



*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 12/3/19

# xGenius a new dimension

## 1. General

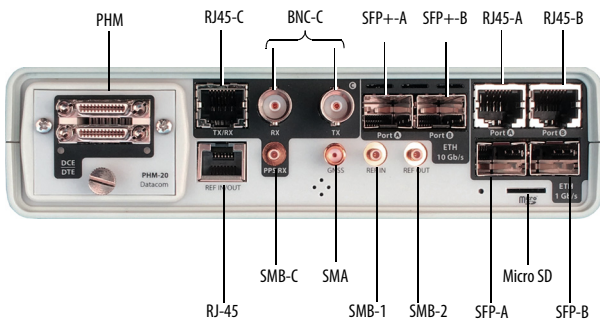
### 1.1 Operation Modes

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

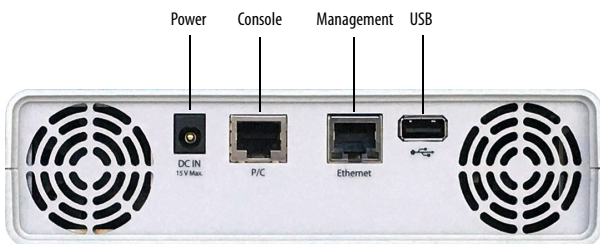
Connection	Operation modes							
	Eth	Eth L1	T1/E1	Analog	Data	Clock	E0	C37.94
End-point	YES	YES	YES	YES	YES		YES	YES
Monitor	YES		YES		YES	YES	YES	YES
Pass	YES							YES
Loop	YES	YES	YES		YES		YES	YES
MuxDmux			YES					

### 1.2 Ports and Connectors

#### Front Panel



#### Back Panel



**Figure 1.** Ports and connectors

## 1.3 Test Interface and Clock Reference Summary





**Table 2.** Native Test Interfaces and Clock References

□ Clock references, ■ Test signals

	Operation modes				
	10GE	1GE	T1/E1	Clk Monitor	Cable
RJ45-A		Ethernet, IP PTP, SyncE			Ethernet
		SyncE			SyncE
RJ45-B		Ethernet, IP PTP, SyncE			Ethernet
		SyncE			SyncE
SFP-A		Ethernet, IP PTP, SyncE			
		SyncE			
SFP-B		Ethernet, IP PTP, SyncE			
		SyncE			
SFP+-A	Ethernet, IP PTP, SyncE				
	SyncE				
SFP+-B	Ethernet, IP PTP, SyncE				
	SyncE				
BNC-C			E1	5/10 MHz 2448 kHz 1544 kHz	
RJ45-C			T1/E1	5/10 MHz 2048 kHz 1544 kHz 1 PPS/1 PP2S ToD	
SMB-C				1PPS/1PP2S	
SMA	GNSS	GNSS	GNSS	GNSS	GNSS
SMB-1	1PPS/1PP2S	1PPS/1PP2S	1PPS/1PP2S	1PPS/1PP2S	1PPS/1PP2S
SMB-2	1PPS/1PP2S	1PPS/1PP2S	1PPS/1PP2S	1PPS/1PP2S	1PPS/1PP2S
RJ45-1	T1/E1 5/10 MHz 2048 kHz 1544 kHz 1 PPS/1 PP2S ToD	T1/E1 5/10 MHz 2048 kHz 1544 kHz 1 PPS/1 PP2S ToD	T1/E1 5/10 MHz 2048 kHz 1544 kHz 1 PPS/1 PP2S ToD	T1/E1 5/10 MHz 2048 kHz 1544 kHz 1 PPS/1 PP2S ToD	T1/E1 5/10 MHz 2048 kHz 1544 kHz 1 PPS/1 PP2S ToD

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**Table 3. PHM Interfaces**

	Layout	Modes	Connectors
PHM-20		Datacom endpoint Datacom monitor Datacom loop	SS26 DCE SS26 DTE
PHM-21		IEEE C37.94 endpoint IEEE C37.94 through IEEE C37.94 monitor IEEE C37.94 loop	2 x SFP
PHM-22		G.703/E0 endpoint G.703/E0 monitor G.703/E0 loop	RJ-45
PHM-23		Analog	RJ-45 Headset

**1.4 Internal Clock**

- Rubidium better than  $\pm 5.0e-11$
- OCXO better than  $\pm 0.1$  ppm
- Internal time reference better than  $\pm 2.0$  ppm

**1.5 Rubidium features**

**GNSS Locked**

- Time/Phase Accuracy to UTC:  $\pm 20$  ns at  $1\sigma$  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):  $\pm 100$  ns / 2h,  $\pm 1.0\mu s / 24$  h

**Freerun**

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

**1.6 Built-in GNSS receiver**

- SMA connector
- GPS, Glonass, Beidou, Galileo support single / multiple selection
- Onmidirectional 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 PPS, 1PP2S balanced and unbalanced compatible with standard ITU-T G.8271. ToD 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

**1.8 Clock Reference Outputs**

- 2048 kHz and 10 MHz unbalanced.
- 1 PPS, 1 PP2S, balanced and unbalanced compatible with standard ITU-T G.8271. ToD balanced compatible with ITU-T G.8271 and NMEA
- Custom delay compensation for phase and time outputs

**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

**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  $\pm 125$  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)**

- 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**

**5.1 IPv4**

- Sour / Dest edition

- Dest MAC address edition or set up by ARP
- DSCP CoS label editon, TTL and transport protocol
- IP checksum errors insertion
- UDP source and destination port 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

- 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 field

## 7.4 IPv6 Selection

- IPv6 sour / 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 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

### 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, 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

## 10.4 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<sup>L</sup>TE components (ITU-T G.8271.1)
- High frequency TE (ITU-T G.8271.1 d<sup>H</sup>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 (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 TCP test - 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 and 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)
- 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)
- 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 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)

### 14.5 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 (± pulses)
- 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 μ law)
- CAS A, B, C, D bit analysis
- FDL analysis (ESF frame format)

### 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

### Modes

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

### 14.10 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

#### 14.11 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 < 10 mUipp

#### 14.12 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

#### Jitter Results

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

#### Filters

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

#### 14.13 Wander Analysis

- Range: 1  $\mu$ Hz to 10 Hz
- Sampling: 50 Hz
- Amplitude: 0 to  $\pm 2$  s (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

## 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 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)
- 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

#### 15.6 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, 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

#### 15.8 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)

#### 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  $\mu$ 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 < 10 mUipp

#### 15.12 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 (max. depends on modulation freq.)
- Resolution: 1 mUipp or  $1/10^4$
- Accuracy: better than ITU-T 0.172

#### Jitter Results

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

**Filters**

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

15.13 **Wander Analysis**

- Range: 1  $\mu\text{Hz}$  to 10 Hz
- Sampling: 50 Hz
- Amplitude: 0 to  $\pm 2$  s (single range)
- Accuracy: 2 ns
- Wander masks: E1 ITU-T G.823, PDH ITU-T G.823 / ETSI EN 300 462-3-1, PDH ITU-T G.8261 CES, PDH ITU-T G.8261 CES (option 2A), PDH ITU-T G.8261 CES, PRC ITU-T G.811, PRC ETSI EN 300 462-3-1, PRC ITU-T G.823, SSU ITU-T G.823 / ETSI EN 300 462-3-1, SSU ITU-T G.812 Noise generation, constant temperature, SSU ITU-T G.812 Noise tolerance, SSU ITU-T G.812 Noise transfer, variable temperature, SSU ITU-T G.812 Noise transfer, SEC ITU-T G.823 / ETSI EN 300 462-3-1, SEC ITU-T G.813 Constant temperature (option 1), SEC ITU-T G.813 Constant temperature (option 2), SEC ITU-T G.813 Holdover (option 2), SEC ITU-T G.813 Noise tolerance (option 1), SEC ITU-T G.813 Noise tolerance (option 2), SEC ITU-T G.813 Noise transfer (option 2), SEC ITU-T G.813 Reference switching (option 2), SEC ITU-T G.813 Variable temperature (option 1)

**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 SS26 (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  $\pm 25,000$  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**

**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**

**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 EO**

17.1 **Interfaces**

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

- One way Forward / Reverse Path delay
- Asymmetry with min. / max. records
- Patch cord delay compensation
- Pass / Fail indication

## 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
- Patch cord delay compensation
- Pass / Fail indication

### 19.8 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 (max. depends on modulation freq.)
- Resolution: 1 mUIpp or 1/10e4
- Accuracy: better than ITU-T 0.172

#### 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)

### 19.9 Wander Analysis

- Range: 1  $\mu$ Hz to 10 Hz
- Sampling: 50 Hz
- Amplitude: 0 to  $\pm 2$  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

## 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  $\Omega$ )

### 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 UIpp (max. depends on modulation freq.)
- Resolution: 1 mUIpp or 1/10e4
- Accuracy: better than ITU-T 0.172

#### 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)

#### Filters (1544 kHz)

- LP (f < 40 kHz)
- LP+HP1 (10 Hz < f < 40 kHz)
- LP+HP2 (8 kHz < f < 100 kHz)

### 20.3 Wander Analysis

- Range: 1  $\mu$ Hz to 10 Hz
- Sampling: 50 Hz
- Amplitude: 0 to  $\pm 2$  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

- Independent loopback control for each port
- Custom latency generation up to 50 ms at 2048 kHz

## 22. Service Disruption Time

- Interfaces: E1/T1, C37.94, Datacom, Co/contra-directional, centralized
- Resolution is 100  $\mu$ s 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%

