



*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.*

# Datasheet

Updated on 14/6/18

## xGenius a new dimension

### 1. General

#### 1.1 Operation Modes

**Table 1.**  
Operation modes vs. Connection modes

		Operation modes							
		10G	Eth L1	T1/E1	Analog	Data	Clock	Cable	C37.94
Connection	End-point	YES	YES	YES	YES	YES		YES	YES
	Monitor	YES		YES		YES	YES		YES
	Pass	YES		YES					
	Loop	YES		YES					
	MuxDmux			YES					

#### 1.2 Ports

##### Front Panel

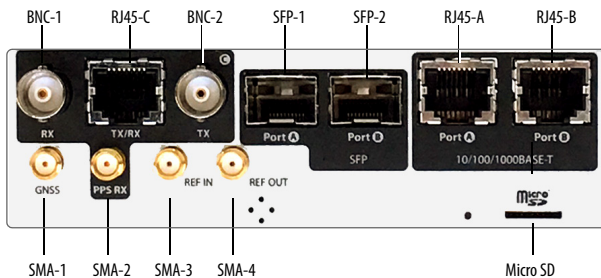
- Port A - B: 2 x SFP+, 2 x RJ45 connectors
- Port C: balanced RJ45 120 Ω / unbalanced BNC 75 Ω
- Port D: balanced RJ45 120 Ω (through special adapter)

##### Rear Panel

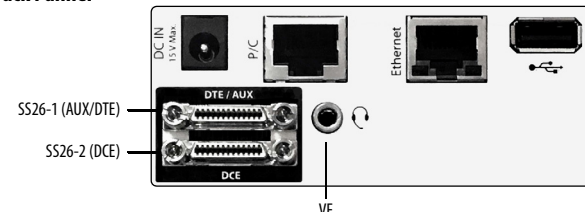
- AUX-DTE / DCE Port: Smart Serial
- VF Port: analogue voice frequency

#### 1.3 Time and Network Interfaces

##### Front Panel



##### Back Panel



**Figure 1.** Interfaces at Front and Back panels

#### 1.4 Input and Output signals

**Table 2.** Input Test and Time References

Internal Oscillator, Time references, Test signals

	Operation modes							
	10G/IP	T1/E1	Analog	Datcom	Clock	Cable	C37.94	
Internal Oscillator	Rubidium OCXO TCXO	Rubidium OCXO TCXO	Rubidium OCXO TCXO	Rubidium OCXO TCXO	Rubidium OCXO TCXO	Rubidium OCXO TCXO	Rubidium OCXO TCXO	
BNC-1	T1/E1 10 MHz 2.0 MHz 1.5 MHz	E1			10 MHz 2.0 MHz 1.5 MHz	T1/E1 10 MHz 2.0 MHz 1.5 MHz		
RJ45-C	T1/E1 10 MHz 2.0 MHz 1.5 MHz	T1/E1			1PPS ToD 10 MHz 2.0 MHz 1.5 MHz	T1/E1 10 MHz 2.0 MHz 1.5 MHz		
BNC-2								
RJ45-A	Ethernet, IP PTP, SyncE SyncE					Ethernet SyncE		
RJ45-B	Ethernet, IP PTP, SyncE SyncE					Ethernet SyncE		
SFP-1	Ethernet, IP PTP, SyncE SyncE							
SFP-2	Ethernet, IP PTP, SyncE SyncE							
SMA-1	GNSS	GNSS	GNSS	GNSS	GNSS	GNSS	GNSS	
SMA-2					1PPS			
SMA-3	1PPS	1PPS	1PPS	1PPS	1PPS	1PPS	1PPS	
SMA-4								
SS26-1	ToD 1PPS	1PPS ToD 10 MHz 2.0 MHz 1.5 MHz T1/E1	1PPS ToD 10 MHz 2.0 MHz 1.5 MHz T1/E1	V11, V24, V35, V36, EIA530, EIA530A, Co-dir	1PPS ToD 10 MHz 2.0 MHz 1.5 MHz T1/E1	ToD 1PPS	C37.94	
SS26-2				V11, V24, V35, V36, EIA530, EIA530A, Co-dir				
VF			Analog					

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**Table 3. Output Test and Time References**

□ Time references, ■ Test signals

		Operation modes						
		10G/IP	T1/E1	Analog	Data	Clock	Cable	C37.94
Output Interfaces	BNC-1							
	RJ45-C		T1/E1					
	BNC-2	10 MHz 2.0 MHz	E1				10 MHz 2.0 MHz	
	RJ45-A	Ethernet, IP PTP, SyncE					Ethernet	
	RJ45-B	Ethernet, IP PTP, SyncE					Ethernet	
	SFP-1	Ethernet, IP PTP, SyncE						
	SFP-2	Ethernet, IP PTP, SyncE						
	SMA-1							
	SMA-2							
	SMA-3							
	SMA-4	1PPS	1PPS	1PPS	1PPS	1PPS	1PPS	1PPS
	SS26-1	ToD 1PPS	ToD 1PPS	ToD 1PPS	V11, V24, V35, V36, EIA530, EIA530A, Co-dir	ToD 1PPS	ToD 1PPS	C37.94
	SS26-2				V11, V24, V35, V36, EIA530, EIA530A, Co-dir			
VF			Analog					

**1.5 Internal Clock**

- Rubidium better than ±5.0e-11
- OCXO better than ±0.1 ppm
- Internal time reference better than ±2.0 ppm

**1.6 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 / 24h
- 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

**1.7 Built-in GNSS receiver**

- GPS, Glonass, Beidou, Galileo support single / multiple selection
- Onmidirectional magnetic antenna
- SMA connector
- 4V to 5V DC output

**1.8 Input Clock References**

- GNSS
- ToD
- 1PPS
- SyncE
- T1/E1 (1544 kb/s, 2048 kb/s)
- 1544 kHz, 2048 kHz, 10 MHz
- Custom delay compensation for phase and time

**1.9 Output Clock**

- ToD

- 1PPS
- 2048 MHz, 10 MHz
- Custom delay compensation for phase and time

**2. Ethernet Phy**

**2.1 Interfaces**

**SFP / SFP+ ports**

- 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 10GBASE-T, 1000BASE-T, 1000BASE-SX, 1000BASE-LX, 1000BASE-ZX, 1000BASE-BX, 100BASE-FX, 100BASE-TX, 10GBASE-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

**Power over Ethernet (PoE)**

- Interfaces: 10BASE-T, 100BASE-T, 1000BASE-TX
- PoE pass-through in transparent mode

**2.2 Synchronous Ethernet**

**SFP / SFP+ ports**

- 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, 1000BASE-T, 1000BASE-SX, 1000BASE-LX, 1000BASE-ZX, 1000BASE-BX, 100BASE-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, SSM, QL: generation, decoding, forwarding
- Sinusoidal wander generation on Ethernet interfaces (ITU-T O.174)

**2.3 Power over Ethernet (PoE)**

- Through RJ-45 port A and port B
- IEEE 802.3af-2003 and PoE+ (IEEE 802.3at-2009) detection
- Pass-through when configured inthrough 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 through 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 errors insertion

**4. MPLS**

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

**5. IP**

**5.1 IPv4**

- Sour / Dest edition
- Dest MAC address edition or set up by ARP
- DSCP CoS label edition, TTL and transport protocol
- IP checksum errors insertion
- UDP edition

## 5.2 Protocols

- ARP
- DHCP
- DNS
- Ping
- Traceroute

## 6. UDP Traffic Generator

- 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

- HF, LF, MF, Long/Short continuous random, PRBS 23, A-seed, B-seed

#### Layer 2-4

- PRBS 11, PRBS 15, PRBS 20, PRBS 23, PBRS 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 sour / dest address
- IPv4 protocol
- DSCP fields

### 7.4 IPv6 Selection

- IPv6 sour / dest address
- IPv6 flow label

### 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 O.172)
- 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, 65-127, 128-255, 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
- PTP

### 9.4 Bandwidth Statistics

- Current, max, min, avg in b/s, f/s, %
- Unicast, multicast, broadcast in %
- IP and UDP in b/s, f/s, %
- IPv4 and IPv6 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
- Generation / Analysis of 128 PTP packet/sec
- 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 profiles
- Compatible with ITU-T G.8265.1 and G.8275.1 Telecom profiles
- Simultaneous testing with PTP measurements

### 10.2 PTP Results

### 10.3 Protocol state

- Port, best master clock, master identity
- Grandmaster identity, BMC priorities, clock class, accuracy, variance, time source, master IP or Ethernet address

10.4 **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, max, avg, 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

10.5 **Floor Delay metrics**

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

10.6 **Wander metrics**

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

10.7 **Time Error (TE) test**

- Two-way TE and max |TE|
- Constant TE (cTE) and dynamic TE (dTE) components
- Low frequency TE as the cTE + d<sup>L</sup>TE components (ITU-T G.8271.1)
- High frequency TE (ITU-T G.8271.1 d<sup>H</sup>TE)

10.8 **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 (SyncE)

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/not 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 **RFC 6349**

- Modes: active (client), passive (server)
- ALBEDO / IPerf3 endpoints in client mode
- Configurable MTU and MSS
- Configurable Bottleneck Bandwidth (BB) in f/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
- Analysis of ICMP Port unreachable replies received in the traceroute test

14. **T1 (ANSI T1.102)**

14.1 **Connectors**

- Balanced (RJ-48) 120 Ω

14.2 **Line**

- Configurable impedance: nominal, PMP 20, 25, 30 dB, high (> 1000 Ω)
- Cable delay equalization up to a 6 dB attenuation
- Configurable output freq. offset ±25,000 ppm
- Line codes: B8ZS, AMI
- Input Level: From 0 dB to -45 dB
- Jitter compliance: ANSI T1.102-1999, ITU-T G.823
- Line attenuation (dB)
- Pulse mask compliance (ANSI T1.102-1999, ITU G.703)

14.3 **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 (ANSI T1.102-1999, ITU G.703)

**Pulse Mask Analysis**

- Operation modes: Eye diagram or continuous run
- Width, rise / fall time, level, overshoot / undershoot (± pulses)
- Pass / Fail compliance with ANSI T1.101-1999 T1 mask

14.4 **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)

14.5 **Patterns**

- 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)

14.6 **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 μ law)
- CAS A, B, C, D bit analysis
- FDL analysis (ESF frame format)

14.7 **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)

14.8 **Event Insertion**

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

**Modes**

- Anomalies: single, rate
- Defects: continuous, burst of M, M out of N

14.9 **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

14.10 **Jitter / Wander Generation**

- Waveform: sinusoidal
- Range: 1  $\mu$ Hz to 100 kHz
- Resolution: 0.1 Hz (jitter), 1  $\mu$ Hz (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 < 10m Uipp

14.11 **Jitter Analysis**

- Interfaces: T1, 1544 kHz
- Closed loop method
- 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  $1/10e4$
- Accuracy: better than ITU-T 0.172

**Jitter Results**

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

**Filters (ANSI T1.102 T1)**

- LP ( $f < 40$  kHz)
- LP+HP1 ( $10 \text{ Hz} < f < 40$  kHz)
- LP+HP2 ( $8 \text{ kHz} < f < 100$  kHz)

14.12 **Wander Analysis**

- Interfaces: T1, 1544 kHz, 10 MHz, 1 PPS
- Open loop method
- Range: 1  $\mu$ Hz to 10 Hz
- Sampling: 50 Hz
- Amplitude: 0 to  $\pm 2$  s (single range)

**Results**

- Tables and Graphs
- Accuracy: 2 ns
- Built-in and real time
- 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

15. **E1 (ITU-T G.703)**

15.1 **Connectors**

- 2 x Unbalanced (BNC) 75  $\Omega$
- Balanced (RJ-48) 120  $\Omega$

15.2 **Line**

- Configurable impedance: nominal, PMP 20 / 25 / 30dB, high (> 1000  $\Omega$ )
- Recovered or synthesized clock
- Configurable output freq. offset  $\pm 25,000$  ppm
- Line codes: HDB3, AMI
- Input Level: From 0 dB to -45 dB
- Pulse mask compliance: ITU-T G.703
- Jitter compliance: ITU-T G.823

15.3 **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 (ANSI T1.102-1999, ITU G.703)

15.4 **Frame**

- 2048 kb/s unframed (ITU-T G.704, G.704 CRC / CAS / CRC+CAS)
- Nx64 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

15.5 **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)

15.6 **Frame and Pattern Analysis**

- Defects: LOS, LOF, AIS, RDI, CRC-LOM, CAS-LOM, MAIS, MRDI, LSS, All 0, All 1, Slip
- Anomalies: Code, FAS error, 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

15.7 **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)

15.8 **Event Insertion**

- Physical: Code, AIS, LOS
- Frame: FAS/CRC/MFAS error, REBE, LOF, MAIS, CAS-LOM, RAI, MRAI, CRC-LOM
- Pattern: TSE, Slip, LSS, All 0, All 1

**Modes**

- Anomalies: single, rate
- Defects: continuous, burst of M, M out of N

15.9 **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

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- Waveform: sinusoidal
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- Resolution: 0.1 Hz (jitter), 1  $\mu$ Hz (wander)
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- Amplitude: 0 to 1000 Uipp
- Resolution: 1 mUipp or  $1/10e4$
- Accuracy: better than ITU-T 0.172

**Jitter Results**

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

**Filters E1**

- LP ( $f < 100$  kHz)
- LP+HP1 ( $20 \text{ Hz} < f < 100$  kHz)
- LP+HP2 ( $18 \text{ kHz} < f < 100$  kHz)
- LP+RMS ( $12 \text{ kHz} < f < 100$  kHz)

15.12 **Wander Analysis**

- Interfaces: T1, 1544 kHz, 10 MHz, 1 PPS
- Open loop method
- Range: 1  $\mu$ Hz to 10 Hz
- Sampling: 50 Hz
- Amplitude: 0 to  $\pm 2$  s (single range)

**Results**

- Tables and Graphs
- Accuracy: 2 ns
- Built-in and real time
- 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 SS26 (Smart Serial Universal) for DTE / DCE (see Fig.1)

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.21 / V.11 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  $\pm 25,000$  ppm
- Data, Stop, Parity bits and Inter-word gap configuration in V.24

16.4 **Operation Modes**

- DTE / DCE emulation, Full duplex monitor

16.5 **Event Insertion**

- Physical: LOC
- Pattern: TSE, Slip, LSS, All 0, All 1
- V24: FRM, PRTY

**Modes**

- Anomalies: single, rate
- Defects: continuous

16.6 **Analysis**

**Line 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**

- Patch cord delay compensation

**Two-way delay**

- Round Trip Delay (RTD)
- Current / max / min results

**One-way delay**

- Forward / Reverse Path delay
- Asymmetry with min / max results

17. **Co-Directional (ITU-T G.703 / E0)**

17.1 **Interfaces**

- Balanced (RJ-45) 120  $\Omega$
- 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, 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

18. **Voice Frequency Test**

- Tone Generation (from 10 to 4000 Hz, from 0 to -60 dBm)
- Analysis: Level (dBm0), Frequency (Hz)
- ITU-T G.711 analysis: Max / Min / Avg code

18.1 **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

19. **IEEE C37.94**

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
- Patch cord delay compensation

20. **Clock Monitor Mode**

- Frequency inputs: 2048, 1544 and 10 kHz
- Time inputs: 1PPS, ToD
- TIE, MTIE and TDEV: for all inputs
- TE and max |TE|: for 1PPS
- TE dynamic and constant components
- Jitter and wander generation in 1544 and 2048 kHz interfaces

21. **Platform**

21.1 **Ergonomics**

- Size: 260 x 160 x 63 mm
- Weight: 1.9 kg (two pack of batteries always included)

21.2 **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 or VNC

21.3 **Results**

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

21.4 **Board**

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

21.5 **Batteries**

- 2 x Li Ion Polymer
- Duration depends on multiple factors including application, aging, temperature, screen, etc.

21.6 **Operational Ranges**

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