes: Eye diagram or continuous run
- Frequency (Hz), frequency deviation (ppm)
- Range: 0–1000 Uipp
- Amplitude: 0 to ±1000 Uipp (max depends on modulation freq)
- Resolution: 0.1 Hz (jitter), 1 μHz (wander)
- Accuracy: better than ITU-T 0.172
- Intrinsic jitter < 10 mUipp

15.9 Event Insertion

- Physical: Code, AIS, LOS
- Frame: FAS/CRC/MFAS error, REBE, LOF, MAIS, CAS-LOM, RDI, MRDI, CRC-LOM
- Pattern: TSE, Slip, LSS, All 0, All 1
- Modes
- Anomalies: single, rate
- Defects: continuous, burst of M, M out of N

15.10 Latency

- Modes: Two way delay
- One way assisted with GNSS or ToD and remote-end identification
- Results
- Round Trip Delay (RTD)
- One way Forward / Reverse Path delay
- Asymmetry with min. / max. records
- Patch cord delay compensation
- Pass / Fail indication

15.11 Jitter / Wander Generation

- Waveform: sinusoidal
- Range: 1 μHz to 100 kHz
- Resolution: 0.1 Hz (jitter), 1 μHz (wander)
- Amplitude: 0–1000 Uipp. max depends on modulation freq
- Resolution: 1 mUipp or 1/10^4 configured value
- Accuracy: better than 0.172
- Intrinsic jitter < 10 mUipp

15.12 Jitter Analysis

- Modulation range: 1 to 100 kHz (locking time 10 s), 1 to 100 kHz (locking time < 1 s)
- Amplitude: 0 to 1000 Uipp (max. depends on modulation freq.)
- Resolution: 1 mUipp or 1/10^4
- Accuracy: better than ITU-T 0.172

15.13 Jitter Results

- Peak to peak, RMS, jitter, hits detection and count
- Observation time: 1, 10, 60 s
Filters
- LP (f < 100 kHz)
- LP+HP1 (20 Hz < f < 100 kHz)
- LP+HP2 (18 kHz < f < 100 kHz)
- LP+RMS (12 kHz < f < 100 kHz)

**Wander Analysis**
- Range: 1 µHz to 10 Hz
- Sampling: 50 Hz
- Amplitude: 0 to ±0.2 µs (single range)
- Accuracy: 2 ns

**Results**
- Tables and Graphs
- Instantaneous: TIE, freq, offset, freq, drift
- Built in real time TIE, MTIE, TDEV (ITU-T G.810)
- Statistics range: 10^2, 10^3, 10^4, 10^5, 10^6 s
- Frequency offset, frequency drift with maximum records
- MTIE and TDEV resolution: 100 ps
- Pass / Fail based on standard masks

**16. Data Communications**

**16.1 Connector**
- 2 x S526 (Smart Serial Universal) for DTE / DCE

**16.2 Interfaces**
- V.24 / V.28 asynchronous from 50 b/s to 128 kb/s
- V.24 / V.28 synchronous from 50 b/s to 128 kb/s
- X.12 / V.11 asynchronous from 50 b/s to 128 kb/s
- X.21 / V.11 synchronous from 50 b/s to 2048 kb/s
- V.35 from 50 b/s to 2048 kb/s
- V.36 (RS-449) from 50 b/s to 2048 kb/s
- EIA-530 from 50 b/s to 2048 kb/s
- EIA-530A from 50 b/s to 2048 kb/s

**16.3 Line**
- Clock selection in V.24 / V.28 synchronous, V.35, V.36, EIA-530/EIA-530a
- Configurable output frequency offset ±25,000 ppm
- Data, Stop, Parity bits and inter-word gap configuration in asynchronous interfaces

**16.4 Operation Modes**
- DTE / DCE emulation, Full duplex monitor

**16.5 Event Insertion**
- Pattern: TSE, Slip, LSS, All 0, All 1
- Asynchronous interfaces: FRM, PRTY
- Modes
  - Anomalies: single, rate
  - Defects: continuous

**16.6 Analysis**
- Frequency (Hz), freq, deviation (ppm)
- Received chars
- Events detection
  - Anomalies: FRM, PRTY, TSE, TSBE
  - Defects: LOC, LSS, All 0, All 1, Slips

**Performance**
- Results and PASS/FAIL indication
  - G.821: ES, SES, UAS, DM

**16.7 Latency**

**Modes**
- Two way delay
- One way assisted with GNSS or ToD and remote-end identification

**Results**
- Round Trip Delay (RTD)
- One way Forward / Reverse Path delay
- Asymmetry with min. / max. records
- Patch cord delay compensation
- Pass / Fail indication

**17. ITU-T G.703 E0**

**17.1 Interfaces**
- Balanced (RJ-45) 120 Ω
- G.703 co-directional, contra-directional and centralized interface
- Bit rates 48, 56, 64, 72, 128, 144, 192, 256 kb/s

**17.2 Event Insertion**
- Physical: LOS, AIS
- Pattern: TSE, Slip, LSS, All 0, All 1
- Modes
  - Anomalies: single, rate, burst
  - Defects: continuous

**17.3 Analysis**
- Line Analysis
  - Frequency (Hz), freq, deviation (ppm)
  - Received chars
- Events detection
  - Anomalies: TSE, TSBE
  - Defects: LOS, AIS, LSS, All 0, All 1
- Modes
  - Asynchronous: ES, SES, DM
  - Defects: LOS, AIS, LSS, All 0, All 1, Slips
- Performance
  - Results and PASS/FAIL indication
  - G.821: ES, SES, UAS, DM

**17.4 Latency**
- Modes
  - Two way delay
  - One way assisted with GNSS or ToD and remote-end identification

**Results**
- Round Trip Delay (RTD)
- One way Forward / Reverse Path delay
- Asymmetry with min. / max. records
- Patch cord delay compensation
- Pass / Fail indication

**18. Voice Frequency Test**
- Tone generation and analysis function
- Level from -60 dBm to +3 dBm in steps of 0.1 dB
- Frequency between 2 Hz and 4000 Hz in steps of 1 Hz

**Results**
- Signal level (dBm), Noise level (dBm), Signal Frequency (Hz)
- Sensitivity: -60 dBm (signal measurements), -80 dBm (noise measurements)
- ITU-T G.711 analysis: maximum code, minimum code, average code
- Frequency sweep test

**18.1 Latency**

**Modes**
- Two way delay
- One way assisted with GNSS or ToD and remote-end identification

**Results**
- Round Trip Delay (RTD)
19. IEEE C37.94
   - Dual port operation over SMF or MMF with suitable SFP
   - Endpoint, pass-through and monitor operation modes

19.1 Interfaces
   - SFP 850 nm, MMF, 2048 kb/s, 1500 m
   - SFP 1310 nm, SMF, 2048 kb/s, 10 km

19.2 Line
   - Clock: Recovered or Internal
   - Modes: End point, Monitor
   - Results: PASS / FAIL
   - Laser: ON / OFF control

19.3 Frame
   - Unframed / Framed operation
   - Configurable bit-rate from 64 to 768 kb/s in 64 kb/s steps

19.4 Event Insertion
   - Physical: AIS, LOS
   - Frame: FAS, RDI
   - Pattern: TSE, Slip, LSS, All 0, All 1
   - Modes
     - Anomalies: single, rate
     - Defects: continuous, burst of M, M out of N

19.5 Analysis
   - SFP info
     - Transceiver, Vendor, Model, Wavelength
     - Tx Optical power (dBm)
     - Rx Optical power (dBm)
   - Line Analysis
     - Frequency (Hz), freq. deviation (ppm)
     - Received data rate (kb/s)
   - Events detection
     - Anomalies: Code, FAS, TSE
     - Defects: ACT, LOS, RDI, AIS, LSS, All 0, All 1, Slips

19.6 Performance
   - Results and PASS/FAIL indication
   - G.821: ES, SES, UAS, DM

19.7 Latency
   - Modes
     - Two way delay
     - One way assisted with GNSS or ToD and remote-end identification
   - Results
     - Round Trip Delay (RTD)
     - One way Forward / Reverse Path delay
     - Asymmetry with min. / max. records
     - Path code delay compensation
     - Pass / Fail indication

19.8 Jitter Analysis
   - Modeulation range: 1 to 100 kHz (locking time 10 s), 1 to 100 kHz (locking time 1 s), 10 to 100 kHz (locking time < 1 s)
   - Amplitude: 0 to 1000 μLpp (max. depends on modulation freq.)
   - Resolution: 1 μLpp or 1/10e4
   - Accuracy: better than ITU-T G.172
   - Jitter Results
     - Peak to peak, RMS, jitter, hits detection and count
     - Observation time: 1, 10, 60 s
   - Filters
     - LP (f < 100 kHz)

20. Clock Monitor Mode
   - Frequency inputs: 2048 kHz, 1544 kHz, 5 MHz, 10 MHz in RJ-48 or BNC connectors
   - Time inputs: 1 PPS and 1PP2S over SMB or RJ-48 connectors
   - ToD (ITU-T G.8271, China Mobile, NMEA) over RJ-48 connectors
   - Configurable input impedance: nominal line impedance, PMP 20 dB, high impedance (> 1000 Ω)

20.1 Line Analysis
   - Interfaces: 2048 kHz, 1544 kHz, 10 MHz
   - Line attenuation (dB)
   - Frequency (Hz), frequency deviation (ppm)

20.2 Jitter Analysis
   - Interfaces: 1544 kHz, 2048kHz
   - Modulation range: 1 to 100 kHz (locking time 10 s), 1 to 100 kHz (locking time 1 s), 10 to 100 kHz (locking time < 1 s)
   - Amplitude: 0 to 1000 μLpp (max. depends on modulation freq.)
   - Resolution: 1 μLpp or 1/10e4
   - Accuracy: better than ITU-T G.172
   - Jitter Results
     - Peak to peak, RMS, jitter, hits detection and count
     - Observation time: 1, 10, 60 s
   - Filters (2048 kHz)
     - LP (f < 100 kHz)
     - LP+HP1 (20 Hz < f < 100 kHz)
     - LP+HP2 (18 kHz < f < 100 kHz)
     - LP+RMS (12 kHz < f < 100 kHz)

20.3 Wander Analysis
   - Range: 1 μHz to 10 Hz
   - Sampling: 50 Hz
   - Amplitude: 0 to ±2 s (single range)
   - Accuracy: 2 ns
   - Results
     - Tables and Graphs
     - Instantaneous: TE / TIE, freq. offset, freq. drift
     - Built-in real time TIE, MTIE, TDEV (ITU-T G.810)
     - Statistics range: 10^2, 10^3, 10^4, 10^5, 10^6 s
     - Frequency offset, frequency drift with maximum records
     - MTIE and TDEV resolution: 100 ps
     - Pass / Fail based on standard masks

21. Port Loopback
   - Interfaces: E1, T1, IEEE C37.94, data communications, G.703 co-directional, G.703 contra-directional, G.703 centralized
22. Service Disruption Time
- Interfaces: E1/T1, C37.94, Datacom, Co/contra-directional, centralized
- Resolution is 100 µs or the smaller allowed by the detection rules
- Statistics are service disruption events count.
- Total disrupted time, max, min, avg
- Time in the last disruption event

22.1 Triggers
- In-service: LOS, AIS, LOC, RDI
- Out-of-service: TSE, 1s, 0s

23. Platform
23.1 Ergonomics
- Size: 260 x 160 x 63 mm
- Weight: 1.9 kg (two pack of batteries included)

23.2 Graphical User Interface
- Screen: 8 inch, TFT color (800 x 480 pixels)
- GUI controlled by Touch-screen, Keyboard or Mouse
- One click preconfigured tests
- Advanced navigation
- Web based report and configuration file management
- Full remote control: SNMP and VNC

23.3 Results
- Local storage in txt and pdf files
- File transfer to SD card and USB port
- File management through web interface and SNMP

23.4 Board
- 1 x USB ports
- 1 x RJ45 port
- 2 x application LEDs
- 4 x system LEDs: Run, Event, Power, DC
- Software upgrade through USB

23.5 Batteries
- 2 x Li Ion Polymer
- Duration depends on many factors: application, aging, temp, screen...

23.6 Operational Ranges
- Operational range: -10°C to +50°C
- Storage range: -20°C to +70°C
- Operation humidity: 5% to 95%