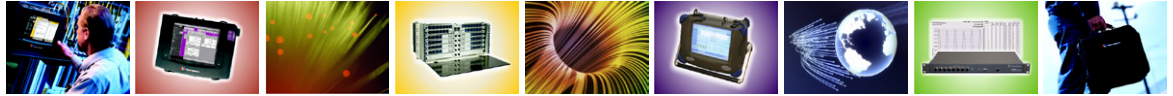




# Insure Error-Free Networks...



## NIC Jitter and Wander Module

### Technical Specifications

#### Jitter Generation Specifications

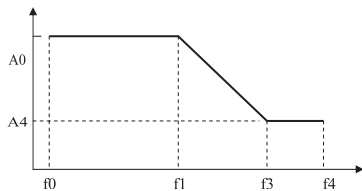
**Bit Rates** OC-3/STM-1 (155.52 Mbps), STM-1e (155.52 Mbps), OC-12/STM-4 (622.08 Mbps), OC-48/STM-16 (2488.32 Mbps), OTU1 OTN (2666.06 Mbps), OC-192/STM-64 (9953.28 Mbps), OUT2 OTN (10709.00 Mbps)

**Automated Jitter Compliance Testing** **Jitter Tolerance:** Built in test limits per Telcordia, ITU, ANSI, and ETSI standards; user defined jitter tolerance masks (100 points max), jitter tolerance test types:  
 - Power penalty acceptance  
 - Power penalty measure  
 - Onset of errors acceptance  
 - Onset of errors measure

**Jitter Transfer:** Built in test limits per Telcordia, ITU, ANSI, and ETSI standards; user defined jitter transfer masks (100 points max); accuracy per 0.172

**Jitter Modulation** Built-in modulation generator (sinewave) frequency source 9 Hz to 80 MHz

**Jitter Amplitude** 0 to 3600 Ulpp, resolution = 0.001 Ulpp



Rate (Mb/s)	A0 (UI)	A4 (UI)	f0 (Hz)	f1 (Hz)	f3 (Hz)	f4 (Hz)
10709.0	3600	0.2	9	667	12 M	80 M
9953.28	3600	0.2	9	667	12 M	80 M
2666.06	900	0.3	9	2222	6.67 M	20 M
2488.32	900	0.3	9	2222	6.67 M	20 M
622.08	450	0.3	9	1111	1.67 M	5 M
155.52	450	0.3	9	289	433 k	1.3 M

**Generation Range**

**Jitter Generation Frequency Accuracy** For  $f_m \leq 10$  MHz  $\pm 1\%$   
 For  $10$  MHz  $< f_m < 60$  MHz  $\pm 5\%$   
 For  $60$  MHz  $< f_m \leq 80$  MHz  $\pm 6\%$

**Frequency Resolution**

Jitter Modulation Frequency	Resolution
9 Hz – 999.99 Hz	0.01 Hz
1 KHz – 999.99 KHz	0.01 KHz
1 MHz – 80.00 MHz	0.01 MHz

**Jitter Generator Amplitude Accuracy**  $\pm Q\%$  of amplitude setting  $\pm X$  Ulpp  
 X is the fixed error (defined per 0.172)

Rate	Q
10709.00 Mbps:	8% < 500 KHz
	12% 500 KHz – 2 MHz
	15% > 2 MHz
9953.28 Mbps:	8% < 500 KHz
	12% 500 KHz – 2 MHz
	15% > 2 MHz
2666.06 Mbps:	8% < 500 KHz
	12% > 500 KHz
2488.32 Mbps:	8% < 500 KHz
	12% > 500 KHz
622.08 Mbps:	8% < 500 KHz
	12% > 500 KHz
	15% > 500 KHz
155.52 Mbps:	8% < 500 KHz
	12% > 500 KHz

X is the fixed error defined per 0.172  
 0.02 UI @ 10709.00 Mbps, 9953.28 Mbps (typical)  
 0.02 UI @ 2488.32 Mbps, 2666.06 Mbps  
 0.01 UI @ 622.08 Mbps, 155.52 Mbps

**Jitter Generator Intrinsic**  
 10709.00 Mbps: 0.040 Ulpp<sup>6,7</sup>  
 9953.28 Mbps: 0.040 Ulpp<sup>5,6</sup>  
 2666.06 Mbps: 0.050 Ulpp<sup>1,7</sup>  
 2488.32 Mbps: 0.040 Ulpp<sup>1,5</sup>  
 622.08 Mbps: 0.030 Ulpp<sup>2,5</sup>  
 155.52 Mbps: 0.020 Ulpp<sup>3,5</sup>  
 STM-1e: 0.030 Ulpp<sup>4,5</sup>

**Notes:**

- 1) Optical output, measurement BW 5 kHz - 20 MHz (typical)
- 2) Optical output, measurement BW 1 kHz - 5 MHz (typical)
- 3) Optical output, measurement BW 500 Hz - 1.3 MHz (typical)
- 4) STM1e output, 0 dB Gain, measurement BW 500 Hz - 1.3 MHz (typical)
- 5) Intrinsic values assume a structured STM-Nc signal with a payload of PRBS 2<sup>23</sup> - 1
- 6) Optical output, measurement BW 20 KHz - 80 MHz (typical)
- 7) Intrinsic values assume a structured OTU-N signal with a structured SDH payload. The SDH payload is comprised of an STM-Nc signal with a payload of PRBAS 2<sup>23</sup> - 1. N is 16 for OTU1. N is 64 for OTU2.

#### Jitter Measurement Specifications

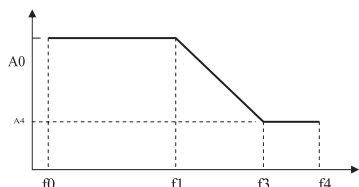
**Bit Rates** OC-3/STM-1 (155.52 Mbps), STM-1e (155.52 Mbps), OC-12/STM-4 (622.08 Mbps), OC-48/STM-16 (2488.32 Mbps), OTU1 OTN (2666.06 Mbps), OC-192/STM-64 (9953.28 Mbps), OTU2 OTN (10709.00 Mbps)

**Automated Jitter Compliance Testing** Jitter Generation: Built in test limits per Telcordia, ITU, ANSI, and ETSI standards; user defined jitter generation limits

# NIC Jitter and Wander Module

## Technical Specifications

### Jitter Measurement Range



Rate (Mb/s)	A0 (UI)	A4 (UI)	f0 (Hz)	f1 (Hz)	f3 (Hz)	f4 (Hz)
10709.0	3600	0.2	9	667	12 M	80 M
9953.28	3600	0.2	9	667	12 M	80 M
2666.06	900	0.3	10	2222	6.67 M	20 M
2488.32	900	0.3	10	2222	6.67 M	20 M
622.08	450	0.3	10	1111	1.67 M	5 M
155.52	450	0.3	10	289	433 k	1.3 M

Measurement Resolution 0.001 UI for peak-to-peak jitter  
0.0001 UI for RMS jitter

### Measurement Bandwidths

Bit Rate	HPF -3dB freq	LPF -3dB freq
10709.00 Mb/s	10 KHz	80 MHz
10709.00 Mb/s	20 KHz	80 MHz
10709.00 Mb/s	50 KHz	80 MHz
10709.00 Mb/s	4 MHz	80 MHz
9953.28 Mb/s	10 KHz	80 MHz
9953.28 Mb/s	20 KHz	80 MHz
9953.28 Mb/s	50 KHz	80 MHz
9953.28 Mb/s	4 MHz	80 MHz
2666.06 Mb/s	5 kHz	20 MHz
2666.06 Mb/s	12 kHz	20 MHz
2666.06 Mb/s	1 MHz	20 MHz
2488.32 Mb/s	5 kHz	20 MHz
2488.32 Mb/s	12 kHz	20 MHz
2488.32 Mb/s	1 MHz	20 MHz
622.08 Mb/s	1 kHz	5 MHz
622.08 Mb/s	12 kHz	5 MHz
622.08 Mb/s	250 kHz	5 MHz
155.52 Mb/s	500 Hz	1.3 MHz
155.52 Mb/s	12 kHz	1.3 MHz
155.52 Mb/s	65 kHz	1.3 MHz

Ulrms is available on 12 kHz filter at 2666.06 Mbps, 2488.32 Mbps, 622.08 Mbps, and 155.52 Mbps

Ulrms is available on 50 kHz filter at 9953.28 Mbps, 10709.00 Mbps

Frequency Response of Measurement Function All high-pass filters (HPF) are first-order (-20 dB/dec); All low-pass filters (LPF) are third-order (-60 dB/dec) maximally flat; HPF -3dB Frequency Error < ±5%; LPF -3dB Frequency Error < ±10%

Measurement filter characteristics meet or exceed requirements of ITU recommendation 0.172

Jitter Measurement Result Accuracy Peak to peak: ±R% of reading ±W  
RMS: ±R% of reading ±.005 UI  
R = 5% for all bit rates and measurement bandwidths

Bit Rate	Measurement Bandwidth	W			
		U <sub>pp</sub> <sup>(a,b,c)</sup>	U <sub>pp</sub> (Max)	U <sub>lrms</sub>	U <sub>lrms</sub> (Max)
STM-1e	500Hz – 1.3MHz	0.030	0.035	-	-
	12 kHz – 1.3 MHz	0.030	0.035	0.005	0.005
	65kHz – 1.3 MHz	0.025	0.025	-	-
155.52 Mb/s	500Hz – 1.3MHz	0.030	0.035	-	-
	12kHz – 1.3MHz	0.030	0.035	0.005	0.005
	65kHz – 1.3 MHz	0.030	0.035	-	-
622.08 Mb/s	1kHz – 5MHz	0.030	0.035	-	-
	12kHz – 5MHz	0.030	0.035	0.005	0.005
	250kHz – 5MHz	0.030	0.035	-	-
2488.32 Mb/s	5kHz – 20MHz	0.045	0.050	-	-
	12kHz – 20MHz	0.045	0.050	0.005	0.005
	1MHz – 20MHz	0.045	0.050	-	-
2666.06 Mb/s	5kHz – 20MHz	0.045	0.050	-	-
	12kHz – 20MHz	0.045	0.050	0.005	0.005
	1MHz – 20MHz	0.045	0.050	-	-
9953.28 Mb/s	10kHz – 80MHz	0.035	0.050	-	-
	20kHz – 80MHz	0.035	0.050	0.005	0.005
	50kHz – 80MHz	0.035	0.050	-	-
10709.00 Mb/s	4MHz – 80MHz	0.035	0.050	-	-
	10kHz – 80MHz	0.035	0.050	-	-
	20kHz – 80MHz	0.035	0.050	0.005	0.005
	50kHz – 80MHz	0.035	0.050	-	-
	4MHz – 80MHz	0.035	0.050	-	-
	4MHz – 80MHz	0.035	0.050	-	-

- (a) typical
- (b) All SONET/SDH values are for a STM-Nc structured signal containing a payload of PRBS 2<sup>23</sup>-1
- (c) All OTN values are assumed a structured OTU-N signal with a structured SDH payload. The SDH payload is comprised of an STM-Nc signal containing a payload of PRBS 2<sup>23</sup>-1. N is 16 for OTU1. N is 64 for OTU2.

### Measurement Capabilities

Sliding window of 1 second, 60 seconds, or infinite size (max hold) Peak-to-peak jitter (UI)

Positive peak jitter (UI)  
Negative peak jitter (UI)  
RMS jitter (UI)  
Jitter hit count  
Jitter hit seconds (variable threshold over entire measurement range)  
Loss of signal seconds count

### Notes:

- 1) For structured data signals per 0.172 Annex A
- 2) For optical input power levels between -10 dBm and -12 dBm per 0.172 section 9.4.1 clause b

## Internal Transmit Clock

Frequency Deviation ±4.6 ppm

## Transmitter Inputs and Outputs

Optical Transmit Wavelength: 1290-1320 nm / 1529.55-1563.05 nm  
Average output power: ≥ -2 dBm, 0 dBm typical  
Extinction Ratio: ≥10 dB @ 1550 nm; ≥8.2 dB @ 1310nm; Max power: 5mW (continuous wave)

STM-1E Transmit Amplitude: ~1V  
Coupling: AC, non-Isolated  
Connector: BNC  
Impedance: 75 ohm  
Line Coding: CMI

# NIC Jitter and Wander Module

## Technical Specifications

**Reference Clock Output** Frequency: 622.08 MHz  
Amplitude: >650 mVpp, 800 mVpp typical  
Coupling: AC  
Connector: SMA  
Impedance: 50 ohm

**Trigger Output** Amplitude: >650 mVpp, 800 mVpp typical  
Coupling: AC  
Connector: SMA  
Impedance: 50 ohm

### Receiver Inputs and Outputs

**Optical Receive** Sensitivity: -22 dBm @ bit rates < 2488.32 Mbps (PRBS23,  $1 \times 10^{-10}$  BER); -15 dBm @ 9953.28 Mbps and 10709.00 Mbps (PRBS23,  $1 \times 10^{-10}$  BER)  
Overload: > 0 dBm (1 dBm Typical)  
Optical Return Loss: < 27 dB  
Wavelength: 1250-1600 nm  
Optimum Jitter Measurement range: -10 dBm to -12 dBm

**STM-1E Receive** Amplitude: 1V Max; Coupling: AC, non-Isolated;  
Connector: BNC; Impedance: 75 ohm;  
Line Coding: CMI  
Selectable Gain: Normal (0dB) or Monitor (-20 dB)

**Recovered Clock Output** Amplitude: >600 mVpp, 800 mVpp Typical  
Coupling: AC; Connector: SMA; Impedance: 50 ohm

**Demodulated Output** Maximum Amplitude: 1.0 Vpp + - 5%  
Selectable Sensitivity: 1 U1pp/V, 4 U1pp/V, 16 U1pp/V, 64 U1pp/V, 256 U1pp/V, 1024 U1pp/V, or 4096 U1pp/V  
Coupling: DC; Connector: SMA; Impedance: 50 ohm

## Wander

All wander measurements and tests require use of an external PC.

**Bit Rates** OC-3/STM-1 (155.52 Mbps), STM-1e (155.52 Mbps), OC-12/STM-4 (622.08 Mbps), (OC-48/STM-16) 2488.32 Mbps, (OC-192/STM-64) 9953.28 Mbps, (OTN) 10709.00 Mbps

**Output Filter** 10 Hz  $\pm$  0.1% first-order roll off

**Maximum Slew Rate**  $\pm$ 100,000 ns/sec

**Wander Patterns** Sine Wave:  
Modulation frequency range: 1  $\mu$ Hz to 24.9 Hz  
Resolution: 1  $\mu$ Hz  
Amplitude range: 0 to 100,000 ns pp @  $f_m \leq 1$ Hz,  
0 to x @  $f_m > 1$  Hz where x = (100,000 ns pp /  $f_m$ )  
Accuracy:  $\pm$  0.1% of setting  $\pm$  1 ns

Trapezoid wave, triangle wave:  
Similar to sine wave but has linear slews

TDEV noise patterns:  
TDEV tolerance, SSU Type 1 TDEV tolerance

Phase transients: Fixed transients:  
Duration: 16.37 ms  
Height: 1000 ns or 1200 ns

Transient Ramp: User selectable height and duration  
Duration: 0.02 – 1,000,000 sec  
Height: 1 – 20,000 ns

**Wander Analyzer** Measurement duration: Min: 10 seconds  
Max: Limited only by external PC available disk space.  
Disk space used at approximately 1.42 Mbytes per hour (20 ms storage interval).

Sample Rate: 50 Hz  
Sample storage intervals: 20 ms, 1 sec, 10 secs  
Input frequency: 0 to 10 Hz  
Anti-alias filter: 10 Hz  $\pm$  0.1% first-order roll off  
Maximum slew rate:  $\pm$ 100,000 ns/sec

TIE, MTIE, MRTIE, TDEV measurement range:  
Unlimited for signals with  $\pm$ 100,000 ns/sec max slew rate

Noise:  $\pm$  2.5 ns  
Amplitude Accuracy:  $\pm$  1%  $\pm$  2.5 ns  
Bandwidth: 0 Hz to 10 Hz  
Resolution: 1 nanosecond  
Observation time: 0.02 to 10,000,000 second

Test Masks: Masks from various standards are displayed along with the measurement graphs and tests for pass or fail are performed

Integration Time: 0.02 to 167000 second

Frequency Offset and Frequency Drift measurements:  
Calculation and display of frequency offset and drift rate from TIE data

**Frequency Drift** Range: 0-867.480 ppm/sec  
Accuracy: < 1%  $\pm$  0.01 ppm/sec  
Bandwidth: 0 Hz to 0.5 Hz  
Resolution: 0.001 ppm/sec

**Frequency Offset Resolution** 0.000001 ppm

# NIC Jitter and Wander Module

## Technical Specifications

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### KEY FEATURES

- Stable, repeatable digital jitter measurement
- Applicable to product design, production floor and field
- Proprietary SiGe chip technology
- Patented Digital Phase Analysis (DPA)
- Wide jitter dynamic range
- Same high resolution for the entire jitter range
- Compliant to ITU-T 0.172, G.825, G.958 and Telcordia GR-253

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