Tektronix®

DSA8300 Digital Serial Analyzer, 80C00 Series Optical Sampling Modules, 80E00 Series Electrical Sampling Modules, 80A00 Modules Specifications

Technical Reference

077-0571-04

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www.tek.com

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Preface

This manual contains the specifications and performance verification procedures for the DSA8300 Digital Serial Analyzer, the extender cables, and the modules that can be installed in this instrument (except the 80A03 module).

NOTE. *The 80A03 instruction manual contains its own specifications and servicing information.*

Read this preface to learn how this manual is structured, what conventions it uses, and where you can find other information related to this product.

Manual structure

This manual is divided into chapters that are made up of related subordinate topics. These topics can be cross referenced as sections.

Be sure to read the introductions to all procedures. These introductions provide important information needed to do the service correctly, safely, and efficiently.

Manual conventions

This manual uses certain conventions that you should become familiar with before attempting service.

Modules

Throughout this manual, the term *module* appears. A module is composed of electrical and mechanical assemblies, circuit cards, interconnecting cables, and a user-accessible front panel. References to a module are different than references to products such as “Sampling modules”, “Phase Reference modules”, or “Accessory modules”, which are products installed in the instrument compartments or on extender cables.

Related documentation

The following documents relate to the instrument this manual supports:

- *DSA8300 Digital Serial Analyzer Quick Start User Manual.* Tektronix part number 071-2897-XX.
- *DSA8300 Digital Serial Analyzer Service Manual.* Tektronix part number 071-2049-XX.
- *DSA8300 Digital Serial Analyzer Help.* Installed with the application software and accessed from the instrument Help menu.

- *DSA8300 Digital Serial Analyzer Programmer Guide.* An online document accessed from the instrument Help menu.
- *80E01, 80E02, 80E03, 80E04, and 80E06 Electrical Sampling Modules User Manual.* Tektronix part number 071-0434-XX.
- *80C00 and 80E00 Series Electrical and Optical Sampling Modules User Manual*, Tektronix part number 071-3059-XX.
- *80A02 EOS/ESD Protection Module Instructions.* Tektronix part number 071-1317-XX
- *80A03 TekConnect Probe Interface Module Instructions.* Tektronix part number 071-1298-XX.
- *80A05 Electrical Clock Recovery Module User Manual.* Tektronix part number 071-1467-XX.
- *DSA8300, DSA8200, CSA8200, CSA8000, CSA8000B, TDS8200, TDS8000, and TDS8000B Rackmount Kit Instructions.* Tektronix part number 071-0696-XX.
- *80N01 Extender Cable Instructions.* Tektronix part number 071-2037-XX

DSA8300 specifications

NOTE. *This specification is for the DSA8300 mainframe (instrument); the specifications for the optical, electrical, and other modules that insert in the module compartments of the DSA8300 front panel are included later in this document.*

This section contains the specifications for the DSA8300 Digital Serial Analyzer.

NOTE. *The 82A04/B Phase Reference modules affect the DSA8300 mainframe specifications; therefore, the 82A04/B module specifications are part of the DSA8300 mainframe specifications.*

All specifications are guaranteed unless noted as "typical." Typical specifications are provided for your convenience but are not guaranteed. Specifications that are marked with the ✓ symbol are checked in the *DSA8300 Digital Serial Analyzer Performance Verification Technical Reference* manual.

All specifications apply to the instrument and sampling modules unless noted otherwise. To meet specifications, these conditions must first be met:

- The instrument must have been calibrated/adjusted at an ambient temperature between +10 °C and +40 °C.
- The instrument must have been operating continuously for 20 minutes within the operating temperature range specified.
- The instrument must be in an environment with temperature, altitude, humidity, and vibration within the operating limits described in these specifications.

NOTE. *"Sampling Interface" refers to both the small module compartments and the large module compartments, unless otherwise specified.*

Table 1: DSA8300 - signal acquisition specifications

Description	Characteristics
Number of input channels	8 acquisition channels, maximum.
Number of small sampling module compartments	4 compartments, 2 channels per compartment, for a total of 8 channels [1].
Number of large sampling module compartments	2 compartments, for a total of 4 channels [1].
Small Sampling Module Interface	Tekprobe-Sampling Level 3. Hot switching is not permitted on this interface.
Large Sampling Module Interface	Tekprobe-Sampling Level 3. Hot switching is not permitted on this interface.

Table 1: DSA8300 - signal acquisition specifications (cont.)

Description	Characteristics
Compartment assignments and conflict resolution	Population of the Ch 1 / Ch 2 large compartment with any module (other than one requiring power only) displaces functionality of the Ch 1 / Ch 2 small compartment. Population of the Ch 3 / Ch 4 large compartment with any module (other than one requiring power only) displaces functionality of the Ch 3 / Ch 4 small compartment.
Compartment utilization	Supports the 80xxx and 82xxx nomenclated modules, including Phase Reference modules.
Real time accessory interface	Small and large slots support TekProbe-SMA, Levels 1 and 2, on modules equipped with front-panel probe connectors. TekConnect probes are supported with 80A03 accessory for all small slot modules. Hot switching is permitted on this real time accessory interface.
Vertical sensitivity ranges	10 mV to 1 V full scale at TekProbe-sampling interface. May be scaled according to sampling module scaling characteristics and attached real-time probes.
Vertical operating range	–1.6 V to +1.6 V at TekProbe-sampling interface. May be scaled according to sampling module scaling characteristics and attached real-time probes, .
Vertical number of digitized bits	16 bits at TekProbe-Sampling interface.
Offset capabilities	Open loop offset mode is supported at TekProbe-Sampling interface.
Offset range	–1.6 V to +1.6 V maximum at TekProbe-Sampling interface. May be limited to a smaller range and scaled according to sampling module offset and scaling characteristics.

[1] Total channels ≤8.

Table 2: DSA8300 - timebase specifications

Description	Characteristics
Horizontal modes	
Mainframe	Supports Free Run mode, Edge triggered mode, Clock Trigger mode and TDR mode. The 10 MHz reference may be internal or external for TDR mode only.
Mainframe with 82A04/B	Supports Legacy Free Run and triggered modes.
Sampling rate	
Mainframe (regular modes)	DC–200 kHz maximum, dictated by trigger rate and actual holdoff setting. If trigger rate is less than the maximum, or the requested holdoff exceeds the minimum, the trigger rate and/or holdoff determines the sampling rate. TDR operation allows manual setting to 300 kHz.
Mainframe with 82A04/B (phase corrected modes)	DC–200 kHz maximum, one channel. If trigger rate is less than the maximum, or the requested holdoff exceeds the minimum, the trigger rate and / or holdoff determines the sampling rate.
Record length [1]	20, 50, 100, 250, 500, 1000, 2000, 4000, 8000, and 16000 samples.
Horizontal scale range	100 fs/div to 5 ms/div in 1, 2, 5 steps, or 100 fs increments.
Horizontal position range	
Mainframe	50 ms maximum.

Table 2: DSA8300 - timebase specifications (cont.)

Description	Characteristics
Mainframe with 82A04/B	Range is determined by the following formula, where (f) equals the reference clock frequency: $maxTimeOfFirstPoint = \frac{1}{f} \times 2^{16}$
Horizontal resolution	62.5 as (attoseconds; 10^{-18}) minimum.
Horizontal position setting resolution	10 fs minimum.
Time interval accuracy	Strobe placement accuracy for a given horizontal interval and position. (Contribution from 80E04 sampling module is included in the specification.)
✓ Edge triggered mode, front panel edge trigger source	For 100 or more tests performed over specified interval, Horizontal scale > 20 ps/div, right-most point of measurement interval <150 ns: Mean accuracy is 0.1% of specified interval or better Standard deviation is ≤1.5 ps
Edge triggered mode, front panel edge trigger source (typical)	For 100 or more tests performed over specified interval, Horizontal scale ≤20 ps/div, right-most point of measurement interval <150 ns: Mean accuracy = 1 ps +0.5% of interval, typical
✓ Clock Other mode, front panel clock source	For 100 or more tests performed over specified interval, Horizontal scale >20 ps/div, right-most point of measurement interval <150 ns: Mean accuracy = 0.1% of specified interval or better Standard deviation is ≤3 ps
Clock Other mode, front panel clock source (typical)	For 100 or more tests performed over specified interval, Horizontal scale ≤20 ps/div, right-most point of measurement interval <150 ns: Mean Accuracy = 1 ps + 0.5% of interval, typical
✓ Clock Eye mode, front panel clock source	For 100 or more tests performed over a given interval, standard deviation is ≤1.5 ps
Clock Eye mode, front panel clock source (typical)	For 100 or more tests performed over a given interval, standard deviation = 0.1 ps typical
✓ TDR mode, locked to external 10 MHz reference	For 100 or more tests performed over specified interval, Horizontal scale >20 ps/div, right-most point of measurement interval <150 ns: Mean accuracy = 0.01% of specified interval or better Standard deviation is ≤1.5 ps
TDR mode, locked to external 10 MHz reference (typical)	For 100 or more tests performed over specified interval, Horizontal scale ≤20 ps/div, right-most point of measurement interval <150 ns: Mean accuracy = 0.01% of specified interval
Timing accuracy	Mainframe equipped with 82A04/B
Random phase corrected mode (typical)	Maximum timing deviation 0.2% of phase reference signal period, relative to phase reference signal Assumes that phase reference frequency has been correctly entered. Operation of the phase reference clock at frequencies requiring extended bandwidth or signal conditioning may require an instrument option

Table 2: DSA8300 - timebase specifications (cont.)

Description	Characteristics
Triggered phase corrected mode (typical)	Maximum timing deviation relative to phase reference signal: 0.2% of phase reference signal period typical for measurements made >40 ns after trigger event 0.4% of phase reference signal period typical for measurements made ≤40 ns after trigger event Assumes that phase reference frequency has been correctly entered. Operation of the phase reference clock at frequencies requiring extended bandwidth or signal conditioning may require an instrument option
Horizontal deskew range and resolution	
Mainframe	–500 ps to +100 ns on any individual channel in 1 ps increments
Mainframe with 82A04/B	Deskew range extends over the full clock cycle of the phase reference.

1 The total number of samples contained in a single acquired waveform record (memory length in IEEE 1057, 2.2.1).

2 80E02 sampling module is included in this specification.

Table 3: DSA8300 - trigger specifications

Description	Characteristics
Trigger sources	
Mainframe	Clock Input/Prescale Trigger (front panel) Trigger Direct Input (front panel) Free run trigger TDR Left and right large slot internal pattern clock (with appropriately equipped large slot modules)
Mainframe with 82A04/B	A phase reference signal may be applied to the instrument, when equipped with an 82A04B Phase Reference module, to provide additional phase information for signals acquired in Triggered Phase Corrected modes and primary phase information for signals acquired in Free Run Phase Corrected modes. Two bandwidth options are available for the 82A04/B and may be required over specific frequency ranges of operation: The base product has an 8 GHz – 25 GHz range of operation. Option 60G extends the upper frequency range of operation to 60 GHz.
Variable trigger hold off range and resolution	Adjustable 5 µs to 2 ms in 1 ns increments. Applies only to front panel edge trigger operation and Clock Other trigger mode.
Front Panel Edge Trigger	Front Panel triggering on signal applied to dedicated front panel connector with Holdoff, Level Adjust, High Frequency On/Off
Mode	Normal mode: Wait for edge trigger
Input characteristics	50 Ω input resistance, DC coupled
±Slope select	Edge + mode: Triggers on positive-slewing edge Edge - mode: Triggers on negative-slewing edge

Table 3: DSA8300 - trigger specifications (cont.)

Description	Characteristics
Noise reject on/off select	Noise Reject Off mode: Removes trigger hysteresis and improves sensitivity. Should be used when trigger slew rate exceeds 1 V/ns Noise Reject On Mode: Retains trigger hysteresis and improves noise rejection at low slew rates
Input range	±1.5 V (DC + peak AC) maximum input voltage
Maximum operating trigger signal	1 Vpp (the maximum amplitude trigger signal input for maintaining calibrated time base operation)
Level range	Adjustable between ±1.0 V
✓ Sensitivity	100 mVpp, DC – 3 GHz (50 mV typical, DC – 4 GHz typical)
Level resolution	1 mV
✓Level accuracy	50 mV + 0.10 * Level
✓ Delay jitter	1.5 ps RMS + 10 ppm of horizontal position, or better (1.1 ps RMS + 5 ppm of horizontal position typical)
Minimum pulse width, typical	167 ps
Real time accessory interface	TekProbe-SMA, Levels 1 and 2. Hot switching is permitted on this real time accessory interface
Front panel clock trigger	
Capabilities and conditions, typical	Clock triggering on signal applied to dedicated front panel connector.
Input characteristics, typical	50 Ω AC coupled input resistance Fixed offset at zero volts If using a real time accessory on the front panel CLOCK TRIGGER/PRESCALE INPUT connector, the accessory offset is fixed at zero volts.
Absolute maximum input, typical	1.1 Vpp
✓Sensitivity and usable range	200 mVpp to 1000 mVpp over the range 800 MHz - 15 GHz, slew rate ≥ 2V/ns (150 mVpp to 1000 mVpp over the range 150 MHz - 20 GHz, typical)
Clock pattern lengths supported	2 to 2^{23} (8,388,608) inclusive
✓ Delay jitter, Clock Other mode	1.4 ps RMS + 10 ppm of horizontal position, or better (900 fs RMS + 5 ppm of horizontal position, typical)
✓ Delay jitter, Clock Eye mode	800 MHz ≤ f_{CLOCK} < 1.25 GHz: 900 fs RMS or better 1.25 GHz ≤ f_{CLOCK} < 11.2 GHz: 500 fs RMS or better 11.2 GHz ≤ f_{CLOCK} < 15 GHz: 600 fs RMS or better

Table 3: DSA8300 - trigger specifications (cont.)

Description	Characteristics
Delay jitter, Clock Eye mode, typical	150 MHz ≤ f_{CLOCK} < 400 MHz: 900 fs RMS or better 400 MHz ≤ f_{CLOCK} < 800 MHz: 800 fs RMS or better 800 MHz ≤ f_{CLOCK} < 1.25 GHz: 720 fs RMS or better 1.25 GHz ≤ f_{CLOCK} < 11.2 GHz: 375 fs RMS or better 11.2 GHz ≤ f_{CLOCK} < 20 GHz: 425 fs RMS or better
Trigger, TDR mode rates	Rates from 25 kHz to 300 kHz internally provided to edge trigger, to TDR stimulus drives in small sampling module interfaces, and to TDR Clock Out on front panel

1 The input resistance at the external direct trigger input and the maximum input voltage.

2 Maximum signal input for maintaining calibrated time base operation.

3 Section 4.10.2 in IEEE standard number 1057. The minimum signal levels required for stable edge triggering of an acquisition.

Table 4: DSA8300 - trigger - phase correction modes (mainframe with 82A04/B phase reference module) specifications

Description	Characteristics
Phase correction capabilities and conditions	A phase reference signal may be applied to a DSA8300 equipped with the 82A04/B Phase Reference module to provide additional phase information for signals being acquired in Triggered Phase Corrected modes and primary phase information for signals being acquired in Free Run Phase Corrected modes. For Phase Corrected Triggered modes, the phase correction functionality overlays the functionality of the basic trigger operation, although restrictions may be imposed.
Number of phase reference module inputs	One per 82A04/B module. Up to three 82A04/B modules may be inserted in the small compartments of the DSA8300 and characterized to operate with one or more vertical sampling module(s); only one phase correction module at a time can be used.
Phase reference input connector	Precision 1.85 mm female connector (V). A 2.4 mm male to 2.92 mm (K) female adapter is provided as a standard accessory to provide connection to 3.5 mm compatible male connectors.
Phase reference module input characteristics (typical)	50 Ω AC coupled through 5 pF 82A04/B optional filter accessories may alter both the input characteristics and the vertical signal ranges of the Phase Correction input. The specifications listed herein apply to the direct module input only and do not include the effect of any filters.
Phase reference module input dynamic range (nonclipping)	2 V_{p-p} (offset ±1000 mV)
Phase reference module input maximum nondestruct range	±3 V maximum
Phase reference module input signal level	600 mV_{p-p} to 1.8 V_{p-p} to achieve typical specified jitter performance
Phase reference mode jitter	Triggered and Free Run Phase Corrected Modes, 8 GHz – 60 GHz clock, 600 mV – 1.8 V_{p-p} input: 100 fs_{RMS} or better. Triggered and Free Run Phase Corrected Modes, 2 GHz – 8 GHz sine wave clock, 600 mV – 1.8 V_{p-p} input: 200 fs_{RMS} or better. The jitter increase between 8 GHz and 2 GHz is roughly inversely proportional to the clock frequency. Operation of the phase reference clock at frequencies requiring extended bandwidth or signal conditioning may require an optional filter accessory.

Table 4: DSA8300 - trigger - phase correction modes (mainframe with 82A04/B phase reference module) specifications (cont.)

Description	Characteristics
Phase reference module compensation temperature range (typical)	±5 °C where compensation was performed. If compartment is changed on mainframe, or if a sampling module extender is employed, or the length of the sampling module extender is changed, the Phase Reference module must be recompensated.
✓ Phase reference module input operating frequency	With 82A04/B: 8 GHz to 25 GHz With 82A04/B-60G: 8 GHz to 60 GHz

Table 4: DSA8300 - trigger - phase correction modes (mainframe with 82A04/B phase reference module) specifications (cont.)

Description	Characteristics
Phase reference module input operating frequency (typical)	
With 82A04/B	2 GHz to 25 GHz usable range Operation below 8 GHz requires the use of external filters, as follows: ■ 2 GHz – 4 GHz: requires 2.2 GHz peaked lowpass filter kit, Tektronix part number 020-2566-00 ■ 4 GHz – 6 GHz: requires 4 GHz lowpass filter kit, Tektronix kit part number 020-2567-00 ■ 6 GHz – 10 GHz: requires 6 GHz filter lowpass filter kit, Tektronix kit part number 020-2568-00 2 GHz to 25 GHz settable range.
With 82A04/B-60G	2 GHz to 60 GHz usable range. Operation below 8 GHz requires the use of external filters as noted for the standard 82A04. 2 GHz to 110 GHz settable range.

Table 5: DSA8300 - Display specifications

Specifications	Characteristics
Display type	210.4 mm (wide) x 157.8 mm (high), 263 mm (10.4 inch) diagonal, liquid crystal active matrix color display (LCD).
Display resolution	1024 horizontal by 768 vertical pixels.
Pixel pitch	Pixels are 0.2055 mm (horizontal) and 0.2055 mm (vertical).
Pressure-sensitive touch screen	A pressure sensitive touch screen pointing device is mounted on top of and supporting the 10.4” color display. Resolution is 10 bit. It is set up as a Windows pointing device and emulates a USB mouse. Can be set up for single or double click. A stylus is included.

Table 6: DSA8300 - Ports

Specifications	Characteristics
Video output	DVI-I connector on the rear panel. Useable as the second monitor. Video is DDC2B compliant.
Serial port	Two each, 9-pin D-subminature serial-port connectors using NS16C550 compatible UARTs supporting transfer speeds up to 115.2 kbits/sec.
Keyboard and mouse interface	PS/2 compatible connectors.
LAN interface	RJ-45 LAN connector supporting 10BASE-T, 100BASE-T, and Gigabit Ethernet.
External audio connectors	External audio jacks for MIC IN, LINE OUT
USB interface	USB 2.0 high speed connectors (front and rear panels).
GPIB interface	Complies with IEEE 488.2.

Table 6: DSA8300 - Ports (cont.)

Specifications	Characteristics
Internal clock trigger out	Square wave output from 50 Ω back termination synchronized to the TDR internal clock drive signal. Refer to *Trigger System - Internal Clock*. Typical performance into 50 Ω termination: –0.20 to +0.20 V low level +0.90 to +1.10 V high level
DC calibration output	DC voltage from low impedance drive, programmable to 1 mV over ±1.25 V range maximum into 50 Ω termination.
✓ DC calibration output accuracy	0.2 mV + 0.1% into 50 Ω
DC calibration output accuracy (typical)	0.1 mV + 0.1% into 50 Ω
External 10 MHz reference input	500 mV_{p-p} to 5 V_{p-p} AC coupled into 1 kΩ, ±5 V maximum

Table 7: DSA8300 - Data storage

Specifications	Characteristics
CD-RW/DVD drive capacity	CD-RW, DVD+/-R, DVD+/-R DL, DVD+RW, DVD-RW Multi Drive, mounted on front panel
Hard disk drive capacity	160 Gbytes

Table 8: DSA8300 - Power consumption, fuses, and cooling

Specifications	Characteristics
Source voltage and frequency	Range for the line voltage needed to power the instrument within which the instrument meets its performance requirements 100-240 V_{RMS} ±10%, 50/60 Hz 115 V RMS ±10%, 400 Hz CAT II
Fuse rating	Current and voltage ratings and type of the fuse used to fuse the source line voltage Two sizes can be used (each fuse type requires a different fuse cap): (0.25 x 1.25 inch size): UL 198G & CSA C22.2, No. 59 Fast acting: 8 Amp, 250 V; Tektronix part number 159-0046-00, BUSSMAN part number ABC-8, LITTLEFUSE part number 314008 (5 x 20 mm size): IEC 127, sheet 1, fast acting "F", high breaking capacity, 6.3 Amp, 250 V, BUSSMAN part number GDA ±6.3, LITTLEFUSE part number 21606.3

Table 8: DSA8300 - Power consumption, fuses, and cooling (cont.)

Specifications	Characteristics
Power requirements (typical)	Maximum: 600 Watts. Fully Loaded: 330 Watts, typical. Mainframe with keyboard and mouse, no modules: 205 Watts, typical.
	An example of a fully loaded mainframe for these characteristic loads has the following optical modules, electrical modules, and active probes installed: one 80C11-CR4 one 80A05-10G three 067-0387-02 one 067-0397-02 There is typically a slight 10 W deviation in the dissipation for various line conditions ranging from 48 Hz through 400 Hz as well as operating ambient temperature
Cooling requirements	Mainframe uses six fans with the fan speed regulated by internal temperature sensors. A 2″ (51 mm) clearance must be maintained on the left side and right side of the instrument. A 0.75″ (19 mm) clearance must be maintained on the bottom of the instrument for forced air flow intake. Do not operate the instrument on a bench with the feet removed Do not place any loose object underneath or nearby the instrument intake where it may be drawn against the air vents. No clearance is required on the front, back, and top.

Table 9: DSA8300 - mechanical

Specifications	Characteristics
Construction material	Chassis: Aluminum alloy Cosmetic covers: PC/ABS thermoplastic Front panel: Aluminum alloy with PC/thermoplastic overlay Module doors: Nickel plated stainless steel Bottom cover: Vinyl clad sheet metal Circuit boards: Glass-laminate
Weight, mainframe	22.23 kg (49.0 lb) (keyboard, mouse, top pouch, power cord, front shield installed, and no modules installed)
Weight, overall packaged	35.8 kg (79 lb)
Overall dimensions, mainframe only	Height: 343 mm (13.5 in) Width: 457 mm (18.0 in) Depth: 419 mm (16.5 in) The dimensions do not include feet, rack mount kit, or protruding connectors
Overall dimensions, packaged mainframe	Height: 613 mm (24.12 in) Width: 695 mm (27.37 in) Depth: 756 mm (29.75 in)

Table 10: DSA8300 - Environmental [1]

Description	Characteristics
Dynamics	
Random vibration, operating	0.141 g_{RMS}, from 5 to 200 Hz, 10 minutes each axis (3 axis, 30 minutes total)
Random vibration, nonoperating	2.28 g_{RMS}, from 5 to 500 Hz, 10 minutes each axis (3 axis, 30 minutes total)
Atmospherics	
Temperature:	Operating: +10 °C to +40 °C. (Upper rating derates to +35 °C for all sampling modules on two-meter extender cable 012-1569-00) Nonoperating: –22 °C to +60 °C
Relative humidity:	Operating: 20% to 80% relative humidity, with a maximum wet bulb temperature of 29 °C at or below +40 °C (upper limits derates to 45% relative humidity at +40 °C, non-condensing) Nonoperating (no media in drive): 5% to 90% relative humidity, with a maximum wet bulb temperature of 29 °C at or below +60 °C (upper limits derates to 20% relative humidity at +60 °C, non-condensing)
Altitude:	Operating: 3,048 m (10,000 ft.) Nonoperating: 12,190 m (40,000 ft.)

Table 10: DSA8300 - Environmental [1] (cont.)

Description	Characteristics
Electrostatic discharge susceptibility	Meets or exceeds the EMC requirements of the following standards: ■ EN 61326-1 European Community Requirements ■ IEC 61000-4-2 Electrostatic Discharge Immunity ■ IEC 61000-4-3 RF Field Immunity (3 V/m, 80 MHz to 1 GHz, 80% amplitude modulated with a 1 kHz sinewave) ■ IEC 61000-4-4 Electrical Fast Transient/Burst Immunity (1.0 kV on AC mains, 0.5 kV on I/O cables) ■ IEC 61000-4-5 AC Surge (1.0 kV Differential Mode, 2.0 kV Common Mode) ■ IEC 61000-4-6 RF Conducted Immunity (3 V, 150 kHz to 80 MHz, amplitude modulated with a 1 kHz sine wave) ■ IEC 61000-4-11 AC Mains Voltage Dips and Interruption Immunity ■ Up to 4 kV Contact Discharge ■ Up to 8 kV Air Discharge
Emissions	Meets or exceeds the EMC requirements of the following standards: ■ European Community Requirements (including EN 61326, Amendment 2) ■ EN55011 Class A Radiated Emissions ■ EN55011 Class A Conducted Emissions ■ EN 61000-3-2 Power Harmonic Current Emissions ■ EN 61000-3-3 Voltage Changes, Fluctuations & Flicker

1 Environmental specifications apply to all properly installed modules unless noted otherwise.

Table 11: 82A04/B Phase Reference module - mechanical

Specifications	Characteristics
Construction material	Chassis: Aluminum alloy Front panel: Plastic laminate Circuit boards: Glass-laminate Cabinet sleeve and end covers: Aluminum
Weight	0.4 kg (13 oz.). Weigh includes one each 2.4 mm to 2.92 mm adapter
Overall Dimensions	Height 25 mm (1.0 in.) Width 79 mm (3.1 in.) Depth 135 mm (5.3 in.) Does not include connector, adapter, connector cover, or lock down hardware protruding from front or rear panels

80E00 electrical sampling modules specifications

This section contains specifications for the following electrical sampling modules:

80E01	80E02	80E03
80E04	80E06	80E07/B [1]
80E08/B [1]	80E09/B [1]	80E10/B [1]
80E11/11X1 [1]		

[1] Multiple models of the module. For example, 80E07/B refers to both the 80E07 and the 80E07B modules. Specification differences between models will be clearly marked.

All specifications are guaranteed unless noted as "typical." Typical specifications are provided for your convenience but are not guaranteed. Specifications that are marked with the ✓ symbol are checked in the *Performance Verification* document.

All specifications apply to all electrical sampling models unless noted otherwise. To meet specifications, these conditions must first be met:

- The instrument must have been calibrated/adjusted at an ambient temperature between +20 °C and +30 °C.
- The instrument must have been operating continuously for 20 minutes within the operating temperature range specified.
- The instrument must be in an environment with temperature, altitude, humidity, and vibration within the operating limits described in these specifications.
- A compensation must have been performed. Recompensation is required if a module is moved to another compartment or a module extender is added or removed.

NOTE. *For Certifications, refer to the System Specifications section. (See page 1, DSA8300 specifications.)*

Table 12: Electrical sampling modules – signal acquisition

Specifications	Characteristics	
Real time accessory interface	Tekprobe-SMA interface is provided through the electrical sampling-module interface, one per vertical channel (except for 82A04/B, 80E07B, 80E08B, 80E09B, 80E10B, 80E11/X1).	
Number of input channels	*Sampling module*	*Channels*
	80E06, 80E11X1	1
	80E02, 80E03, 80E04, 80E07/B, 80E08/B, 80E09/B, 80E10/B, 80E11	2

Table 12: Electrical sampling modules – signal acquisition (cont.)

Specifications	Characteristics	
Channel input connector	*Sampling module*	*Input connector*
	80E02, 80E03, 80E04	3.5 mm female SMA compatible connector
	80E01	2.4 mm female connector
	80E06, 80E09/B, 80E10/B, 80E11/11X1	1.85 mm (V) female connector [8]
	80E07B, 80E08/B	2.92 mm (K) female SMA-compatible connector
✓ Input impedance	*Sampling module*	*Impedance*
	80E01, 80E02, 80E03, 80E04, 80E06	50 Ω ±0.5 Ω
	80E07/B, 80E08/B, 80E09/B, 80E10/B, 80E11/11X1	50 Ω ±1 Ω
Vertical dynamic range, nonclipping	80E02, 80E03, 80E04, 80E06, 80E07/B, 80E08/B, 80E09/B, 80E10/B,	1 V_{pp} (offset ±500 mV)
	80E11/11X1	800 mV_{pp} (offset ±400 mV)
Vertical operating range [1], maximum	*Sampling module*	*Operating range*
	80E01, 80E02, 80E03, 80E04, 80E06	±1.6 V
	80E07/B, 80E08/B, 80E09/B, 80E10/B, 80E11/11X1	±1.1 V
Vertical nondestruct range [2] (maximum input voltage)	*Sampling module*	*Maximum input*
	80E01, 80E06, 80E07/B, 80E08/B, 80E09/B, 80E10/B, 80E11/11X1	±2.0 V (DC + peak AC)
	80E02, 80E03, 80E04	±3.0 V (DC + peak AC)
Vertical number of digitized bits	16 bits full scale	
Vertical sensitivity range [3]	The range of available full scale input settings.	
	Sampling module	*Sensitivity range*
	80E01, 80E02, 80E03, 80E04, 80E06, 80E07/B, 80E08/B, 80E09/B, 80E10/B	10 mV to 1 V full scale
	80E11/11X1	8 mV to 800 mV full scale
Vertical offset range [1]	*Sampling module*	*Offset range*
	80E01, 80E02, 80E03, 80E04, 80E06	±1.6 V
	80E07/B, 80E08/B, 80E09/B, 80E10/B, 80E11/11X1	±1.1 V
Compensation temperature range (all modules)	±5 °C about temperature where compensation was performed. If the module is moved to another compartment on the mainframe, is installed on a module extender, or the length of the sampling module extender cable is changed, the channel(s) must be recompensated.	
✓ DC vertical voltage accuracy, single point, within ±5 °C of compensated temperature (all modules)	±2 mV <system offset> ±0.007 * (assigned offset) ±0.02 * (vertical value – assigned offset)	

Table 12: Electrical sampling modules – signal acquisition (cont.)

Specifications	Characteristics		
✓ DC vertical voltage deviation from linear least squares fit (all modules)	±10 mV		
✓ Analog bandwidth [5]	*Sampling module*		*Bandwidth*
	80E01		DC to 50 GHz, better than ±3 dB
	80E06		DC to 65 GHz, better than ±3 dB
			DC to 70 GHz, better than ±3 dB, typical
	80E07/B, 80E08/B		DC to 30 GHz, better than ±3 dB
	80E09/B		DC to 60 GHz, better than ±3 dB
	80E10/B		DC to 50 GHz, better than ±3 dB
	80E11/11X1		DC to 70 GHz, better than ±3 dB
Analog bandwidth [5]	*Sampling module*		*Bandwidth*
	80E02		12.5 GHz, typical
	80E03 and 80E04		20 GHz, typical
Analog bandwidth, reduced frequency set points, typical	*Sampling module*		*Bandwidth*
	80E07/B, 80E08/B		20 GHz
	80E09/B, 80E10/B		30 GHz, 40 GHz
	80E11/11X1		60 GHz, 40 GHz
Rise time [4], typical	*Sampling module*	*Bandwidth setting*	*Rise time*
	80E01	N/A	≤7 ps
	80E02	N/A	≤28 ps
	80E03, 80E04	N/A	≤17.5 ps
	80E06	N/A	≤5.0 ps
	80E07/B, 80E08/B	30 GHz	11.67 ps
		20 GHz	17.5 ps
	80E09/B	60 GHz	5.83 ps
		40 GHz	8.75 ps
		30 GHz	11.67 ps
	80E10/B	50 GHz	7 ps
		40 GHz	8.75 ps
		30 GHz	11.67 ps
	80E11/11X1	70 GHz	5.00 ps
		60 GHz	5.83 ps
		40 GHz	8.75 ps

Table 12: Electrical sampling modules – signal acquisition (cont.)

Specifications	Characteristics		
✓ Random noise, displayed	*Sampling module*	*Bandwidth setting*	*Noise*
	80E01	50 GHz (fixed)	≤2.3 mV_{RMS} (1.8 mV_{RMS}, typical)
	80E02	12.5 GHz (fixed)	≤800 μV_{RMS} (400 μV_{RMS}, typical)
	80E03 and 80E04	20 GHz (fixed)	≤1.2 mV_{RMS} (600 μV_{RMS}, typical)
	80E06	65 GHz (fixed)	≤2.4 mV_{RMS} (≤1.8 mV_{RMS}, typical)
	80E07/B, 80E08/B	30 GHz	<410 μV_{RMS} (<300 μV_{RMS}, typical)
		20 GHz	<380 μV_{RMS} (<280 μV_{RMS}, typical)
	80E09/B	60 GHz	<600 μV_{RMS} (<450 μV_{RMS}, typical)
		40 GHz	<480 μV_{RMS} (<330 μV_{RMS}, typical)
		30 GHz	<410 μV_{RMS} (<300 μV_{RMS}, typical
	80E10/B	50 GHz	<700 μV_{RMS} (<600 μV_{RMS}, typical)
		40 GHz	<480 μV_{RMS} (<370 μV_{RMS}, typical)
		30 GHz	<410 μV_{RMS} (<300 μV_{RMS}, typical)
	80E11/11X1	70 GHz	<1100 μV_{RMS} (<950 μV_{RMS}, typical)
		60 GHz	<600 μV_{RMS} (<450 μV_{RMS}, typical)
		40 GHz	<480 μV_{RMS} (<330 μV_{RMS}, typical)

Table 12: Electrical sampling modules – signal acquisition (cont.)

Specifications	Characteristics	
Step response aberrations [7], typical	*Sampling module*	*Aberrations, step transition* [6]
	80E01	±3% or less over the zone 10 ns to 20 ps before step transition +12%, –5% or less for the first 300 ps following step transition +5.5%, –3% or less over the zone 300 ps to 3 ns following step transition ±1% or less over the zone 3 ns to 100 ns following step transition ±0.5% after 100 ns following step transition
	80E02, 80E03, and 80E04	±3% or less over the zone 10 ns to 20 ps before step transition +10%, –5% or less for the first 300 ps following step transition ±3% or less over the zone 300 ps to 5 ns following step transition ±1% or less over the zone 5 ns to 100 ns following step transition ±0.5% after 100 ns following step transition
	80E06	+ 5% or less for the first 300 ps following step transition
	80E07/B, 80E08/B, 80E09/B, 80E10/B, 80E11/11X1	At maximum sampler bandwidth setting: ±1% or less over the zone 10 ns to 20 ps before step transition +6%, –10% or less over the first 400 ps following step transition +0%, –4% or less over the zone 400 ps to 3 ns following step transition +1%, –2% or less over the zone 3 ns to 100 ns following step transition ±1% or less after 100 ns following step transition
Acquistion delay adjust range, typical	*Sampling module*	*Delay adjust range*
	80E07, 80E08, 80E09, 80E10	±250 ps, each channel
	80E11/11X1	±35 ps, each channel
✓ Acquistion delay adjust range	80E07B, 80E08B, 80E09B, 80E10B	±150 ps, each channel, relative to center value (zero)

Table 12: Electrical sampling modules – signal acquisition (cont.)

Specifications	Characteristics	
Acquistion delay adjust resolution	*Sampling module*	*Delay adjust resolution*
	80E07, 80E08, 80E09, 80E10	135 fs
	80E07B, 80E08B, 80E09B, 80E10B, 80E11/11X1	Varies across adjust range; hardware allows sub-picosecond control resolution

1 Vertical operating range defines the maximum range over which the offset plus peak input signal can operate. The offset may be limited as a function of vertical sensitivity and dynamic range, such that no signal exceeding the maximum operating range can be displayed.

2 Vertical nondestruct range defines the maximum range over which offset plus peak input signal can operate without irreversible damage to the instrument. Operation to instrument specification is not guarantied outside of the vertical operating range.

3 *Input Signal Ranges* in IEEE std 1057, section 2.2.1.

4 IEEE std 1057, section 4.8.2, *Transition Duration of Step Response*. The 80E01, 80E07/B, 80E08/B, 80E09/B, and 80E10/B rise time is calculated from the 0.35 bandwidth-risetime product. The 80E06 rise time is calculated from the 0.35 typical bandwidth-risetime product.

5 IEEE std 1057, section 4.6, *Analog Bandwidth*.

6 IEEE std 1057, section 4.8.4, *Overshoot and Precursors*. Step transition occurs at the point of minimum radius of the waveform curvature, after the 50% amplitude point of the step leading edge.

7 When tested using a V-connector equipped 50 Ω, ultrafast PIN Photodetector with greater than 50 GHz bandwidth, which is driven by an ultrafast, mode-locked impulse laser (for example, the Calmar FPL-01).

8 Because the 2.4 mm connector of this adapter will mechanically interface with the 1.85 mm connector of the 80E06, it serves as a 1.85 mm-to-2.92 mm connector for the 80E06 module.

Table 13: Electrical sampling modules (80E04, 80E08/B, and 80E10/B TDR sampling modules) – TDR system

Specifications	Characteristics	
Number of TDR channels	2, one per channel	
TDR operation modes	Step output with positive edge polarity, negative edge polarity, and TDR off, independently selectable for each channel.	
TDR maximum input voltage	Specifications are not guaranteed with any DUT applying signal. Do not apply input voltage during TDR operation.	
✓ TDR system reflected rise time [1]	*Sampling module*	*Reflected rise time*
	80E04	≤35 ps each polarity
	80E08/B	≤22 ps, each polarity
		≤20 ps, each polarity, typical
	80E10/B	≤16 ps, each polarity
		≤15 ps, each polarity, typical
TDR incident edge amplitude, typical	80E04, 80E08/B, 80E10/B	±250 mV step into 50 Ω each polarity
TDR system incident rise time, typical	*Sampling module*	*Incident rise time*
	80E04	≤28 ps
	80E08/B	≤18 ps, each polarity
	80E10/B	≤12 ps, each polarity

Table 13: Electrical sampling modules (80E04, 80E08/B, and 80E10/B TDR sampling modules) – TDR system (cont.)

Specifications	Characteristics	
✓ TDR system step response aberrations, incident edge [2]	*Sampling module*	*Step response aberrations*
	80E04	±3% or less over the zone 10 ns to 20 ps before step transition +10%, –5% or less typical for the first 400 ps following step transition ±3% or less over the zone 400 ps to 5 ns following step transition ±1% or less after 5 ns following step transition
	80E08, 80E10	At maximum sampler bandwidth setting, both polarities of TDR: ±1% or less over the zone 10 ns to 20 ps before step transition +25%, –2% or less over the zone 14 ps to 150 ps following step transition +12%, –2% or less over the zone 150 ps to 400 ps following step transition ±2% or less over the zone 400 ps to 5 ns following step transition +1%, –2% or less over the zone 5 ns to 100 ns following step transition ±1% after 100 ns following step transition
	80E08B, 80E10B	At maximum sampler bandwidth setting, both polarities of TDR: ±1% or less over the zone 10 ns to 20 ps before step transition +12%, –2% or less over the zone 150 ps to 400 ps following step transition ±2% or less over the zone 400 ps to 5 ns following step transition +1%, –2% or less over the zone 5 ns to 100 ns following step transition ±1% after 100 ns following step transition
✓TDR incident edge delay adjust range	*Sampling module*	*Incident edge delay adjust*
	80E08B, 80E10B	Minimum: ±200 ps relative to center value (zero) on each channel
✓TDR incident edge delay adjust range, typical	*Sampling module*	*Incident edge delay adjust*
	80E08/B, 80E10/B	±250 ps, each channel and each polarity

Table 13: Electrical sampling modules (80E04, 80E08/B, and 80E10/B TDR sampling modules) – TDR system (cont.)

Specifications	Characteristics	
TDR incident edge delay adjust resolution, typical	*Sampling module*	*Incident edge delay adjust resolution*
	80E08/B, 80E10/B	135 fs
TDR step maximum repetition rate	80E08/B, 80E10/B	300 kHz

1 IEEE std 1057, section 4.8.2, transition duration of step response.

2 IEEE std 1057, section 4.8.4, overshoot and precursors.

Table 14: Electrical sampling modules – phase reference mode

Specifications	Characteristics	
Phase reference mode jitter, Triggered mode, typical	*Sampling module*	*Jitter*
	80E07B, 80E08B, 80E09B, 80E10B	100 fs RMS maximum under the following conditions of input signal, when used with 82A04B phase reference module installed on an 80N01 2-meter extender: ■ 10 GHz with 1.4 V_{pp} at 82A04B front connector and 700 mV_{pp} at sampling remote front connector ■ 14 GHz with 800 mV_{pp} at 82A04B front connector and 400 mV_{pp} at sampling remote front connector
✓ Phase reference mode jitter, Triggered mode	80E11, 80E11X1	100 fs RMS maximum under the following conditions of input signal, when used with 82A04B phase reference module, with neither module installed in the Ch 3/4 position: ■ 10 GHz with 1.4 V_{pp} at 82A04B front connector and 700 mV_{pp} at 80E11/11X1 front connector ■ 14 GHz with 800 mV_{pp} at 82A04B front connector and 400 mV_{pp} at 80E11/11X1 front connector

Table 14: Electrical sampling modules – phase reference mode (cont.)

Specifications	Characteristics	
Phase reference mode jitter, Free Run mode, typical	80E07B, 80E08B, 80E09B, 80E10B	100 fs RMS maximum under the following conditions of input signal, when used with 82A04B phase reference module installed on an 80N01 2-meter extender: ■ 10 GHz with 1.4 V_{pp} at 82A04B front connector and 700 mV_{pp} at sampling remote front connector ■ 14 GHz with 800 mV_{pp} at 82A04B front connector and 400 mV_{pp} at sampling remote front connector
	80E11, 80E11X1	100 fs RMS maximum under the following conditions of input signal, when used with 82A04B phase reference module, with neither module installed in the Ch 3/4 position: ■ 10 GHz with 1.4 V_{pp} at 82A04B front connector and 700 mV_{pp} at 80E11/11X1 front connector ■ 14 GHz with 800 mV_{pp} at 82A04B front connector and 400 mV_{pp} at 80E11/11X1 front connector
Phase reference mode jitter, other conditions, typical	80E07B, 80E08B, 80E09B, 80E10B, 80E11, 80E11X1	200 fs RMS typical at input signals less than specified voltages in *Phase reference mode jitter, Triggered mode* specification, (but limited to 300 mV_{pp}), or without specified extender on 82A04B, or with the legacy 82A04 phase reference module

Table 15: Electrical sampling modules – timebase system

Specifications	Characteristics	
Sampling rate	DC-200 kHz maximum (300 KHz maximum for TDR operation)	
Horizontal position range, minimum, (deskew adjust range between channels)	*Sampling module*	*Position range*
	80E01, 80E02, 80E03, 80E04, 80E06	19 ns, no extender cable present
	80E07/B, 80E08/B, 80E09/B, 80E10/B	29 ns, external direct trigger operation
	80E11/11X1	19 ns, external direct trigger operation

Table 16: Electrical sampling modules – power consumption

Specifications	Characteristics	
Power dissipation	*Sampling module*	*Power dissipation*
	80E01	1.1 W
	80E02, 80E03	1.8 W
	80E04	3.2 W
	80E06	2.4 W
	80E07, 80E09	5.1 W
	80E07B, 80E09B	4.4 W
	80E08, 80E10	6.5 W
	80E08B, 80E10B	6.2 W
	80E11	6.1 W
	80E11X1	3.9 W

Table 17: Electrical sampling modules – mechanical

Specifications	Characteristics		
Weight (unpackaged)	*Sampling module*	*Weight*	
	80E01, 80E02, 80E03, 80E04, 80E06	0.4 kg (13 oz.)	
	80E07/B, 80E08/B	861 gm (29.11 oz)	
	80E09/B, 80E10/B	868 gm (29.35 oz) including two 2.4 mm to 2.92 mm adapters	
	80E011	390 gm (13.80 oz) including two 2.4 mm to 2.92 mm adapters	
	80E011X1	319 gm (11.30 oz) including one 2.4 mm to 2.92 mm adapter	
Overall dimensions	Does not include connectors, connector savers, connector covers, push buttons, or lock-down hardware protruding from the front or rear panels.		
	Sampling module	*Dimensions*	
	80E01, 80E02, 80E03, 80E04, 80E06, 80E11/11X1	Height:	25 mm (1.0 in)
		Width:	79 mm (3.1 in)
	80E07/B, 80E08/B, 80E09/B, 80E10/B main module	Depth:	135 mm (5.3 in)
	80E07/B, 80E08/B, 80E09/B, 80E10/B remote module	Height:	25 mm (1.0 in)
		Width:	55 mm (2.2 in)
		Depth:	75 mm (3.0 in)
		Remote cable length:	2 meters
Construction material	Chassis:	aluminum alloy	
	Front panel:	plastic laminate	
	Circuit boards:	glass-laminate	
	Cabinet:	aluminum	

80C00 optical sampling modules specifications

This section contains specifications for the 80C00 Series Optical Modules. All specifications are guaranteed unless noted as "typical." Typical specifications are provided for your convenience but are not guaranteed. Except for limits noted "typical," specifications that are marked with the ✓ symbol are checked in the *Performance Verification* section of the service manual.

All specifications apply to all 80C00 Series Optical Modules unless noted otherwise. To meet specifications, the following conditions must first be met:

- The instrument must have been calibrated/adjusted at an ambient temperature between +20 °C and +30 °C.
- The instrument must have been operating continuously for 20 minutes within the operating temperature range specified.
- Vertical compensation must have been performed with the module installed in the same compartment used when the compensation was performed. Ambient temperature must be within ±2 °C of the compensation temperature.
- The instrument must be in an environment with temperature, altitude, humidity, and vibration within the operating limits described in these specifications.

NOTE. *"Sampling Interface" refers to both the electrical sampling module interface and the optical module interface, unless otherwise specified.*

NOTE. *For Certifications, refer to the System Specifications section. (See page 1, DSA8300 specifications.)*

Table 18: Optical modules – descriptions

Name	Characteristics
80C01	Long wavelength 1100 nm – 1650 nm. Unamplified O/E converter with two user-selectable optical bandwidths:
	12.5 GHz
	>20 GHz
	or three user-selectable reference receiver responses:
	OC-12/STM-4 SONET/SDH for 622.08 Mb/s
	OC-48/STM-64 SONET/SDH for 2.488 Gb/s
	OC-192/STM-64 SONET/SDH for 9.953 Gb/s

Table 18: Optical modules – descriptions (cont.)

Name	Characteristics
80C02	Long wavelength 1100 nm – 1650 nm. Unamplified O/E converter with three user-selectable optical bandwidths: 12.5 GHz 20 GHz 30 GHz
	or one user-selectable reference receiver response: OC-192/STM-64 SONET/SDH for 9.953 Gb/s
80C03	Broad wavelength 700 nm – 1650 nm. Amplified O/E converter with optical bandwidth of 2.5 GHz. The 2.5 Gb/s, OC-48/STM-16, and 2.0 GHz modes all use a physical path that has OC-48/STM-16 reference receiver type response. Two other selectable reference receiver responses: GFC for 1.063 Gb/s GBE for 1.250 Gb/s
80C04	Long wavelength 1100 nm – 1650 nm unamplified. Unamplified O/E converter with two user-selectable optical bandwidths: 20 GHz 30 GHz
	or two user-selectable reference receiver responses: OC-192/STM-64 SONET/SDH for 9.953 Gb/s ITU-T G.975 for 10.664 Gb/s
80C05	Long wavelength 1520 nm – 1580 nm unamplified. Three user-selectable optical bandwidths: 20 GHz 30 GHz 40 GHz
	or one reference receiver response: OC-192/STM-64 SONET/SDH for 9.953 Gb/s
80C06	Long wavelength 1520 nm – 1580 nm. O/E converter unamplified, 55 GHz optical sampler accepts high power optical signals typical for RZ signaling. Particularly well-suited for 40 Gb/s RZ telecom applications, as well as general purpose optical component testing.
80C07	Broad wavelength 700 nm – 1650 nm. Amplified O/E converter with optical bandwidth of 2.5 GHz. The OC-48 and 2.5 GHz modes all use a physical path that has OC-48 reference receiver type response. There are three user-selectable reference receiver responses: OC-48/STM-64 SONET/SDH for 2.488 Gb/s OC-3/STM-1 SONET/SDH for 155.4 Mb/s OC-12/STM-4 SONET/SDH for 622.08 Mb/s

Table 18: Optical modules – descriptions (cont.)

Name	Characteristics
80C07B	Broad wavelength 700 nm – 1650 nm. Amplified O/E converter with optical bandwidth of 2.5 GHz. The OC-48, 2GBE, INFINIBAND, and 2.5 GHz modes all use a physical path that has OC-48 reference receiver type response. There are eight user-selectable reference receiver responses: OC-3/STM-1 SONET/SDH for 155.4 Mb/s OC-12/STM-4 SONET/SDH for 622.08 Mb/s OC-48/STM-64 SONET/SDH for 2.488 Gb/s GBE for 1.250 Gb/s 2GBE for 2.5Gb/s Infiniband Optical for 2.500 Gb/s GFC for 1.063 Gb/s 2GFC for 2.125 Gb/s
80C08	Broad wavelength 700 nm - 1650 nm. Amplified O/E converter with maximum optical bandwidth (in combination with the internal electrical sampler) of 10 GHz. There are two data rate receiver setups selectable: 10GBASE-W for 9.953 Gb/s 10GBASE-R for 10.3125 Gb/s
80C08B	Broad wavelength 700 nm – 1650 nm amplified O/E converter with maximum optical bandwidth (in combination with the internal electrical sampler) of 9.5 GHz. There are four user-selectable reference receiver responses: 10GBASE-W - for 9.953 Gb/s 10GBASE-R for 10.3125 Gb/s 10GFC for 10.51875 Gb/s OC-192/STM-64 SONET/SDH for 9.953 Gb/s
80C08C	Broad wavelength 700 nm – 1650 nm amplified O/E converter with maximum optical bandwidth (in combination with the internal electrical sampler) of >9.5 GHz. There are six user-selectable reference receiver responses: OC-192/STM-64 SONET/SDH for 9.953 Gb/s 10GBASE-W - for 9.953 Gb/s 10GBASE-R for 10.3125 Gb/s 10GFC for 10.51875 Gb/s 10GBE FEC for 10.096 Gb/s 10GBFC FEC for 11.317 Gb/s or two data filters: ITU-T G.975 for 10.664 Gb/s ITU-T G.709 for 10.709 Gb/s

Table 18: Optical modules – descriptions (cont.)

Name	Characteristics
80C08D	Broad wavelength 700 nm – 1650 nm amplified O/E converter with maximum optical bandwidth (in combination with the internal electrical sampler) of >9.5 GHz.
	There are six user-selectable reference receiver responses:
	OC-192/STM-64 SONET/SDH for 9.953 Gb/s
	10GBASE-W - for 9.953 Gb/s
	10GBASE-R for 10.3125 Gb/s
	10GFC for 10.51875 Gb/s
	10GBE FEC for 10.096 Gb/s
	10GBFC FEC for 11.317 Gb/s
	or two data filters:
	ITU-T G.975 for 10.664 Gb/s
	ITU-T G.709 for 10.709 Gb/s
80C09	Long wavelength 1100 nm – 1650 nm. Unamplified O/E converter with two user-selectable optical bandwidths:
	20 GHz 30 GHz
	or two user-selectable reference receiver responses:
	OC-192/STM-64 SONET/SDH for 9.953 Gb/s ITU-T G.709 for 10.709 Gb/s
80C10	Long wavelength 1310 nm and 1550 nm. Unamplified O/E converter with two user-selectable optical bandwidths:
	30 GHz 65 GHz
	or two user-selectable reference receiver responses:
	OC-768/STM-256, VSR-2000 G.693, 40G NRZ G.959.1 for 39.813 Gb/s ITU3, VSR-2000 w/ FEC, 4x10G LAN PHY OTU3 for 43.018 Gb/s
80C10B	Long wavelength 1310 nm and 1550 nm. Unamplified O/E converter with three user-selectable optical bandwidths:
	30 GHz (not available with Option F1)
	65 GHz
	80 GHz (not available with Option F1)
	or three user-selectable reference receiver responses:
	OC-768/STM-256, VSR-2000 G.693, 40G NRZ G.959.1 for 39.813 Gb/s
	ITU3, VSR-2000 w/ FEC, 4x10G LAN PHY OTU3 for 43.018 Gb/s
	40GBASE-FR for 41.250 Gb/s
	Option F1 includes the following additional reference receiver filter rates:
	100GBASE-R4 for 25.781 Gb/s
	100GBASE-R4 FEC for 27.739 Gb/s
	Infiniband EDR for 25.781 Gb/s

Table 18: Optical modules – descriptions (cont.)

Name	Characteristics
80C10C	Long wavelength 1310 nm and 1550 nm. Unamplified O/E converter with three optical bandwidths: 55 GHz (Option F2) 70 GHz (Option F1) 80 GHz (Option F3)
	Option F1 (70 GHz) includes the following reference receiver filter rates: 100GBASE-R4 for 25.781 Gb/s OTU4 for 27.952 Gb/s OC-768/STM-256, VSR-2000 G.693, 40G NRZ G.959.1 for 39.813 Gb/s 40GBASE-FR for 41.250 Gb/s 32GFC at 28.05 Gb/s 32Gb/s Infiniband EDR for 25.781 Gb/s
	Option F2 (55 GHz) includes the following reference receiver filter rates: 100GBASE-R4 for 25.781 Gb/s OUT-4 for 27.952Gb/s 32GFC at 28.05Gb/s 32Gb/s Infiniband EDR for 25.871 Gb/s
	Option F3 (80 GHz) includes the following reference receiver filter rates: OC-768/STM-256, VSR-2000 G.693, 40G NRZ G.959.1 for 39.813 Gb/s 40GBASE-FR for 41.250 Gb/s OTU-3, VSR-2000 w/ FEC, 4x10G LAN PHY OTU3 for 43.018 Gb/s
80C11	Long wavelength 1100 nm – 1650 nm. Unamplified O/E converter with two user-selectable optical bandwidths: 20 GHz 30 GHz
	or nine user-selectable reference receiver responses: OC-192/STM-64 SONET/SDH for 9.953 Gb/s 10GBASE-W - for 9.953 Gb/s 10GBASE-R for 10.3125 Gb/s 10GBE FEC for 10.096 Gb/s 10GBFC FEC for 11.317 Gb/s 10GFC for 10.51875 Gb/s 16GFC for 14.025 Gb/s ITU-T G.975 for 10.664 Gb/s ITU-T G.709 for 10.709 Gb/s

Table 18: Optical modules – descriptions (cont.)

Name	Characteristics
80C11B	Long wavelength 1100 nm – 1650 nm. Unamplified O/E converter with two user-selectable optical bandwidths: 20 GHz 30 GHz
	or the following user-selectable reference receiver responses: OC-192/STM-64 SONET/SDH for 9.953 Gb/s 10GBASE-W - for 9.953 Gb/s 10GBASE-R for 10.3125 Gb/s 10GBE FEC for 10.096 Gb/s 10GBFC FEC for 11.317 Gb/s 10GFC for 10.51875 Gb/s 16GFC for 14.025 Gb/s ITU-T G.975 for 10.664 Gb/s ITU-T G.709 for 10.709 Gb/s
80C12	Broad wavelength 700 nm – 1650 nm. Amplified O/E converter with maximum optical bandwidth (in combination with the internal electrical sampler) of >8.5 GHz (>9.5 GHz in Option 10G).
	A variety of filter options are available that support 2 to 4 filters from the following list: GFC for 1.063 Gb/s 2GFC for 2.125 Gb/s 10GBASE-X4 for 3.125Gb/s 10GFC-X4 for 3.188Gb/s VSR-5 for 3.318 Gb/s 4GFC for 4.25 Gb/s
	Some filter options support a filterless full-bandwidth setting (9 GHz) in place of one hardware filter.
	Option 10G provides the following reference receiver filter rates: OC-192/STM-64 SONET/SDH for 9.953 Gb/s 10GBASE-W - for 9.953 Gb/s 10GBASE-R for 10.3125 Gb/s 10GFC for 10.51875 Gb/s ITU-T G.975 for 10.664 Gb/s ITU-T G.709 for 10.709 Gb/s 10GBE FEC for 10.096 Gb/s 10GBFC FEC for 11.317 Gb/s >9.5 GHz full bandwidth

Table 18: Optical modules – descriptions (cont.)

Name	Characteristics
80C12B	Broad wavelength 700 nm – 1650 nm. Amplified O/E converter with maximum optical bandwidth (in combination with the internal electrical sampler) of 12 GHz.
	Supported filter rates (module is purchased with four options. Options 10GP and F0 are mutually exclusive):
	Option F1: OC-3/STM-1 SONET/SDH for 155.4 Mb/s
	Option F2: OC-12/STM-4 SONET/SDH for 622.08 Mb/s
	Option F3: GFC for 1.063 Gb/s
	Option F4: GBE for 1.250 Gb/s
	Option F5: 2GFC for 2.125 Gb/s
	Option F6: OC-48/STM-64 SONET/SDH for 2.488 Gb/s, 2GBE for 2.5Gb/s, Infiniband Optical for 2.500 Gb/s
	Option F7: FEC2.666 for 2.666Gb/s
	Option F8: 10GBASE-X4 for 3.125Gb/s
	Option F9: 4GFC for 4.25 Gb/s
	Option F10: Infiniband Optical for 5.0Gb/s
	Option F11: OBSAI 8x for 6.144 Gb/s
	Option F12: CPRI7 3x for 7.3728 Gb/s
	Option F0: 12 GHz unfiltered bandwidth, FC-8500 for 8.5 Gb/s
	Option 10GP: FC-8500 for 8.5Gb/s 8GFC for 8.5Gb/s OC-192/STM-64 SONET/SDH for 9.953 Gb/s 10GBASE-W - for 9.953 Gb/s 10GBASE-R for 10.3125 Gb/s 40GBASE-R4 for 10.3125 Gb/s 100GBASE-R10 for 10.3125 Gb/s 10GFC for 10.51875 Gb/s ITU-T G.975 for 10.664 Gb/s ITU-T G.709 for 10.709 Gb/s 10GBE FEC for 10.096 Gb/s 10GBFC FEC for 11.317 Gb/s 12 GHz

Table 18: Optical modules – descriptions (cont.)

Name	Characteristics
80C12B-10G	Broad wavelength 700 nm – 1650 nm. Amplified O/E converter with maximum optical bandwidth (in combination with the internal electrical sampler) of 12 GHz.
	Supported filter rates are:
	FC-8500 for 8.5Gb/s
	OC-192/STM-64 SONET/SDH for 9.953 Gb/s
	10GBASE-W - for 9.953 Gb/s
	10GBASE-R for 10.3125 Gb/s
	40GBASE-R4 for 10.3125 Gb/s
	100GBASE-R10 for 10.3125 Gb/s
	10GFC for 10.51875 Gb/s
	ITU-T G.975 for 10.664 Gb/s
	ITU-T G.709 for 10.709 Gb/s
	10GBE FEC for 10.096 Gb/s
	10GBFC FEC for 11.317 Gb/s
	12 GHz
80C14	Broad wavelength 700 nm – 1650 nm. Amplified O/E converter with maximum optical bandwidth (in combination with the internal electrical sampler) of 14 GHz.
	Supported filter rates are:
	FC-8500 for 8.5Gb/s
	8GFC for 8.5Gb/s
	OC-192/STM-64 SONET/SDH for 9.953 Gb/s
	10GBASE-W - for 9.953 Gb/s
	10GBASE-R for 10.3125 Gb/s
	40GBASE-R4 for 10.3125 Gb/s
	100GBASE-R10 for 10.3125 Gb/s
	10GFC for 10.51875 Gb/s
	ITU-T G.975 for 10.664 Gb/s
	ITU-T G.709 for 10.709 Gb/s
	10GBE FEC for 10.096 Gb/s
	10GBFC FEC for 11.317 Gb/s
	SONET FEC12.5 for 12.500 Gb/s
	16GFC for 14.025 Gb/s
	Infiniband Optical for 14.0625 Gb/s
	14GHz

Table 18: Optical modules – descriptions (cont.)

Name	Characteristics
80C15	32 GHz full bandwidth and fully integrated reference receiver filtering, enabling conformance testing of both single and multi-mode conformance testing from 800 nm – 1600 nm. Supported filter rates are: 25.781 Gb/s (100GBASE-ER4, -LR4, -SR4, Inifiniband EDR) 27.952 Gb/s (OTU-4) 28.05 Gb/s (32G Fibre Channel)
80C17/80C18	800-1600nm Simplified O/E converter with two user selectable optical bandwidths: 30 GHz 22 GHz Four user selectable Optical Reference Receiver responses: FC28050, OTU27952 – (28 GBd) ENET266PAM4 – (26.6 GBd) ENET2574R4, INF25781 – (25.78 GBd) ENET257SR4TDEC – (16.8 GBd)
80C20/80C21	1250-1600nm Simplified O/E converter with two selectable optical bandwidths: 53 GHz 35.4 GHz Selectable Optical Reference Receiver responses: OC-768/STM-256, OC768 – (40.61 GBd) FEC43.02 Gb/s, FEC43018 – (44.0436 GBd) OTU-4, OTU27952 – (28.6416 GBd) 100GBase-R4, ENET257R4, INF25781, INF25781 – (26.38842 GBd) 40GBase-FR, ENET41250 – (42.075 GBd) ENET/PAM4 53.1G TDECQ, ENET531PAM4TDECQ – (35.4167 GBd) 32GFCr0, FC28050 – (28.611 GBd)
80C25GBE	Long wavelength 1310 nm and 1550 nm. Unamplified O/E converter with optical bandwidth of 65 GHz. There are two reference receiver filter rates: 100GBASE-R4 for 25.781 Gb/s 100GBASE-R4 FEC for 27.739 Gb/s

Table 19: Optical modules: inputs

Name	Characteristics
Number of input channels	1 optical (all models) 2 optical (80C18 and 80C21 only)
Internal fiber diameter [1]	
80C01, 80C02, 80C04, 80C05, 80C06, 80C09, 80C10, 80C10B, 80C10C, 80C11, 80C11B, 80C20, 80C21, 80C25GBE	9 µm/125 µm single mode
80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C, 80C08D, 80C12, 80C12B, 80C14, 80C15	Multimode fiber, 62.5 µm core, 125 µm cladding
80C17, 80C18	Multimode Fiber 50 µm core, 125 µm cladding
Fiber connector (all optical modules)	UCI (Universal Connector Interface) male connector The UCI supports numerous user interchangeable industry standard connector styles. These include FC, ST, SC, and DIN. All connections are PC style (Physical Contact) to minimize reflections from the interface.
Optical return loss	
80C01, 80C02, 80C04, 80C05, 80C06, 80C09, 80C10, 80C10B, 80C11, 80C11B, 80C25GBE	>30 dB for single-mode fiber
80C10C	Main acquisition channel input: –27 dB maximum at 1550 nm, –24 dB maximum at 1310 nm, for single-mode fiber HSPR input: –27 dB maximum, –30 dB typical
80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C, 80C08D, 80C12,80C12B, 80C14, 80C15	>14 dB for multi-mode fiber >24 dB for single-mode fiber
80C17, 80C18	>16 dB or better
80C20, 80C21	>25 dB or better (Tested at 1310 nm and 1550 nm by manufacturer)
Absolute maximum nondestructive optical input [2]	
80C01, 80C02, 80C03, 80C04, 80C07, 80C07B, 80C09, 80C11, 80C11B	5 mW average power; 10 mW peak power
80C05, 80C10, 80C10B, 80C10C, 80C25GBE	20 mW average power; 60 mW power
80C06	20 mW average power; 60 mW power

Table 19: Optical modules: inputs (cont.)

Name		Characteristics
	80C08, 80C08B, 80C08C, 80C08D, 80C12	1 mW average power; 10 mW peak power for 60 ms
	80C12B, 80C14	850 nm: 4 mW average power 1310/1550 nm: 2 mW average power 10 mW peak power for 60 ms
	80C15	850 nm: 5 mW average, 6 mW peak power 1310/1550 nm: 8 mW average, 10 mW peak power Peak power:<10 ns duration, 50% duty cycle
	80C17, 80C18	2 µW average power, 4 µW peak power
	80C20, 80C21	1310/1550 nm: 5 mW (7 dBm) average power
Maximum operating ranges [3]		
	80C01, 80C02, 80C04, 80C09	0 mW to 10 mW displayed limits, not including offset.
	80C03, 80C07, 80C07B	0 mW to 1 mW displayed limits, not including offset.
	80C05	0 mW to 30 mW displayed limits, not including offset. However, signal limit is 10 mW average optical power, 20 mW displayed peak power.
	80C06	0 mW to 60 mW displayed limits, including offset, and respecting that the signal limit is 15 mW average optical power, 30 mW displayed peak power.
	80C08, 80C08B, 80C08C, 80C08D, 80C12	0 to 2 mW displayed limits, not including offset.
	80C12B, 80C14	0 mW to 3 mW, not including offset. 5.5 mW with offset. However, non-destruct signal limits of 2 mW average power at 1310/1550 nm, and 3 mW average power at 850 nm must be obeyed.
	80C10, 80C10B, 80C10C Opt F3	0 mW to 30 mW displayed limits, not including offset.
	80C10C Opt. F1, F2	0 mW to 15 mW displayed limits, not including offset.
	80C10B-F1, 80C25GBE	0 mW to 20 mW displayed limits, not including offset.
	80C11, 80C11B	5 mW average power; 10 mW peak power. Optical input powers below non-destruct levels may exceed saturation and compression limits of the particular module.
	80C15	0 mW to 8 mW displayed limits, not including offset.
	80C17, 80C18	0 mW to 3.5 mW
	80C20, 80C21	0 mW to 8 mW

1 Single-mode fiber (Corning SMF-28 specs).

2 The optical input powers below nondestructive levels may exceed saturation and compression limits of the module.

3 Certain performance characteristics such as reference receiver and filter settings may have more restricted power levels to maintain guaranteed performance.

Table 20: Optical modules: Effective wavelength range, typical [1]

Module	Characteristics
80C01, 80C02, 80C04, 80C09, 80C11, 80C11B	1100 nm to 1650 nm
80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C, 80C08D, 80C12, 80C12B, 80C14	700 nm to 1650 nm
80C05, 80C06	1520 nm to 1580 nm
80C10, 80C10B, 80C25GBE	1550 nm: 1520 nm to 1620 nm 1310 nm: 1290 nm to 1330 nm
80C10C	1290 nm to 1620 nm
80C15, 80C17, 80C18	800 nm to 1600 nm
80C20, 80C21	1200 nm to 1650 nm

[1] The optical wavelengths that the product accepts while providing a reasonable (25% of peak optimum) conversion gain.

Table 21: Optical modules: calibrated wavelengths

Module	Characteristics
80C01, 80C02, 80C04, 80C09, 80C10, 80C10B, 80C10C, 80C11, 80C11B, 80C25GBE	1550 nm and 1310 nm (all ±20 nm)
80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C, 80C08D	1550 nm, 1310 nm, 850 nm, and 780 nm (all ±20 nm)
80C05, 80C06	1550 nm ±20 nm
80C12, 80C12B, 80C14, 80C15, 80C17, 80C18	1550 nm, 1310 nm, and 850 nm (all ±20 nm)
80C20, 80C21	1310 nm and 1550 nm (all ±20 nm)

Table 22: Optical modules: polarization dependence

Module	Characteristics
80C10C, 80C15	1550 nm input: ±0.45 dB maximum (±0.3 dB typical) 1310 nm input: ±0.40 dB maximum (±0.25 dB typical)
80C17, 80C18	1550 nm input: ±0.45 dB maximum (±0.3 dB typical) 1310 nm input: ±0.40 dB maximum (±0.3 dB typical)
80C20, 80C21	1550 nm and 1310 nm input: ±0.2 dB

Table 23: Optical modules: dark level

Module	Setting	✓Characteristics
To achieve these levels, perform a dark level compensation. If any of the following instrument settings or conditions change, you must perform another dark level compensation: Trigger rate setting Vertical offset setting Filter or bandwidth setting Ambient temperature change of more than 1 °C ELECTRICAL SIGNAL OUT front panel connection (80C12 only)		
80C01	OC-12, OC-48, OC-192	<10 µW ±2% (vertical offset)
	20 GHz	<10 µW ±4% (vertical offset)
80C02	OC-192	<10 µW ±2% (vertical offset)
	20 GHz, 30 GHz	<10 µW ±4% (vertical offset)
80C03, 80C07, 80C07B	All settings	<500 nW ±2% (vertical offset)
80C04	OC-192, 10.66 Gb/s	<10 µW ±2% (vertical offset)
	20 GHz, 30 GHz	<10 µW ±4% (vertical offset)
80C05	OC-192	<10 µW ±2% (vertical offset)
	20 GHz, 30 GHz, 40 GHz	<30 µW ±4% (vertical offset)
80C06	50 GHz	<25 µW ±4% (vertical offset)
80C08, 80C08B, 80C08C, 80C12, 80C12B, 80C14	All settings	<1.0 µW ±2% × (vertical offset)
80C15	All settings	<10 µW ±4% × (vertical offset)
80C17, 80C18	Applies to filters with greater than 22 GHz bandwidth	<10 µW ±4% × (vertical offset)
80C09	OC-192, 10.71 Gb/s	<10 µW ±2% (vertical offset)
	20 GHz, 30 GHz	<10 µW ±4% (vertical offset)
80C10, 80C10B, 80C10C, 80C25GBE	1550 nm	±[25 µW +4% × |vertical offset|]
	1310 nm	±[35 µW +4%× |vertical offset|]
80C11, 80C11B	For all settings except 16GFC (80C11), 20 GHz, 30 GHz	<10 µW ±2% (vertical offset)
	16GFC (80C11 only)	<10 µW ±3% (vertical offset)
	20 GHz, 30 GHz	<10 µW ±4% (vertical offset)
80C20, 80C21	Applies to filters with greater than 25 GHz bandwidth	±(10 µW + (4% (vertical offset)))

Table 24: Optical modules: main instrument display vertical scale factors

	Maximum	Minimum
80C01, 80C02, 80C04, 80C09, 80C11, 80C11B	1 mW per division	10 µW per division
80C03, 80C07, 80C07B	100 µW per division	1 µW per division
80C05	3 mW per division	30 µW per division
80C06	6 mW per division	60 µW per division
80C08, 80C08B, 80C08C, 80C08D, 80C12	200 µW per division	2 µW per division
80C12B, 80C14	300 µW per division	3 µW per division
80C10, 80C10B, 80C10C-F3	3 mW per division	30 µW per division
80C10B-F1, 80C25GBE	2 mW per division	20 µW per division
80C10C-F1 -F2	1.5 mW per division	15 µW per division
80C15	0.8 mW per division	6 µW per division
80C17, 80C18	0.35 mW per division	3.5 µW per division
80C20, 80C21	800 uW per division	8.0 uW per division

Table 25: Optical modules: vertical offset range

Module	Characteristics
80C01	±8 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)
80C02, 80C04, 80C09, 80C11, 80C11B	±6 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)
80C03	±1 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)
80C05, 80C10, 80C10B, 80C10C-F3	±15 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)
80C10C-F1 -F2	±7.5 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)
80C10B-F1, 80C25GBE	±10 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)
80C06	±40 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)
80C07, 80C07B	±1 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)

Table 25: Optical modules: vertical offset range (cont.)

Module	Characteristics
80C08, 80C08B, 80C08C, 80C08D, 80C12, 80C20, 80C21	±4 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)
80C12B, 80C14	±2.5 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)
80C15, 80C17, 80C18	±5 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)

Table 26: Optical modules: DC vertical accuracy, typical [1]

Module	Setting	Accuracy
80C01, 80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C, 80C08D, 80C12, 80C12B, 80C14	All settings	±25 µW ±2% of [(vertical value) – (vertical offset)]
80C02	12.5 GHz, OC-192	±25 µW ±2% of [(vertical value) – (vertical offset)]
	20 GHz	±25 µW ±4% of [(vertical value) – (vertical offset)]
	30 GHz	±25 µW ±6% of [(vertical value) – (vertical offset)]
80C04	10.66 Gb/s, OC-192	±25 µW ±2% of [(vertical value) – (vertical offset)]
	20 GHz	±25 µW ±4% of [(vertical value) – (vertical offset)]
	30 GHz	±25 µW ±6% of [(vertical value) – (vertical offset)]
80C05	OC-192	±25 µW ±2% of [(vertical value) – (vertical offset)]
	20 GHz	±25 µW ±4% of [(vertical value) – (vertical offset)]
	30 GHz	±25 µW ±6% of [(vertical value) – (vertical offset)]
	40 GHz	±25 µW ±8% of [(vertical value) – (vertical offset)]
80C06	50 GHz	±120 µW ±6% of [(vertical value) – (vertical offset)]
80C09	10.71 Gb/s, OC-192	±25 µW ±2% of [(vertical value) – (vertical offset)]
	20 GHz	±25 µW ±4% of [(vertical value) – (vertical offset)]
	30 GHz	±25 µW ±6% of [(vertical value) – (vertical offset)]
80C10	30 GHz	±25 µW ±4% of [(vertical value) – (vertical offset)]
	39 Gb/s, OC-768, FEC 43 Gb/s	±25 µW ±6% of [(vertical value) – (vertical offset)]
	65 GHz setting	±25 µW ±8% of [(vertical value) – (vertical offset)]
80C10B	30 GHz	±25 µW ±4% of [(vertical value) – (vertical offset)]
	OC-768, FEC 43 Gb/s	±25 µW ±6% of [(vertical value) – (vertical offset)]
	40GBASE-FR4	±25 µW ±6% of [(vertical value) – (vertical offset)]
	65 GHz setting	±25 µW ±8% of [(vertical value) – (vertical offset)]
	80 GHz setting	±25 µW ±9% of [(vertical value) – (vertical offset)]

Table 26: Optical modules: DC vertical accuracy, typical [1] (cont.)

Module	Setting	Accuracy
80C10B-F1	65 GHz	±25 µW ±8% of [(vertical value) – (vertical offset)]
	39 Gb/s OC-768, FEC 43 Gb/s	±25 µW ±6% of [(vertical value) – (vertical offset)]
	40GBASE-FR	±25 µW ±6% of [(vertical value) – (vertical offset)]
	100GBASE-R4	±25 µW ±4% of [(vkertical value) – (vertical offset)]
	100GBASE-R4 FEC	±25 µW ±4% of [(vertical value) – (vertical offset)]
80C10C	100GBASE-R4, INF25781, OTU4, 28.05 GHz, 32 GHz	±25 µW ±4% of [(vertical value) – (vertical offset)]
	OC-768, FEC 43 Gb/s, 40GBASE-FR	±25 µW ±6% of [(vertical value) – (vertical offset)]
	55 GHz	±25 µW ±8% of [(vertical value) – (vertical offset)]
	70 GHz and 80 GHz	±25 µW ±9% of [(vertical value) – (vertical offset)]
80C25GBE	65 GHz	±25 µW ±8% of [(vertical value) – (vertical offset)]
	100GBASE-R4	±25 µW ±4% of [(vertical value) – (vertical offset)]
	100GBASE-R4 FEC	±25 µW ±4% of [(vertical value) – (vertical offset)]
80C11, 80C11B	For all settings except 16GFC (80C11), 20 GHz, 30 GHz	±25 µW ±2% of [(vertical reading) – (vertical offset)]
	16GFC (80C11 only)	±25 µW ±3% of [(vertical reading) – (vertical offset)]
	20 GHz	±25 µW ±4% of [(vertical reading) – (vertical offset)]
	30 GHz	±25 µW ±6% of [(vertical reading) – (vertical offset)]
80C15	100GBase-R4, INF25781, OTU-4, 28.05 GHz, 32 GHz settings:	±25 µW ±4% of [(vertical reading) – (vertical offset)]
80C17, 80C18, 80C20, 80C21	For all settings	±25 µW ±4% of [(vertical reading) – (vertical offset)]

[1] Vertical accuracy specifications are referenced to an internal optical power meter reading for a given optical input, and limited to a temperature range within ±5 °C of previous channel compensation and an ambient temperature within 20 °C to 35 °C.

Table 27: Optical modules: DC vertical difference accuracy, typical [1]

Module	Setting	Accuracy
The accuracy of the difference between two cursors in the vertical scale of the same channel.		
80C01	12.5 GHz, OC-192, OC-48, OC-12	±2% of [difference reading]
	20 GHz	±4% of [difference reading]
80C02	12.5 GHz, OC-192	±2% of [difference reading]
	20 GHz	±4% of [difference reading]
	30 GHz	±6% of [difference reading]
80C03, 80C07, 80C07B	All settings	±2% of [difference reading]
80C04	10.66 Gb/s, OC-192	±2% of [difference reading]
	20 GHz	±4% of [difference reading]
	30 GHz	±6% of [difference reading]

Table 27: Optical modules: DC vertical difference accuracy, typical [1] (cont.)

Module	Setting	Accuracy
80C05	OC-192	±2% of [difference reading]
	20 GHz	±4% of [difference reading]
	30 GHz	±6% of [difference reading]
	40 GHz	±8% of [difference reading]
80C06, 80C08, 80C08B, 80C08C, 80C08D, 80C12, 80C12B, 80C14	All settings	±2% of [difference reading]
80C09	10.71 Gb/s, OC-192	±2% of [difference reading]
	20 GHz	±4% of [difference reading]
	30 GHz	±6% of [difference reading]
80C10	30 GHz	±4% of [difference reading]
	39 Gb/s, OC-768, FEC 43 Gb/s	±6% of [difference reading]
	65 GHz	±8% of [difference reading]
80C10B	30 GHz	±4% of [difference reading]
	OC-768, 43 Gb/s, FEC 43 Gb/s	±6% of [difference reading]
	40GBASE-FR	±6% of [difference reading]
	65 GHz	±8% of [difference reading]
	80 GHz	±9% of [difference reading]
80C10C	100GBASE-R4, INF25781, OTU4, 32GFC, 32 GHz	±4% of [difference reading]
	OC-768, FEC 43 Gb/s, 40GBASE-FR	±6% of [difference reading]
	55 GHz	±8% of [difference reading]
	70 GHz and 80 GHz	±9% of [difference reading]
80C10B-F1	65 GHz	±8% of [difference reading]
	OC-768, FEC 43 Gb/s	±6% of [difference reading]
	40GBASE-FR	±6% of [difference reading]
	100GBASE-R4	±4% of [difference reading]
	100GBASE-R4 FEC	±4% of [difference reading]
80C25GBE	65 GHz	±8% of [difference reading]
	100GBASE-R4	±4% of [difference reading]
	100GBASE-R4 FEC	±4% of [difference reading]
80C11, 80C11B	For all settings except 16GFC (80C11), 20 GHz, 30 GHz	±2% of [difference reading]
	16GFC (80C11 only)	±3% of [difference reading]
	20 GHz	±4% of [difference reading]
	30 GHz	±6% of [difference reading]

Table 27: Optical modules: DC vertical difference accuracy, typical [1] (cont.)

Module	Setting	Accuracy
80C15, 80C17, 80C18	100GBase-R4, INF25781, OTU-4, 28.05 GHz, 32 GHz settings:	±4% of [difference reading]
80C20, 80C21 [2]	53 GHz optical BW	±4% of [difference reading]

1 Vertical accuracy specifications are referenced to an internal optical power meter reading for a given optical input, and limited to a temperature range within ±5 °C of previous channel compensation and an ambient temperature within 20 °C to 35 °C (18 °C to 28 °C for the 80C20 and 80C21 modules).

2 Valid for calibrated wavelengths at 1310 nm ±20 nm (for 1310 nm front panel input only) and 1550 nm ±20 nm (for 1550 nm front panel input only) or for User calibrations.

Table 28: Optical modules: offset capabilities

Module	Characteristics
All modules	Open loop. User assigned, fixed offset value is applied to channel.

Table 29: Optical modules: minimum optical bandwidth [1, 2]

Module	Setting	✓Bandwidth, minimum	Bandwidth, typical
✓Optical bandwidth, minimum (-3 dB)			
80C01	20 GHz	>20 GHz	
	12.5 GHz	>12.5 GHz	
80C02	30 GHz	>28 GHz	>30 GHz
(≤2 mW_{pp} input signal)	20 GHz	>20 GHz	
	12.5 GHz	>12.5 GHz	
80C02-CR	30 GHz	>28 GHz	>29 GHz
(≤2 mW_{pp} input signal)			
80C03	2.5 GHz	>2.3 GHz	2.5 GHz
(≤200 μW_{pp} input signal)			
80C04	30 GHz	>28 GHz	>30 GHz
(≤2 mW_{pp} input signal)	20 GHz	>20 GHz	
80C04-CR1, 80C04-CR2	30 GHz	>28 GHz	>29 GHz
(≤2 mW_{pp} input signal)			
80C05	20 GHz	>20 GHz	
	30 GHz	>30 GHz	
	40 GHz		>40 GHz
80C06	55 GHz [3]		>50 GHz
80C07, 80C07B	2.5 GHz	>2.3 GHz	2.5 GHz
(≤200 μW_{pp} input signal)			

Table 29: Optical modules: minimum optical bandwidth [1], [2] (cont.)

Module	Setting	✓Bandwidth, minimum	Bandwidth, typical
80C08, 80C08B, 80C08C ($\leq$500 μW_{pp} input signal)	10 GHz	>9 GHz	>10 GHz
80C08D ($\leq$500 μW_{pp} input signal)	12 GHz	>11 GHz	>12 GHz
80C09 ($\leq$2 mW_{pp} input signal)	30 GHz	>28 GHz	>30 GHz
	20 GHz	>20 GHz	
80C09-CR1 ($\leq$2 mW_{pp} input signal)	30 GHz	>28 GHz	>29 GHz
80C09, 80C09-CR1 ($\leq$2 mW_{pp} input signal)	30 GHz	>28 GHz	
80C10	30 GHz	>30 GHz	
	65 GHz	>60 GHz	>65 GHz
80C10B	30 GHz	>30 GHz	
	80 GHz	>75 GHz	>80 GHz
80C10B, 80C10B-F1	65 GHz	>60 GHz	>65 GHz
80C10C-F1, F2, F3	55 GHz	50 GHz	55 GHz
80C10C-F1, F3	70 GHz	65 GHz	70 GHz
80C10C-F3	80 GHz	75 GHz	80 GHz
80C11, 80C11-CR	20 GHz	>20 GHz	
	30 GHz	>28 GHz	>30 GHz
80C12 ($\leq$500 μW_{pp} input signal)	9 GHz (options F2, F3, F5, F6, FC)	>8.5 GHz	>9 GHz
	10 GHz (Option 10G)	>9.5 GHz	>10 GHz
80C12B ($\leq$800 μW_{pp} input signal, 1310/1550 nm) ($\leq$1300 μW_{pp} input signal, 850 nm)	1.25 GHz (Opt F4)	>1.15 GHz	1.25 GHz
	2.125 GHz (Opt F5)	>1.95 GHz	2.13 GHz
	2.5 GHz (Opt F6)	>2.30 GHz	2.50 GHz
	2.666 GHz (Opt F7)	>2.45 GHz	2.67 GHz
	3.188 GHz (Opt F8)	>2.91 GHz	3.19 GHz
	4.25 GHz (Opt F9)	>3.91 GHz	4.25 GHz
	5.0 GHz (Opt F10)	>4.44 GHz	5.00 GHz
	6.144 GHz (Opt F11)	>5.46 GHz	6.14 GHz
	7.373 GHz (Opt F12)	>6.54 GHz	7.37 GHz
	12 GHz (Options F0, 10G, 10GP only)	>11 GHz	12 GHz

Table 29: Optical modules: minimum optical bandwidth [1], [2] (cont.)

Module	Setting	✓Bandwidth, minimum	Bandwidth, typical
80C14 (≤800 μW_{pp} input signal, 1310/1550 nm) (≤1300 μW_{pp} input signal, 850 nm)	14 GHz	>13 GHz	14 GHz
80C25GBE	65 GHz	>60 GHz	>65 GHz
80C15	32 GHz	>27 GHz	32 GHz
80C17, 80C18	30 GHz	29 GHz	30 GHz

1 Optical bandwidth is the frequency at which the responsivity of the optical to electrical conversion process is reduced by 50% (6 dB).

2 This specification is limited to the instrument operating in an ambient temperature between +20 °C and +30 °C. Nominal frequency response is specified at the indicated optical input signal levels.

3 Optical bandwidth of the 50 GHz module is defined as (0.48/risetime).

Table 30: Optical modules: rise time, typical

Module	Setting	Rise time
For peak optical signal input which creates <2 mW_{pp} modulation depth.		
80C01	OC-12	750 ps ±50 ps
	OC-48	187 ps ±15 ps
	OC-192	47 ps ±10 ps
	12.5 GHz	<40 ps
	20 GHz	<25 ps
80C02	30 GHz	<16 ps
	20 GHz	<25 ps
	12.5 GHz	<40 ps
	OC-192	47 ps ±10 ps
80C04	30 GHz	<16 ps
	20 GHz	<25 ps
	10.66 Gb/s	44 ps ±10 ps
	OC-192	47 ps ±10 ps
80C05	40 GHz	<12 ps
	30 GHz	<16 ps
	20 GHz	<25 ps
	OC-192	47 ps ±10 ps
80C06	50 GHz	<9.6 ps
80C09	30 GHz	<16 ps
	20 GHz	<25 ps
	10.71 Gb/s, OC-192	44 ps ±10 ps

Table 30: Optical modules: rise time, typical (cont.)

Module	Setting	Rise time
80C11, 80C11B	30 GHz	<16 ps
	20 GHz	<25 ps
	OC-192, 10GBASE-W, 10GBASE-R, 10GBE FEC, 10GFC, 10GFC FEC	47 ps ±10 ps
	16GFC	34 ps ±8 ps
	10.66 Gb/s, 10.71 Gb/s	44 ps ±10 ps
For peak optical signal input which creates <10 mW_{pp} modulation depth.		
80C10	65 GHz	7.4 ps
	30 GHz	16 ps
	OC-768	12 ps
	FEC 43 Gb/s	11.2 ps
80C10B	80 GHz	6 ps
	65 GHz	7.4 ps
	30 GHz	16 ps
	OC-768	12 ps
	FEC 43 Gb/s	11.2 ps
	40GBASE-FR	11.9 ps
80C10B-F1	65 GHz	7.4 ps
	OC-768	12 ps
	FEC 43 Gb/s	11.2 ps
	40GBASE-FR	11.9 ps
	100GBASE-R4	19.2 ps
	100GBASE-R4 FEC	19.2 ps
80C10C-F1	70 GHz	6.9 ps
	100GBASE-R4	18.1 ps
	OTU4 27.9 Gb/s	16.7 ps
	OC-768	11.7ps
	40GBASE-FR	11.3 ps
	FEC 43 Gb/s	10.8 ps
	55 GHz 8.7 ps	8.7 ps
	32 GHz ORR	14.6 ps
	28.05 GHz ORR	16.6 ps

Table 30: Optical modules: rise time, typical (cont.)

Module	Setting	Rise time
80C10C-F2	55 GHz	8.7 ps
	100GBASE-R4	18.1 ps
	OTU4 27.9 Gb/s	16.7 ps
	32 GHz ORR	14.6 ps
	28.05 GHz ORR	16.6 ps
80C10C-F3	80 GHz	6.0 ps
	70 GHz	6.9 ps
	55 GHz	8.7 ps
	OC-768	11.7 ps
	40GBASE-FR	11.3 ps
	FEC 43 Gb/s	10.8 ps
80C25GBE	65 GHz	7.4 ps
	100GBASE-R4	19.2 ps
	100GBASE-R4 FEC	19.2 ps
80C11	30 GHz	<16 ps
	20 GHz	<25 ps
	OC-192, 10GBASE-W, 10GBASE-R, 10GBE FEC, 10GFC, 10GFC FEC	47 ps ±10 ps
	16GFC	34 ps ±8 ps
	10.66 Gb/s, 10.71 Gb/s	44 ps ±10 ps
For peak optical signal input which creates <200 μW_{pp} modulation depth.		
80C03	FC1063	440 ps ±35 ps
	GBE	373 ps ±30 ps
	OC-48	187 ps ±15 ps
80C07	OC-3	3.0 ns ±170 ps
	OC-12	750 ps ±50 ps
	OC-48	187 ps ±15 ps
80C07B	OC-3	3.0 ns ±170 ps
	OC-12	750 ps ±50 ps
	GBE	373 ps ±30 ps
	GFC	440 ps ±35 ps
	2GFC	220 ps ±18 ps
	OC-48, 2GBE, INF2500	187 ps ±15 ps

Table 30: Optical modules: rise time, typical (cont.)

Module	Setting	Rise time
For peak optical signal input which creates <500 μW_{pp} modulation depth.		
80C08	10 GHz	<50 ps
	10GBASE-W, 10GBASE-R	47 ps ±10 ps
80C08B	10 GHz	<50 ps
	10GBASE-W, 10GBASE-R, OC-192, 10GFC	47 ps ±10 ps
80C08C, 80C08D	10 GHz	<50 ps
	10GBASE-W, 10GBASE-R, OC-192, 10GFC, 10GFC FEC, 10GBE FEC, 10.66 GB/s, 10.71 GB/s	47 ps ±10 ps
	10.66 Gb/s, 10.71 GB/s (80C08D only)	44 ps ±10 ps
80C12	GFC	440 ps ±35 ps
	2GFC	220 ps ±18 ps
	10GBASE-X4	150 ps ±12 ps
	10GFC-X4	147 ps ±12 ps
	VSR-5	141 ps ±12 ps
	4GFC	110 ps ±9 ps
	9 GHz	<56 ps
	10 GHz	<50 ps
	OC-192, 10GBASE-W, 10GBASE-R, 10GBE FEC, 10GFC, 10GFC FEC, 10.66 Gb/s, 10.71 Gb/s	47 ps ±10 ps

Table 30: Optical modules: rise time, typical (cont.)

Module	Setting	Rise time
For peak optical signal input which creates <800 μW_{pp} (1310/1550 nm) or <1300 μW_{pp} (850 nm) modulation depth.		
80C12B	OC3	3001 ps ±240 ps
	OC12	750 ps ±70 ps
	GFC	439 ps ±35 ps
	GBE	373 ps ±30 ps
	2GFC	220 ps ±18 ps
	OC48, INF2500, 2GBE	188 ps ±18 ps
	FEC2.666	175 ps ±18 ps
	10GBASE-X4	149 ps ±12 ps
	10GFC-X4	146 ps ±12 ps
	4GFC	110 ps ±9 ps
	INF5000	93 ps ±9 ps
	OBSAI	76 ps ±9 ps
	CPRI7	63 ps ±9 ps
	12 GHz	<42 ps
80C12B-10G(P)	FC-8500	55 ps ±9 ps
	8GFC, OC-192, 10GFC, 10GBASE-W, 10GBASE-R, 40GBASE-R4, 100GBASE-R10, 10GBE FEC, 10GFC FEC, FEC11317	47 ps ±10 ps
	10.66 Gb/s, 10.709 Gb/s	44 ps ±10 ps
80C14	FC-8500	55 ps ±9 ps
	8GFC, OC-192, 10GFC, 10GBASE-W, 10GBASE-R, 40GBASE-R4, 100GBASE-R10, 10GBE FEC, 10GFC FEC	47 ps ±10 ps
	10.66 Gb/s, 10.709 Gb/s	44 ps ±10 ps
	FEC12.5	35 ps ±8 ps
	16GFC, INF14063	33.5 ps ±7 ps
	14 GHz	<36 ps
80C15	32 GHz	14.6 ps ±0.3 ps
	28.05 GHz	16.6 ps ±0.3 ps
	22.00 GHz	23.0 ps ±0.5 ps
	OTU-4	16.7 ps ±0.3 ps
	100GBASE-R4, Infiniband EDR	18.1 ps ±0.3 ps

Table 30: Optical modules: rise time, typical (cont.)

Module	Setting	Rise time
80C17, 80C18	32 GHz	15.2 ps ±0.5 ps
ORR setting	28.05 GHz	17.3 ps ±0.5 ps
	22.00 GHz	21.0 ps ±0.5 ps
	OTU-4	17.3 ps ±0.5 ps
	100GBASE-R4, Infiniband EDR	18.8 ps ±0.5 ps
	ENET266PAM4	18.0 ps ±0.5 ps
	TDEC	27.6 ps ±0.5 ps
The 10% to 90% transition rise time is indirectly determined from the frequency response measurement. The formula used is rise time = 0.48/(optical bandwidth) for optical bandwidth settings. All rise-times tested at 1550 nm only.		
80C20, 280C21	53 GHz	10.24 ps ±1 ps
	35 GHz	13.22 ps ±1 ps
	OC-768/STM-256	12.13 ps ±1 ps
	FEC43.02 Gb/s	11.81 ps ±1 ps
	OTU-4	15.46 ps ±1 ps
	100GBase-R4	17.01 ps ±1.2 ps
	40GBase-R4	12.01 ps ±1 ps
	INF27581	16.58 ps ±1 ps
	ENET/PAM4 53.1G	13.00 ps ±1.1 ps
	32GFCr0	15.21 ps ±1.05 ps

Table 31: Optical modules: time domain vertical response aberrations, typical

Name	Setting	Abberations
For peak optical signal input <5 mW_{p-p} except for 80C03 and 80C07 which creates 200 μW_{pp} modulation depth		
80C01	OC-12, OC-48	<5%
	OC-192, 12.5 GHz	<10%
	20 GHz	<15%
80C02	OC-192	<10%
	12.5 GHz	<15%
	20 GHz	<20%
	30 GHz	<30%
80C03	All settings	<5%

Table 31: Optical modules: time domain vertical response aberrations, typical (cont.)

Name	Setting	Abberations
80C04	OC-192, 10.66 Gb/s	<10%
	20 GHz	<20%
	30 GHz	<30%
80C07, 80C07B	All settings	<5%
80C09	OC-192, 10.71 Gb/s	<10%
	20 GHz	<20%
	30 GHz	<30%
80C11, 80C11B	All settings except 16GFC, 20 GHz, 30 GHz	<10%
	16GFC (80C11 only)	<14%
	20 GHz	<20%
	30 GHz	<30%
For peak optical signal input <10 mW_{p-p}		
80C05	OC-192/STM-64	<5%
	20 GHz, 30 GHz	<10%
	40 GHz	<15%
80C06	50 GHz	<5% (typical)
For peak optical signal input <500 μW_{p-p}		
80C08, 80C08B, 80C08C, 80C08D	All settings	<10% (typical)
80C12	All filter settings (options F1, F2, F3, F4, F5, F6, FC)	<5% (typical)
	9 GHz setting (options F2, F3, F5, F6, FC)	<10% (typical)
	All settings (option 10G)	<10% (typical)
For peak optical signal input <800 μW_{p-p} (1300, 1550 nm) and <1300 μW_{p-p} (850 nm)		
80C12B	<8.5 Gb/s	<8%
	8.5 Gb/s to 11.32 Gb/s	<10%
	12 GHz	<15%
80C14	<8.5 Gb/s	<8%
	8.5 Gb/s to 11.32 Gb/s	<10%
	FEC12.50, 14GFC, FC14025, 14 GHz	<15%
For peak optical signal input <20 mW_{p-p}		
80C10	OC-768, FEC 43 Gb/s, 30 GHz	<5% (maximum) <3% (typical)
	65 GHz	<10% (maximum) <5% (typical)

Table 31: Optical modules: time domain vertical response aberrations, typical (cont.)

Name	Setting	Abberations
80C10B	OC-768, FEC 43 Gb/s, 30 GHz, 40GBASE-FR	<5% (maximum) <3% (typical)
	65 GHz	<10% (maximum) <5% (typical)
	80 GHz	<12% (maximum) <7% (typical)
80C10B-F1	OC-768, FEC 43 Gb/s, 40GBASE-FR	<5% (maximum) <3% (typical)
	65 GHz	<10% (maximum) <5% (typical)
	100GBASE-R4, 100GBASE-R4 FEC	<5% (maximum) <3% (typical)
80C10C	70 GHz, 80 GHz	<12% (maximum) <7% (typical)
	55 GHz	<10% (maximum) <5% (typical)
	100GBASE-ER4, 100GBASE-LR4 OTU4 27.9 Gb/s OC-768 40GBASE-FR FEC 43 Gb/s 32 GHz, 28.05 GHz	<5% (maximum) <3% (typical)
80C15	32 GHz	<17% (maximum) <15% (typical)
	22 GHz	<9% (maximum) <8.3% (typical)
	OTU-4	<13.5% (maximum) <12.4% (typical)
	100GBASE-R4	<12% (maximum) <10.5% (typical)
80C25GBE	65 GHz	<10% (maximum) <5% (typical)
	100GBASE-R4, 100GBASE-R4 FEC	<5% (maximum) <3% (typical)

Table 31: Optical modules: time domain vertical response aberrations, typical (cont.)

Name	Setting	Abberations
For peak optical signal input <3 mW_{p-p}		
80C17, 10C18	30 GHz	<7% (maximum) <4% (typical)
	16.8-28 GHz Filters	<5% (maximum) <3% (typical)
For peak optical signal input <1.5 mW_{p-p}		
80C20, 80C21	30-44 GHz (1550 nm)	<35% (maximum) <30% (typical)
	19-30 GHz Filters (1550 nm)	<25% (maximum) <19% (typical)

Table 32: Vertical equivalent optical noise (max and typical), 80C01 through 80C10 [1]

Module	Setting	Wavelength	✓ Maximum noise	Typical noise
80C01	OC-12, OC-48, OC-192, 12.5 GHz		<12 μW_{rms}	<8 μW_{rms}
	20 GHz		<25 μW_{rms}	<15 μW_{rms}
80C01-CR	OC-12, OC-48, OC-192, 12.5 GHz		<15 μW_{rms}	<10 μW_{rms}
	20 GHz		<25 μW_{rms}	<15 μW_{rms}
80C02	OC-192, 12.5 GHz		<10 μW_{rms}	<6 μW_{rms}
	20 GHz		<15 μW_{rms}	<10 μW_{rms}
	30 GHz		<30 μW_{rms} [2]	<20 μW_{rms}
80C02-CR	OC-192, 12.5 GHz		<12 μW_{rms}	<7 μW_{rms}
	20 GHz		<20 μW_{rms}	<15 μW_{rms}
	30 GHz		<40 μW_{rms} [2]	<30 μW_{rms}
80C03, 80C03-CR	GFC, GBE		<1 μW_{rms}	<0.75 μW_{rms}
	OC-48		<1.5 μW_{rms}	<1 μW_{rms}
80C04	OC-192, 10.66 Gb/s		<10 μW_{rms}	<6 μW_{rms}
	20 GHz		<15 μW_{rms}	<10 μW_{rms}
	30 GHz		<30 μW_{rms} [2]	<20 μW_{rms}
80C04-CR1, 80C04-CR2	OC-192		<12 μW_{rms}	<7 μW_{rms}
	20 GHz		<20 μW_{rms}	<15 μW_{rms}
	30 GHz		<40 μW_{rms} [2]	<30 μW_{rms}
80C05	OC-192		<15 μW_{rms}	<10 μW_{rms}
	20 GHz		<25 μW_{rms}	<15 μW_{rms}
	30 GHz		<35 μW_{rms}	<25 μW_{rms}
	40 GHz		<70 μW_{rms} [2]	<50 μW_{rms}
80C06	50 GHz		<192 μW_{rms}	<150 μW_{rms}

Table 32: Vertical equivalent optical noise (max and typical), 80C01 through 80C10 [1] (cont.)

Module	Setting	Wavelength	✓ Maximum noise	Typical noise
80C07	OC-3, OC-12		<1 μW_{rms}	<0.50 μW_{rms}
	OC-48		<1.5 μW_{rms}	<0.70 μW_{rms}
80C07B	OC-3, OC-12, GFC, GBE		<1 μW_{rms}	<0.50 μW_{rms}
	2GFC		<1.5 μW_{rms}	<0.85 μW_{rms}
	OC-48, 2GBE, INF2500		<1.5 μW_{rms}	<0.70 μW_{rms}
80C08, 80C08B (no clock recovery)	All settings		<5 μW_{rms}	<2.5 μW_{rms}
80C08-CR1, 80C08B-CR1 80C08B-CR2	All settings		<5.5 μW_{rms}	<3.0 μW_{rms}
80C08C, 80C08D (no clock recovery)	All settings	1310 nm, 1550 nm	<3.0 μW_{rms}	<1.7 μW_{rms}
		850 nm	<5.0 μW_{rms}	<3.0 μW_{rms}
		780 nm	<6.0 μW_{rms}	<3.5 μW_{rms}
80C08C-CR1, 80C08D-CR1, 80C08C-CR2, 80C08D-CR2, 80C08C-CR4, 80C08D-CR4	All settings	1310 nm, 1550 nm	<3.5 μW_{rms}	<1.9 μW_{rms}
		850 nm	<5.5 μW_{rms}	<3.3 μW_{rms}
		780 nm	<6.6 μW_{rms}	<3.9 μW_{rms}
80C09	OC-192, FEC 10.71 Gb/s		<10 μW_{rms}	<6 μW_{rms}
	20 GHz		<20 μW_{rms}	<15 μW_{rms}
	30 GHz		<30 μW_{rms} [2]	<20 μW_{rms}
80C09-CR1, 80C09-CR2	OC-192, FEC 10.71 Gb/s		<10 μW_{rms}	<7 μW_{rms}
	20 GHz		<20 μW_{rms}	<15 μW_{rms}
	30 GHz		<30 μW_{rms} [2]	<30 μW_{rms}
80C10	OC-768, 43.02 Gb/s	1310 nm	<110 μW_{rms}	<75 μW_{rms}
		1550 nm	<60 μW_{rms}	<40 μW_{rms}
	30 GHz	1310 nm	<90 μW_{rms}	<55 μW_{rms}
		1550 nm	<50 μW_{rms} (maximum)	<30 μW_{rms} (typical)
	65 GHz	1310 nm	<220 μW_{rms}	<150 μW_{rms}
		1550 nm	<120 μW_{rms}	<85 μW_{rms}

Table 32: Vertical equivalent optical noise (max and typical), 80C01 through 80C10 [1] (cont.)

Module	Setting	Wavelength	✓ Maximum noise	Typical noise
80C10B	OC-768, 43.02 Gb/s, 40GBASE-FR	1310 nm	<50 μW_{rms}	<28 μW_{rms}
		1550 nm	<38 μW_{rms}	<20 μW_{rms}
	30 GHz	1310 nm	<45 μW_{rms}	<26 μW_{rms}
		1550 nm	<35 μW_{rms}	<19 μW_{rms}
	65 GHz	1310 nm	<75 μW_{rms}	<44 μW_{rms}
		1550 nm	<60 μW_{rms}	<33 μW_{rms}
	80 GHz	1310 nm	<130 μW_{rms}	<72 μW_{rms}
		1550 nm	<105 μW_{rms}	<55 μW_{rms}
80C10B-F1	OC-768, 43.02 Gb/s, 40GBASE-FR	1310 nm	<75 μW_{rms}	<45 μW_{rms}
		1550 nm	<40 μW_{rms}	<25 μW_{rms}
	65 GHz	1310 nm	<110 μW_{rms}	<75 μW_{rms}
		1550 nm	<60 μW_{rms}	<40 μW_{rms}
	100GBASE-R4, 100GBASE-R4 FEC	1310 nm	<38 μW_{rms}	<21 μW_{rms}
		1550 nm	<28 μW_{rms}	<15 μW_{rms}
80C10C	100GBASE-R4, INF25781	1310 nm	<23 μW_{rms}	<16 μW_{rms}
		1550 nm	<18 μW_{rms}	<12 μW_{rms}
	OTU-4 (27.952 Gb/s)	1310 nm	<25 μW_{rms}	<17 μW_{rms}
	28.05 GHz	1550 nm	<20 μW_{rms}	<13 μW_{rms}
	OC-768, 40GBASE-FR, FEC 43 Gb/s	1310 nm	<38 μW_{rms}	<24 μW_{rms}
		1550 nm	<29 μW_{rms}	<18 μW_{rms}
	32 GHz	1310 nm	<29 μW_{rms}	<18 μW_{rms}
		1550 nm	<22 μW_{rms}	<14 μW_{rms}
	55 GHz	1310 nm	<52 μW_{rms}	<30 μW_{rms}
		1550 nm	<40 μW_{rms}	<23 μW_{rms}
	70 GHz	1310 nm	<85 μW_{rms}	<46 μW_{rms}
		1550 nm	<65 μW_{rms}	<36 μW_{rms}
	80 GHz	1310 nm	<140 μW_{rms}	<75 μW_{rms}
		1550 nm	<100 μW_{rms}	<55 μW_{rms}
80C10C Opt CRTP	100GBASE-R4, INF25781	1310 nm	<27 μW_{rms}	<19 μW_{rms}
		1550 nm	<21 μW_{rms}	<14 μW_{rms}
	OTU-4 (27.952 Gb/s)	1310 nm	<28 μW_{rms}	<20 μW_{rms}
	28.05 GHz	1550 nm	<23 μW_{rms}	<15 μW_{rms}
	OC-768	1310 nm	<44 μW_{rms}	<28 μW_{rms}
	40GBASE-FR	1550 nm	<34 μW_{rms}	<21 μW_{rms}
	FEC 43 Gb/s			
	32 GHz	1310 nm	<34 μW_{rms}	<21 μW_{rms}
		1550 nm	<26 μW_{rms}	<16 μW_{rms}

Table 32: Vertical equivalent optical noise (max and typical), 80C01 through 80C10 [1] (cont.)

Module	Setting	Wavelength	✓ Maximum noise	Typical noise
	55 GHz	1310 nm	<60 μW_{rms}	<35 μW_{rms}
		1550 nm	<46 μW_{rms}	<27 μW_{rms}
	70 GHz	1310 nm	<100 μW_{rms}	<53 μW_{rms}
		1550 nm	<75 μW_{rms}	<42 μW_{rms}
	80 GHz	1310 nm	<160 μW_{rms}	<86 μW_{rms}
		1550 nm	<115 μW_{rms}	<64 μW_{rms}

1 The optical channel noise with no optical noise input (Dark Level).

2 This specification is limited to the instrument operating in an ambient temperature between +20 °C and +30 °C. Nominal freq response is specified for optical input signals of modulation magnitude such that 2 mW_{pp} (200 μW_{pp} for 80C03 and 80C07; 500 μW_{pp} for 80C08 and 80C12) or less signal is applied at the sampler input.

Table 33: Optical modules: vertical equivalent optical noise (maximum and typical), 80C11 through 80C25BGE

Module	Setting	Wavelength	✓ Maximum Noise	Typical Noise
80C11 (no clock recovery)	OC-192, 10.66 Gb/s, 10.71 Gb/s, 10GBASE-W, 10GBASE-R, 10GBE FEC, 10GFC, 10GFC FEC		<8 μW_{rms}	<5.5 μW_{rms}
	16GFC		<10 μW_{rms}	<7 μW_{rms}
80C11 (no clock recovery)	20 GHz		<14 μW_{rms}	<10 μW_{rms}
	30 GHz (Warranted at ambient temperatures below 30 °C only)		<30 μW_{rms}	<20 μW_{rms}
80C11-CR1, 80C11-CR2, 80C11-CR3, 80C11-CR4	OC-192, 10.66 Gb/s, 10.71 Gb/s, 10GBASE-W, 10GBASE-R, 10GBE FEC, 10GFC, 10GFC FEC		<9 μW_{rms}	<6 μW_{rms}
	16GFC		<11.5 μW_{rms}	<8 μW_{rms}
	20 GHz		<15 μW_{rms}	<11 μW_{rms}
	30 GHz (Warranted at ambient temperatures below 30 °C only)		<35 μW_{rms}	<25 μW_{rms}
80C12	GFC, 2GFC, 4GFC, 10GBASE-X4, 10GFC-X4, VSR-5	1310 nm, 1550 nm	<2.5 μW_{rms}	<1.3 μW_{rms}
		850 mm	<4.0 μW_{rms} (maximum)	<2.1 μW_{rms}
	9 GHz	1310 nm, 1550 nm	<5.0 μW_{rms}	<2.4 μW_{rms}
		850 mm	<8.0 μW_{rms}	<3.8 μW_{rms}
	All settings option 10G	1310 nm, 1550 nm	<5.0 μW_{rms}	<2.4 μW_{rms}
		850 mm	<8.0 μW_{rms}	<3.8 μW_{rms}

Table 33: Optical modules: vertical equivalent optical noise (maximum and typical), 80C11 through 80C25BGE (cont.)

Module	Setting	Wavelength	✓ Maximum Noise	Typical Noise
80C12B (Options F0-F12, 10GP)	OC-3, OC-12, FC1063, GFC, GBE	1310 nm, 1550 nm	<1.3 μW_{RMS}	0.7 μW_{RMS}
		850 mm	<2.1 μW_{RMS}	1.1 μW_{RMS}
	2GFC, OC-48, INF2500, 2GBE, FEC2.666, 10GBASE-X4, 10GFC-X4, 4GFC	1310 nm, 1550 nm	<1.5 μW_{RMS}	0.9 μW_{RMS}
		850 mm	<2.4 μW_{RMS}	1.5 μW_{RMS}
	INF5000, OBSAI, CPRI 7	1310 nm, 1550 nm	<2.2 μW_{RMS}	1.2 μW_{RMS}
		850 mm	<3.5 μW_{RMS}	2.0 μW_{RMS}
	8.5 Gb/s – 11.317 Gb/s	1310 nm, 1550 nm	<2.7 μW_{RMS}	1.6 μW_{RMS}
		850 mm	<4.3 μW_{RMS}	2.6 μW_{RMS}
	12 GHz	1310 nm, 1550 nm	<3.6 μW_{RMS}	2.0 μW_{RMS}
		850 mm	<5.5 μW_{RMS}	3.3 μW_{RMS}
80C12B (Option 10G)	FC-8500, 8GFC, OC-192, 10GBASE-W, 10GBASE-R, 40GBASE-R4, 100GBASE-R10, 10 GFC, 10GFC-FEC, 10GBE-FEC, 10.71 Gb/s, 10.66	1310 nm, 1550 nm	<2.4 μW_{RMS}	1.3 μW_{RMS}
		850 mm	<4.0 μW_{RMS}	2.2 μW_{RMS}
	12 GHz	1310 nm, 1550 nm	<2.9 μW_{RMS}	1.7 μW_{RMS}
		850 mm	<4.8 μW_{RMS}	<2.9 μW_{RMS}
80C14	FC-8500, 8GFC, OC-192, 10GBASE-W, 10GBASE-R, 40GBASE-R4, 100GBASE-R10, 10 GFC, 10GFC-FEC, 10GBE-FEC, 10.71 Gb/s, 10.66 Gb/s	1310 nm, 1550 nm	<2.4 μW_{RMS}	1.3 μW_{RMS}
		850 mm	<4.0 μW_{RMS}	2.2 μW_{RMS}
	FEC12.5	1310 nm, 1550 nm	<2.9 μW_{RMS}	1.7 μW_{RMS}
		850 mm	<4.8 μW_{RMS}	2.9 μW_{RMS}
	16GFC	1310 nm, 1550 nm	<3.7 μW_{RMS}	2.3 μW_{RMS}
		850 mm	<6.0 μW_{RMS}	3.8 μW_{RMS}

Table 33: Optical modules: vertical equivalent optical noise (maximum and typical), 80C11 through 80C25BGE (cont.)

Module	Setting	Wavelength	✓ Maximum Noise	Typical Noise
80C15, 80C15 Opt CRTP	100GBASE-R4, INFINIBAND EDR	1550 nm	<11.9 μW_{RMS}	11.4 μW_{RMS}
		1310 nm	<10.9 μW_{RMS}	10.3 μW_{RMS}
		850 nm	<14.4 μW_{RMS}	13.5 μW_{RMS}
	OTU-4	1550 nm	<12.9 μW_{RMS}	12.4 μW_{RMS}
		1310 nm	<11.8 μW_{RMS}	11.2 μW_{RMS}
		850 nm	<15.6 μW_{RMS}	14.7 μW_{RMS}
	22.0 GHz	1550 nm	<13.3 μW_{RMS}	11.9 μW_{RMS}
		1310 nm	<12.0 μW_{RMS}	10.8 μW_{RMS}
		850 nm	<15.6 μW_{RMS}	14.2 μW_{RMS}
	28.05 GHz	1550 nm	<12.9 μW_{RMS}	12.4 μW_{RMS}
		1310 nm	<11.8 μW_{RMS}	11.2 μW_{RMS}
		850 nm	<15.6 μW_{RMS}	14.7 μW_{RMS}
	32 GHz	1550 nm	<16.2 μW_{RMS}	15.4 μW_{RMS}
		1310 nm	<14.6 μW_{RMS}	13.9 μW_{RMS}
		850 nm	<19.7 μW_{RMS}	18.3 μW_{RMS}

Table 33: Optical modules: vertical equivalent optical noise (maximum and typical), 80C11 through 80C25BGE (cont.)

Module	Setting	Wavelength	✓ Maximum Noise	Typical Noise
80C17, 80C18	16.8 GHz	1550 nm	3.9 μW_{RMS}	3.3 μW_{RMS}
		1310 nm	3.6 μW_{RMS}	3.1 μW_{RMS}
		850 nm	6.0 μW_{RMS}	5.1 μW_{RMS}
	17.7 GHz	1550 nm	3.9 μW_{RMS}	3.4 μW_{RMS}
		1310 nm	3.9 μW_{RMS}	3.2 μW_{RMS}
		850 nm	6.0 μW_{RMS}	5.3 μW_{RMS}
	22 GHz	1550 nm	4.3 μW_{RMS}	3.7 μW_{RMS}
		1310 nm	4.0 μW_{RMS}	3.5 μW_{RMS}
		850 nm	6.6 μW_{RMS}	5.8 μW_{RMS}
	25.78 GHz	1550 nm	4.8 μW_{RMS}	4.2 μW_{RMS}
		1310 nm	4.5 μW_{RMS}	3.9 μW_{RMS}
		850 nm	7.5 μW_{RMS}	6.5 μW_{RMS}
	26.6 GHz	1550 nm	5.2 μW_{RMS}	4.6 μW_{RMS}
		1310 nm	4.8 μW_{RMS}	4.2 μW_{RMS}
		850 nm	8.0 μW_{RMS}	7.0 μW_{RMS}
	28 GHz	1550 nm	5.4 μW_{RMS}	4.7 μW_{RMS}
		1310 nm	5.0 μW_{RMS}	4.3 μW_{RMS}
		850 nm	8.3 μW_{RMS}	7.1 μW_{RMS}
	30 GHz	1550 nm	11.5 μW_{RMS}	9.4 μW_{RMS}
		1310 nm	11.0 μW_{RMS}	8.9 μW_{RMS}
80C20, 80C21 [1]	53 GHz	1550 nm	15.7 μW_{RMS}	13.8 μW_{RMS}
		1310 nm	13.7 μW_{RMS}	12.3 μW_{RMS}
	35 GHz	1550 nm	13.2 μW_{rms}	10.3 μW_{rms}
		1310 nm	12.7 μW_{rms}	9.6 μW_{rms}
	OC-768/STM-256	1550 nm	13.7 μW_{rms}	10.8 μW_{rms}
		1310 nm	12.7 μW_{rms}	9.8 μW_{rms}
	FEC43.02 Gb/s	1550 nm	14.1 μW_{rms}	11.3 μW_{rms}
		1310 nm	13.3 μW_{rms}	10.3 μW_{rms}
	OTU-4	1550 nm	12.7 μW_{rms}	9.8 μW_{rms}
		1310 nm	11.8 μW_{rms}	9.3 μW_{rms}
	100GBase-R4	1550 nm	12.7 μW_{rms}	9.8 μW_{rms}
		1310 nm	11.8 μW_{rms}	9.3 μW_{rms}

Table 33: Optical modules: vertical equivalent optical noise (maximum and typical), 80C11 through 80C25BGE (cont.)

Module	Setting	Wavelength	✓ Maximum Noise	Typical Noise
	40GBase-R4	1550 nm	13.7 μW_{rms}	10.8 μW_{rms}
		1310 nm	12.7 μW_{rms}	9.8 μW_{rms}
	INF27581	1550 nm	12.7 μW_{rms}	9.8 μW_{rms}
		1310 nm	11.8 μW_{rms}	9.3 μW_{rms}
	ENET/PAM4 53.1G	1550 nm	12.7 μW_{rms}	9.8 μW_{rms}
		1310 nm	11.8 μW_{rms}	9.3 μW_{rms}
	32GFCr0	1550 nm	12.7 μW_{rms}	9.8 μW_{rms}
		1310 nm	11.8 μW_{rms}	9.3 μW_{rms}
80C25GBE	65 GHz	1310 nm	<75 μW_{rms}	<44 μW_{rms}
		1550 nm	<60 μW_{rms}	<33 μW_{rms}
	100GBASE-R4, 100GBASE-R4 FEC	1310 nm	<38 μW_{rms}	<21 μW_{rms}
		1550 nm	<28 μW_{rms}	<15 μW_{rms}

1 The values for these modules are the root mean square (RMS) distribution of vertical noise with either no optical input or completely noiseless optical input.

Table 34: 80C10C: Data, $\overline{\text{Data}}$ output

Name	Characteristics		
Electrical output characteristics	50 Ω, AC coupled, 30 kHz low frequency cutoff (typical)		
Maximum amplitudes	*Wavelength*	*Maximum*	*Typical*
	All	<700 mV	<500 mV
Rise times	*Wavelength*	*Maximum*	*Typical*
	All	<16 ps (20-80%)	<14 ps (20-80%)
Output timing alignment	Differential skew: ≤1 ps (defined at the 2.92 mm (female) coaxial connector output reference plane)		
Effective differential optical-to-electrical AC conversion gain (Option CRTP) [1]	*Wavelength*	*Minimum*	*Typical*
	1310 nm	>63 mV/mW	97 mV/mW
	1550 nm	>57 mV/mW	90 mV/mW
Effective differential optical-to-electrical AC conversion gain (Option HSRP) [1]	*Wavelength*	*Minimum*	*Typical*
	1310 nm	> 840 mV/mW	1040 mV/mW
	1550 nm	> 780 mV/mW	960 mV/mW
Bit-error-ratio sensitivity of DATA outputs (Option CRTP)	AOP > 2.3 dBm (to obtain BER ≤10E-12)		

Table 34: 80C10C: Data, $\overline{\text{Data}}$ output (cont.)

Name	Characteristics
Bit-error-ratio sensitivity of DATA outputs (Option HSPR)	AOP > -8 dBm (to obtain BER = <10E-12 for 25.78 - 43.02 Gb/s NRZ input signals (ER=12 dB, PRBS 2^{31}-1 pattern))

1 Applies to linear (non-saturated) operating region of auxiliary photoreceiver (<3.2 mWpp Option CRTP, and 0.32 mWpp Option HSPR).

Table 35: 80C10C: effective clock recovery optical sensitivity (Opt CRTP only)

Name	Characteristics		
Effective clock recovery optical sensitivity at 25.78 Gb/s (Opt CRTP only) 1		1310 nm	1550 nm
	OMA minimum	0.64 mW	0.73 mW
	OMA typical	0.42 mW	0.45 mW
	For ER=12 dB:		
	AOP minimum	–4.4 dBm	–4.0 dBm
	AOP typical	–6.2 dBm	–5.9 dBm
Effective clock recovery optical sensitivity at 41.25 Gb/s (Opt CRTP only) 2		1310 nm	1550 nm
	OMA minimum	1.66 mW	1.82 mW
	OMA typical	1.05 mW	1.12 mW
	For ER=12 dB:		
	AOP minimum	–0.2 dBm	0.2 dBm
	AOP typical	–2.3 dBm	–1.9 dBm

1 When used with Tektronix CR286A-HS clock recovery instrument with differential signal routing from the module's DATA outputs to the CR268A-HS inputs

2 When used with third-party 40G clock recovery instrument with single-ended signal routing from the module's DATA outputs to the clock recovery input (contact Tektronix for details).

Table 36: 80C15: Data, $\overline{\text{Data}}$ output

Name	Characteristics		
Electrical output characteristics	50 Ω single ended, AC coupled, 30 kHz low frequency cutoff (typical)		
Maximum amplitudes	*Wavelength*	*Maximum*	*Typical*
	All	<400 mV	<350 mV
Rise times	*Wavelength*	*Maximum*	*Typical*
	All	<25.0 ps (20%-80%)	<23.5 ps (20%-80%)
Output timing alignment, typical	Differential skew: ≤2 ps (defined at the 2.92 mm (female) coaxial connector output reference plane)		
Effective differential optical-to-electrical AC conversion gain (Option CRTP) 1	*Wavelength*	*Minimum*	*Typical*
	850 nm	>5000 mV/mW	6200 mV/mW
	1310 nm	>9000 mV/mW	10,000 mV/mW
	1550 nm	>9000 mV/mW	10,000 mV/mW

Table 36: 80C15: Data, $\overline{\text{Data}}$ output (cont.)

Name	Characteristics
DATA output versus sampling Instance delay in clock recovery configuration with phase reference timebase, typical	< 1 ns

1 Applies to linear (non-saturated) operating region of auxiliary photoreceiver.

2 The risetime is measured using an 80E15 connector directly to the CRTP output using 2.92 mm - 2.4 mm adaptors.

Table 37: 80C15: Effective clock recovery optical sensitivity (Opt CRTP only)

Name	Characteristics		
Effective clock recovery optical sensitivity at 25.78 Gb/s (Opt CRTP only) [1]	850 nm	1310 nm	1550 nm
OMA minimum	-18 dBm	-20 dBm	-20 dBm
OMA typical	-22 dBm	–24 dBm	–24 dBm

1 When used with Tektronix CR286A-HS clock recovery instrument with differential signal routing from the module's DATA outputs to the CR268A-HS inputs (typical based on specified CR sensitivity of >40 mVpp differential swing, minimum based on type testing of modules).

Table 38: Optical modules: reference receiver frequency response

Name	Characteristics			
✓OC-3/STM-1 155 Mb/s Reference Receiver setting frequency response [1]	In the 155.52 Mb/s NRZ setting, the scalar frequency response is verified to fall within fourth-order Bessel-Thompson reference receiver boundary limits. The OC-3/STM-1 nominal scalar frequency response matches the ITU 155.52 Reference Receiver Nominal curve with the following tolerance:			
	Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
	0.000	–0.50	0.00	0.50
	23.33	–0.61	–0.11	0.39
	46.65	–0.95	–0.45	0.05
	69.98	–1.52	–1.02	–0.52
	93.30	–2.36	–1.86	–1.36
	116.7	–3.50	–3.00	–2.50
	140.0	–5.67	–4.51	–3.35
	155.5	–7.25	–5.71	–4.17
	163.3	–8.08	–6.37	–4.66
	186.6	–10.74	–8.54	–6.35
	209.9	–13.55	–10.93	–8.31
	233.3	–16.41	–13.41	–10.41
✓ OC-12/STM-4 622.08 Mb/s Reference Receiver setting frequency response [1]	In the 622.08 Mb/s NRZ setting, the scalar frequency response is verified to fall within fourth-order Bessel-Thompson reference receiver boundary limits. The OC-12/STM-4 nominal scalar frequency response matches the ITU 622.08 Reference Receiver Nominal curve with the following tolerance:			
	Frequency (MHz)	Lower (dB)	*Nominal (dB)*	*Upper (dB)*
	0.000	–0.50	0.00	0.50
	93.3	–0.61	–0.11	0.39
	186.6	–0.95	–0.45	0.05
	279.9	–1.52	–1.02	–0.52
	373.2	–2.36	–1.86	–1.36
	466.7	–3.50	–3.00	–2.50
	559.9	–5.67	–4.51	–3.35
	622.1	–7.25	–5.71	–4.17
	653.2	–8.08	–6.37	–4.66
	746.5	–10.74	–8.54	–6.35
	839.8	–13.55	–10.93	–8.31
	933.1	–16.41	–13.41	–10.41

Table 38: Optical modules: reference receiver frequency response (cont.)

Name	Characteristics			
✓ OC-48/STM-16 2.488 Gb/s Reference Receiver setting frequency response [1]	Scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits. SONET OC-48/STM-16 frequency response boundary limits are described in ITU-T G.957 Tables I.1 and I.2. For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the Bessel-Thompson transfer function and listed below:			
	Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
	0.000	–0.50	0.00	0.50
	373.3	–0.61	–0.11	0.39
	746.5	–0.95	–0.45	0.05
	1119.7	–1.52	–1.02	–0.52
	1493.1	–2.36	–1.86	–1.36
	1866.3	–3.50	–3.00	–2.50
	2239.5	–5.67	–4.51	–3.35
	2488.3	–7.25	–5.71	–4.17
	2612.8	–8.08	–6.37	–4.66
	2986.0	–10.74	–8.54	–6.35
	3359.3	–13.55	–10.93	–8.31
	3732.6	–16.41	–13.41	–10.41
OC48 FEC (2.666 Gb/s) Reference Receiver setting frequency response	In OC48 FEC setting, scalar frequency response falls within standard NRZ 2.666 Gb/s fourth-order Bessel-Thompson Reference Receiver boundary limits as listed in the following table. SONET OC48 frequency response boundary limits are described in ITU-T G.957 Tables I.1 and I.2. For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function by frequency-scaling the OC48 limits with the OTU1 G.709 overhead ratio 255/238 and listed below:			
	Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	Upper (dB)
	0.000	–0.50	0.00	0.50
	400.0	–0.61	–0.11	0.39
	799.8	–0.95	–0.45	0.05
	1282.5	–1.52	–1.02	–0.52
	1599.8	–2.36	–1.86	–1.36
	1999.6	–3.50	–3.00	–2.50
	2399.5	–5.67	–4.51	–3.35
	2666.0	–7.25	–5.71	–4.17
	2799.4	–8.08	–6.37	–4.66
	3199.3	–10.74	–8.54	–6.35
	3528.7	–13.55	–10.93	–8.31
	3999.2	–16.41	–13.41	–10.41

Table 38: Optical modules: reference receiver frequency response (cont.)

Name	Characteristics			
✓ OC-192/STM-64 9.953 Gb/s Reference Receiver setting frequency response [1]	Scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits. Tektronix manufactures and tests the 80CXX optical modules with 10 Gb/s Reference Receivers to have a new superior and tighter tolerance OC-192/STM-64 Reference Receiver response. ITU agreed on the minimum performance specifications for 10 Gb/s (STM-64/OC-192) optical reference receivers (San Antonio ITU Study Group 15 February 2000). These specifications are used to establish system interoperability and test conformance of optical interfaces to draft ITU-T Recommendation G.691, which is scheduled to be completed in April 2000 (see ITU table A.1/G.691 from the WD 16-48 document from Study Group 15 dated February 2000). For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function and listed below:			
	(MHz) Frequency	(dB) Lower	(dB) Nominal	(dB) Upper
	0.000	–0.85	0.00	0.85
	1493.2	–0.96	–0.11	0.74
	2986.0	–1.30	–0.45	0.40
	4478.8	–1.87	–1.02	0.17
	5972.4	–2.71	–1.86	–1.01
	7465.0	–3.86	–3.00	–2.16
	8958.0	–6.19	–4.51	–2.83
	9953.28	–7.87	–5.71	–3.55
	10451.2	–8.75	–6.37	–3.99
	11944.0	–11.53	–8.54	–5.56
	13437.2	–14.45	–10.93	–7.41
	14930.4	–17.41	–13.41	–9.41

Table 38: Optical modules: reference receiver frequency response (cont.)

Name	Characteristics			
✓OC-768/STM-256 39.813 Gb/s Reference Receiver setting frequency response [1]	Bessel-Thompson Scalar Frequency Response curve and tolerances at various frequencies; based on ±1.00 dB DC to 0.75x(data rate) and ±5.0 dB at 1.5x(data rate). ***NOTE.*** *The table below is a discrete list of some specific values that are commonly listed in ITU standards; curve and tolerances are actually a continuous function.*			
	(GHz) Frequency	(dB) Lower	(dB) Nominal	(dB) Upper
	0	–1.00	0	1.00
	5.97	–1.10	–0.10	0.90
	11.94	–1.45	–0.45	0.55
	17.92	–2.02	–1.02	–0.02
	23.89	–2.86	–1.86	–0.86
	29.86	–4.00	–3.00	–2.00
	35.83	–6.56	–4.51	–2.46
	39.81	–8.37	–5.71	–3.05
	41.80	–9.31	—6.37	–3.43
	47.78	–12.26	–8.54	–4.83
	53.75	–15.32	–10.93	–6.53
	59.72	–18.41	–13.41	–8.41
✓OC-768/STM-256 39.813 Gb/s Reference Receiver setting frequency response [1] (80C10C, Option F1, F3) Applies to 1294 nm – 1330 nm, 1530 nm - 1570 nm	Bessel-Thompson Scalar Frequency Response curve and tolerances at various frequencies; based on ±0.85 dB DC to 0.75x(data rate) and expanding to ±4.0 dB at 1.5x(data rate). ***NOTE.*** *The table below is a discrete list of some specific values that are commonly listed in ITU standards; curve and tolerances are actually a continuous function.*			
	(GHz) Frequency	(dB) Lower	(dB) Nominal	(dB) Upper
	0	–0.85	0	0.85
	5.97	–0.96	–0.11	0.74
	11.94	–1.30	–0.45	0.40
	17.92	–1.87	–1.02	–0.17
	23.89	–2.71	–1.86	–1.01
	29.86	–3.86	–3.00	–2.16
	35.83	–6.19	–4.51	–2.83
	39.81	–7.87	–5.71	–3.55
	41.80	–8.75	–6.37	–3.99
	47.78	–11.53	–8.54	–5.56
	53.75	–14.45	–10.93	–7.41
	59.72	–17.41	–13.41	–9.41

Table 38: Optical modules: reference receiver frequency response (cont.)

Name	Characteristics		
✓OC-768/STM-256 (39.81 Gb/s) Reference Receiver setting frequency response [1] (80C20, 80C21) Applies to 1310 nm – 1550 nm	Bessel-Thompson Scalar Frequency Response curve and tolerances at various frequencies; based on ±0.85 dB DC to 0.75x(data rate) and expanding to ±4.0 dB at 1.5x(data rate). ***NOTE.*** *The table below is a discrete list of some specific values that are commonly listed in ITU standards; curve and tolerances are actually a continuous function.*		
	(GHz) Frequency	(dB) Lower	(dB) Upper
	0.2	0.850	-0.850
	0.4	0.800	-0.900
	0.6	0.738	-0.962
	0.8	0.650	-1.05
	10.0	0.537	-1.16
	15.0	0.138	-1.56
	20.0	-0.435	-2.14
	25.0	-1.2	-2.90
	30.0	-2.17	-3.91
	35.0	-2.71	-5.85
	40.0	-3.59	-7.95
	45.0	-4.79	-10.2
	50.0	-6.22	-12.6
	50.6	-6.4	-12.9
	51.4	-6.65	-13.3

Table 38: Optical modules: reference receiver frequency response (cont.)

Name	Characteristics
✓ 100GBASE-R4 (25.781 Gb/s, ENET25781, Infiniband EDR) and 100GBASE-R4 w/ FEC (27.739 Gb/s, ENET27739) Reference Receiver setting frequency response [2]	The published IEEE P802.3ba 40/100GbE D3.2 standard defines the Optical Reference Receiver specifications for 100GBASE-LR4 and –ER4 variants as follows (per section 88.8.8 in P802.3ba D3.2, June 2010): a standard 4th-order Bessel-Thompson Scalar Frequency Response with a reference frequency of 0.75x(data rate). (0.75*25.78125 GHz=19.337 GHz) ***NOTE.*** *The table below is a discrete list of some specific values that are commonly listed in ITU standards; curve and tolerances are actually a continuous function.*

(MHz) Frequency	(dB) Lower	(dB) Nominal	(dB) Upper
0	–0.85	0	0.85
3867	–0.96	–0.11	0.74
7734	–1.30	–0.45	0.40
11602	–1.87	–1.02	–0.17
15469	–2.71	–1.86	–1.01
19336	–3.86	–3.00	–2.16
23203	–6.19	–4.51	–2.83
25781	–7.87	–5.71	–3.55
27070	–8.75	–6.37	–3.99
30938	–11.53	–8.54	–5.56
34805	–14.45	–10.93	–7.41
38672	–17.41	–13.41	–9.41

Name	Characteristics
✓ 100GBASE-R4 (25.781 Gb/s, ENET257R4, Infiniband EDR) and 100GBASE-R4 w/ FEC (27.739 Gb/s, ENET27739) Reference Receiver setting frequency response [2] (80C20, 80C21)	The published IEEE P802.3ba 40/100GbE D3.2 standard defines the Optical Reference Receiver specifications for 100GBASE-LR4 and –ER4 variants as follows (per section 88.8.8 in P802.3ba D3.2, June 2010): a standard 4th-order Bessel-Thompson Scalar Frequency Response with a reference frequency of 0.75x(data rate). (0.75*25.78125 GHz=19.337 GHz) ***NOTE.*** *The table below is a discrete list of some specific values that are commonly listed in ITU standards; curve and tolerances are actually a continuous function.*

(GHz) Frequency	(dB) Lower	(dB) Upper
0.2	0.850	-0.850
4	0.731	-0.969
6	0.581	-1.12
10.0	0.0946	-1.61
15.0	-0.897	-2.60
20.0	-2.24	-4.25
25.0	-3.31	-7.35
30.0	-5.15	-10.8
33.4	-6.71	-13.4

Table 38: Optical modules: reference receiver frequency response (cont.)

Name	Characteristics			
✓ 40GBASE-FR (41.25 Gb/s, ENET41250) Reference Receiver setting frequency response [2]	At the time of this writing the IEEE P802.3bg 40GbE task force has not yet finalized the ORR specifications for the 40GBASE-FR serial variant. Preliminary tolerances are chosen to match the first draft proposal D1.0 of IEEE 802.3bg released in June 2010 (Sect. 89.7.8). The response follows a standard 4th-order Bessel-Thompson Scalar Frequency Response with a –3dB reference frequency of 0.75 x (data rate); for example, 0.75 x 41.25 GHz = 30.94 GHz. Tolerances are as specified for STM-64 in ITU-T G.691. The table below lists the nominal curve and tolerances at various frequencies; based on ± 0.85 dB DC to 0.75 x (data rate) and expanding to ±4.0 dB at 1.5 x (data rate).			
	(GHz) Frequency	(dB) Lower	(dB) Nominal	(dB) Upper
	0	–0.85	0	0.85
	6188	–0.96	–0.11	0.74
	12375	–1.30	–0.45	0.40
	18563	–1.87	–1.02	–0.17
	24750	–2.71	–1.86	–1.01
	30938	–3.86	–3.00	–2.16
	37125	–6.19	–4.51	–2.83
	41250	–7.87	–5.71	–3.55
	43313	–8.75	–6.37	–3.99
	49500	–11.53	–8.54	–5.56
	55688	–14.45	–10.93	–7.41
	61875	–17.41	–13.41	–9.41

Table 38: Optical modules: reference receiver frequency response (cont.)

Name	Characteristics		
✓ 40GBASE-FR (41.25 Gb/s, ENET41250) Reference Receiver setting frequency response [2] (80C20, 80C21)	At the time of this writing the IEEE P802.3bg 40GbE task force has not yet finalized the ORR specifications for the 40GBASE-FR serial variant. Preliminary tolerances are chosen to match the first draft proposal D1.0 of IEEE 802.3bg released in June 2010 (Sect. 89.7.8). The response follows a standard 4th-order Bessel-Thompson Scalar Frequency Response with a –3dB reference frequency of 0.75 x (data rate); for example, 0.75 x 41.25 GHz = 30.94 GHz. Tolerances are as specified for STM-64 in ITU-T G.691. The table below lists the nominal curve and tolerances at various frequencies; based on ± 0.85 dB DC to 0.75 x (data rate) and expanding to ±4.0 dB at 1.5 x (data rate).		
	(GHz) Frequency	(dB) Lower	(dB) Upper
	0.2	0.850	-0.850
	0.6	0.849	-0.851
	1	0.847	-0.853
	10	0.558	-1.14
	15	0.188	-1.51
	25	-1.05	-2.75
	35	-2.54	-5.36
	45	-4.38	-9.49
	55	-7.19	-14.1
	60	-8.79	-16.5
	61.4	-9.25	-17.2

Table 38: Optical modules: reference receiver frequency response (cont.)

Name	Characteristics			
✓ 10GBASE-W, 10GBASE-R, 40GBASE-R4, 100GBASE-R10, 10GFC, 10GBE FEC (FEC11.10Gb/s), 10GFC FEC (FC11317) Reference Receiver setting frequency response [1]	The 10GBASE-W, 10GBASE-R, 10GFC, 40GBASE-R4, 100GBASE-R10 standards specify an optical reference receiver with a 7.5 GHz fourth-order ideal Bessel-Thompson response. For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function for 9.95328 Gb/s ITU-T Reference Receivers, and from IEEE802.3 and listed below.			
	Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
	0	–0.85	0.00	0.85
	1500	–0.96	–0.11	0.74
	3000	–1.30	–0.45	0.40
	4500	–1.87	–1.02	0.17
	6000	–2.71	–1.86	–1.01
	7500	–3.86	–3.00	–2.16
	9000	–6.19	–4.51	–2.83
	10000	–7.87	–5.71	–3.55
	10500	–8.75	–6.37	–3.99
	12000	–11.53	–8.54	–5.56
	13500	–14.45	–10.93	–7.41
	15000	–17.41	–13.41	–9.41

Table 38: Optical modules: reference receiver frequency response (cont.)

Name	Characteristics			
✓ 10GBASE-4 ENET3125 (3.125 Gb/s) Reference Receiver setting frequency response [1]	In 10GBASE-4 setting, scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits. 10GBASE-4 frequency response boundary limits are derived by simply scaling all frequency values by 2.5X as described in IEEE 802.3z section 38.6.5 (this section refers to ITU G.957 for tolerances). For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the Bessel-Thompson transfer function and listed below:			
	Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
	0.000	–0.50	0.00	0.50
	468.8	–0.61	–0.11	0.39
	937.5	–0.95	–0.45	0.05
	1406	–1.52	–1.02	–0.52
	1875	–2.36	–1.86	–1.36
	2344	–3.50	–3.00	–2.50
	2813	–5.67	–4.51	–3.35
	3125	–7.25	–5.71	–4.17
	3281	–8.08	–6.37	–4.65
	3750	–10.74	–8.54	–6.35
	4219	–13.55	–10.93	–8.31
	4688	–16.41	–13.41	–10.41
✓10GFC-4 (3.188 Gb/s) Reference Receiver setting frequency response [1]	In 10GFC-4 setting, scalar frequency response falls within Industry standard, Bessel-Thompson reference receiver boundary limits. 10GFC-4 frequency response boundary limits are described in ANSI FC-PC. The scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function and listed below (based on ±0.5 dB from DC to 0.75x(rate) and ±3.0 dB at 1.5x(rate):			
	Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
	0.000	-0.50	0.00	0.50
	478.1	–0.61	–0.11	0.39
	956.3	–0.95	–0.45	0.05
	1434	–1.52	–1.02	–0.52
	1913	–2.36	–1.86	–1.36
	2391	–3.50	–3.00	–2.50
	2869	–5.67	–4.51	–3.35
	3188	–7.25	–5.71	–4.17
	3347	–8.08	–6.37	–4.65
	3825	–10.74	–8.54	–6.35
	4303	–13.55	–10.93	–8.31
	4781	–16.41	–13.41	–10.41

Table 38: Optical modules: reference receiver frequency response (cont.)

Name	Characteristics			
✓10.66 Gb/s (G.975) Reference Receiver setting frequency response [1]	This Reference Receiver is essentially identical to the OC-192 9.95328 Gb/s rate with the following changes: the frequency scale for the tolerance curves and nominal –3 dB breakpoints are scaled linearly by the ratio of (10.664 Gb/s)/(9.95328 Gb/s); for example: the 9.953 Gb/s reference receiver has a nominal –3 dB response at 0.75 × 9.95328 GHz = 7.465 GHz. This 10.66 Gb reference receiver has a nominal –3 dB response at (10.664/9.95328) × 7.465 GHz = 7.998 GHz. For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function, the frequencies scaled as described above, and then listed below:			
	Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
	0	–0.85	0	0.85
	1599.8	–0.96	–0.11	0.74
	3199.2	–1.30	–0.45	0.40
	4798.6	–1.87	–1.02	–0.17
	6398.9	–2.71	–1.86	–1.01
	7998.0	–3.86	–3.00	–2.16
	9597.7	–6.19	–4.51	–2.83
	10664.0	–7.87	–5.71	–3.55
	11197.5	–8.75	–6.37	–3.99
	12796.9	–11.53	–8.54	–5.56
	14396.7	–14.45	–10.93	–7.41
	15996.5	–17.41	–13.41	–9.41

Table 38: Optical modules: reference receiver frequency response (cont.)

Name	Characteristics
✓ 10.71 Gb/s (G.709) Reference Receiver setting frequency response [1]	This Reference Receiver is essentially identical to that for the OC-192 9.95328 Gb/s rate with the following changes: the frequency scale for the tolerance curves and nominal –3 dB breakpoints are scaled linearly by the ratio of (10.709 Gb/s)/(9.95328 Gb/s); for example: the 9.953 Gb/s reference receiver has a nominal –3 dB response at 0.75 × 9.95328 GHz = 7.465 GHz. This 10.71 Gb reference receiver has a nominal –3 dB response at (10.709/9.95328) × 7.465 GHz = 8.032 GHz. For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function, the frequencies scaled as described above, and then listed below:

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0	–0.85	0	0.85
1606.6	–0.96	–0.11	0.74
3212.8	–1.30	–0.45	0.40
4819.0	–1.87	–1.02	–0.17
6426.0	–2.71	–1.86	–1.01
8032.0	–3.86	–3.00	–2.16
9638.4	–6.19	–4.51	–2.83
10709.2	–7.87	–5.71	–3.55
11245.0	–8.75	–6.37	–3.99
12851.1	–11.53	–8.54	–5.56
14457.7	–14.45	–10.93	–7.41
16064.4	–17.41	–13.41	–9.41

1 This specification is limited to the instrument operating in an ambient temperature between +20 °C and +30 °C (+18 °C and +28 °C for the 80C20 and 80C21). Nominal frequency response is specified for optical input signals of modulation magnitude such that 2 mW_{pp} (200 μW_{pp} for 80C03 and 80C07; 500 μW_{pp} for 80C08 and 80C12; <800 μW_{pp} at 1310/1550 nm, <1300 μW_{pp} at 850 nm for 80C12B and 80C14) or less signal is applied at the sampler input.

2 The factory calibration and verification of these tolerances are performed in a stable ambient environment of +25 °C ±2 °C. The module is specified to perform within these tolerances over an operating temperature range of +20 °C and +30 °C (+18 °C and +28 °C for the 80C20 and 80C21).

Table 39: 16GFC (14.025 Gb/s) reference receiver setting frequency response, warranted

Description

The 8GFC (ANSI FC-PI-4) and 10GFC standards specify an optical reference receiver with a 7.5 GHz fourth-order ideal Bessel-Thomson frequency response. At the time of writing, reference receiver standards for 16G FibreChannel have not been published in FC-PI-5 (draft rev 0.01). We have expected the use of an ideal fourth-order Bessel-Thomson response with a –3 dB bandwidth of 0.75 x data rate (=10.52 GHz) and tolerance limits identical to 8GFC and 10GFC standards.

For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function, the frequencies scaled as described above, and then listed below.

Nominal response curve and tolerance limits (based on ±0.85 dB from DC to 10.519 GHz and expanding to ±4.0 dB at 21.038 GHz).

(MHz) Frequency	(dB) Lower	(dB) Nominal	(dB) Upper
0	–0.85	0	0.85
2104	–0.96	–0.11	0.74
4208	–1.30	–0.45	0.40
6311	–1.87	–1.02	–0.17
8415	–2.71	–1.86	–1.01
10519	–3.86	–3.00	–2.16
12623	–6.19	–4.51	–2.83
14025	–7.87	–5.71	–3.55
14726	–8.75	–6.37	–3.99
16830	–11.53	–8.54	–5.56
18934	–14.45	–10.93	–7.41
21038	–17.41	–13.41	–9.41

Table 40: 16GFC r6.1 (FC14025) data filter setting frequency response, warranted

Description

In the 16GFC r6.1 (FC14025) setting, scalar frequency response follows a -3 dBe filter bandwidth of 0.75*14.025 GHz= 10.519 GHz with a nominal 4th-order Bessel-Thompson filter shape as described in standard document ANSI FC-PI-5 (rev R6.1) and falls within specified frequency response tolerance limits.

This filter response typically falls within frequency response tolerance limits as specified in the published ANSI FC-PI-5 rev 6.1 draft standard document.

The tabular values are derived from the standard Bessel-Thompson transfer function and tolerance limits for 16GFC per the published specification in FC-PI-5 R6.1. The flare-out point of the tolerance rails is shifted from the standard 0.75x14.025 GHz= 10.519 GHz frequency to 0.658x14.025 GHz= 9.225 GHz.

Frequency (GHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0	–0.85	0	+0.85
1.845	–0.935	–0.085	+0.765
3.690	–1.194	–0.344	+0.506
5.535	–1.633	–0.783	+0.067
7.380	–2.266	–1.416	–0.566
9.225	–3.117	–2.267	–1.417
10.519	–4.68	–3.00	–1.660
11.070	–5.357	–3.368	–1.821
12.915	–7.698	–4.746	–2.610
14.025	–9.180	–5.710	–3.260
14.760	–10.189	–6.402	–3.756
16.605	–12.821	–8.299	–5.203
18.450	–15.546	–10.366	–6.867
20.295	–18.303	–12.527	–8.664
21.038	–19.410	–13.410	–9.410

Table 41: INF14063 data filter setting frequency response, warranted

Description

In the INF14063 setting, scalar frequency response corresponds to a -3 dBe filter bandwidth of 0.75×14.0625 GHz =10.547 GHz with a nominal 4th-order Bessel-Thompson filter shape and falls within specified frequency response tolerance limits.

At the time of writing no published standard for 14G Infiniband FDR standard exists.

The tabular values are derived from the standard Bessel-Thompson transfer function and tolerance limits for 10GBASE-R and scaled up linearly in frequency by a ratio of (14.0625 Gb/s)/(10 Gb/s). The flare-out point of the tolerance rails is shifted from the standard 0.75×14.0625 GHz =10.547 GHz frequency to 0.658×14.0625 GHz =9.25 GHz.

Frequency (GHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0	–0.85	0	+0.85
1.850	–0.935	–0.085	+0.765
3.700	–1.194	–0.344	+0.506
5.550	–1.633	–0.783	+0.067
7.400	–2.266	–1.416	–0.566
9.250	–3.117	–2.267	–1.417
10.547	–4.680	–3.00	–1.660
11.100	–5.357	–3.368	–1.821
12.950	–7.698	–4.746	–2.610
14.065	–9.180	–5.710	–3.260
14.800	–10.189	–6.402	–3.756
16.650	–12.821	–8.299	–5.203
18.500	–15.546	–10.366	–6.867
20.350	–18.303	–12.527	–8.664
21.094	–19.410	–13.410	–9.410

Table 42: FEC12.50 Gb/s (FEC12500) reference receiver setting frequency response, warranted

Description
In the FEC12500 setting, scalar frequency response falls within Industry Standard, 4th-order Bessel-Thompson reference receiver boundary limits for a 12.5 Gb/s data rate with a nominal -3 dB filter frequency of 0.75x12.5 GHz=9.375 GHz and tolerance limits scaled linearly in frequency from the ITU-T published reference receiver standards for OC-192 by a ratio of (12.5 Gb/s) / (9.95328 Gb/s). The nominal scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function for ITU-T OC-192 frequency response and scaled in frequency to 12.5 Gb/s as listed below.

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0	–0.85	0	0.85
1875	–0.96	–0.11	0.74
3750	–1.30	–0.45	0.40
5625	–1.87	–1.02	–0.17
7500	–2.71	–1.86	–1.01
9375	–3.86	–3.00	–2.16
11250	–6.19	–4.51	–2.83
12500	–7.87	–5.71	–3.55
13125	–8.75	–6.37	–3.99
15000	–11.53	–8.54	–5.56
16875	–14.45	–10.93	–7.41
18750	–17.41	–13.41	–9.41

Table 43: FEC 43.02 Gb/s reference receiver setting frequency response, warranted (excludes the 80C20, 80C21)

Description [1]

The forward error correction method defined in ITU-T standard G.709 creates an additional overhead upon a standard OC-768 (STM256) 40 Gb/s data stream in which the data rate is effectively increased by a ratio of 255/236. Table 7-1 in G.709 standard lists this explicit serial data rate on the physical layer.

(GHz) Frequency	(dB) Lower	(dB) Nominal	(dB) Upper
0	–1.00	0	1.00
6.45	–1.10	–0.10	0.90
12.90	–1.45	–0.45	0.55
19.36	–2.02	–1.02	–0.02
25.81	–2.86	–1.86	–0.86
32.26	–4.00	–3.00	–2.00
38.71	–6.56	–4.51	–2.46
43.02	–8.37	–5.71	–3.05
45.17	–9.31	–6.37	–3.43
51.63	–12.26	–8.54	–4.83
58.08	–15.32	–10.93	–6.53
64.53	–18.41	–13.41	–8.41

1 This specification is limited to the instrument operating in an ambient temperature between +20 °C and +30 °C. Nominal freq response is specified for optical input signals of modulation magnitude such that 2 mW_{pp} (200 μW_{pp} for 80C03 and 80C07; 500 μW_{pp} for 80C08 and 80C12) or less signal is applied at the sampler input.

Table 44: FEC 43.02 Gb/s reference receiver setting frequency response, warranted (80C20, 80C21)

Description [1]

The forward error correction method defined in ITU-T standard G.709 creates an additional overhead upon a standard OC-768 (STM256) 40 Gb/s data stream in which the data rate is effectively increased by a ratio of 255/236. Table 7-1 in G.709 standard lists this explicit serial data rate on the physical layer.

(GHz) Frequency	(dB) Lower	(dB) Upper
0.2	0.850	–0.850
1	0.847	–0.853
10	0.582	–1.12
24.2	–7.22	–2.48
34.2	–2.31	–4.54
44.6	–3.87	–8.51
52.4	–5.77	–11.9
57.4	–7.20	–14.1
61.2	–8.36	–15.9
64.0	–9.24	–17.2
64.2	–9.30	–17.3

[1] This specification is limited to the instrument operating in an ambient temperature between +18 °C and +28 °C. Nominal frequency response is specified for optical input signals of modulation magnitude such that 2 mW_{pp} or less signal is applied at the sampler input.

Table 45: FEC 43.02 Gb/s reference receiver setting frequency response (80C10C, Opt F1, F3 only), warranted

Description [1]

The forward error correction method defined in ITU-T standard G.709 creates an additional overhead upon a standard OC-768 (STM256) 40 Gb/s data stream in which the data rate is effectively increased by a ratio of 255/236. Table 7-1 in G.709 standard lists this explicit serial data rate on the physical layer.

(GHz) Frequency	(dB) Lower	(dB) Nominal	(dB) Upper
0	–0.85	0	0.85
6.45	–0.96	–0.11	0.74
12.90	–1.30	–0.45	0.40
19.32	–1.87	–1.02	–0.17
25.81	–2.71	–1.86	–1.01
32.26	–3.86	–3.00	–2.16
38.73	–6.19	–4.51	–2.83
43.02	–7.87	–5.71	–3.55
45.17	–8.75	–6.37	–3.99
51.63	–11.53	–8.54	–5.56
58.08	–14.45	–10.93	–7.41
64.52	–17.41	–13.41	–9.41

1 This specification is limited to the instrument operating in an ambient temperature between +20 °C and +30 °C.

Table 46: ENET2500 (2 GBE) 2.50 Gb/s reference receiver setting frequency response, warranted

Description [1]

Scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits.

2.50 Gb/s frequency response boundary limits are derived by simply scaling all frequency values by 2X as described in IEEE 802.3z section 38.6.5 (this section refers to ITU G.957 for tolerances). For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the Bessel-Thompson transfer function and listed below:

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.000	–0.50	0.00	0.50
375	–0.61	–0.11	0.39
750	–0.95	–0.45	0.05
1125	–1.52	–1.02	–0.52
1500	–2.36	–1.86	–1.36
1875	–3.50	–3.00	–2.50
2250	–5.67	–4.51	–3.35
2500	–7.25	–5.71	–4.17
2625	–8.08	–6.37	–4.66
3000	–10.74	–8.54	–6.35
3375	–13.55	–10.93	–8.31
3750	–16.41	–13.41	–10.41

[1] This specification is limited to the instrument operating in an ambient temperature between +20 °C and +30 °C. Nominal freq response is specified for optical input signals of modulation magnitude such that 2 mW_{pp} (200 μW_{pp} for 80C03 and 80C07; 500 μW_{pp} for 80C08 and 80C12) or less signal is applied at the sampler input.

Table 47: INF2500, INFINIBAND (2.5 Gb/s) reference receiver setting frequency response, warranted

Description			
INF2500 scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits. 2.50 Gb/s frequency response boundary limits are derived by scaling all frequency values by 2X as described in IEEE 802.3z section 38.6.5 (this section refers to ITU G.957 for tolerances). For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the Bessel-Thompson transfer function and listed below:			
(MHz) Frequency	(dB) Lower	(dB) Nominal	(dB) Upper
0.000	–0.50	0.00	0.50
375	–0.61	–0.11	0.39
750	–0.95	–0.45	0.05
1125	–1.52	–1.02	–0.52
1500	–2.36	–1.86	–1.36
1875	–3.50	–3.00	–2.50
2250	–5.67	–4.51	–3.35
2500	–7.25	–5.71	–4.17
2625	–8.08	–6.37	–4.66
3000	–10.74	–8.54	–6.35
3375	–13.55	–10.93	–8.31
3750	–16.41	–13.41	–10.41

Table 48: INF5000 (5.0 Gb/s) reference receiver setting frequency response, warranted

Description
INF5000 scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits.
5.0 Gb/s frequency response boundary limits are derived from an interpolation of frequency response boundary limits as described in ITU G.957 for OC192. The scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function and listed below:

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.00	–0.85	0.00	+0.85
750	–0.96	–0.11	+0.74
1500	–1.30	–0.45	+0.40
2250	–1.87	–1.02	–0.17
3000	–2.71	–1.86	–1.01
3750	–3.86	–3.00	–2.16
4500	–6.19	–4.51	–2.83
5000	–7.87	–5.71	–3.55
5250	–8.75	–6.37	–3.99
6000	–11.53	–8.54	–5.56
6750	–14.45	–10.93	–7.41
7500	–17.41	–13.41	–9.41

Table 49: ENET1250 (GBE) 1.25 Gb/s reference receiver setting frequency response, warranted

Description

Scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits.

1.250 Gb/s frequency response boundary limits are described in IEEE 802.3z section 38.6.5 (this section refers to ITU G.957 for tolerances).

For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the Bessel-Thompson transfer function and listed below:

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.000	–0.50	0.00	0.50
187.5	–0.61	–0.11	0.39
375	–0.95	–0.45	0.05
562.5	–1.52	–1.02	–0.52
750	–2.36	–1.86	–1.36
937.5	–3.50	–3.00	–2.50
1125	–5.67	–4.51	–3.35
1250	–7.25	–5.71	–4.17
1312.5	–8.08	–6.37	–4.66
1500	–10.74	–8.54	–6.35
1687.5	–13.55	–10.93	–8.31
1875	–16.41	–13.41	–10.41

1 This specification is limited to the instrument operating in an ambient temperature between +20 °C and +30 °C. Nominal freq response is specified for optical input signals of modulation magnitude such that 2 mW_{pp} (200 μW_{pp} for 80C03 and 80C07; 500 μW_{pp} for 80C08 and 80C12) or less signal is applied at the sampler input.

Table 50: FC1063 (1.0625 Gb/s) reference receiver setting frequency response, warranted

Description [1]

In FC1063 setting, scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits.

Fibre Channel frequency response boundary limits are described in ANSI FC-PC. For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function and listed below:

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.000	–0.50	0.00	0.50
159.5	–0.61	–0.11	0.39
318.9	–0.95	–0.45	0.05
478.4	–1.52	–1.02	–0.52
637.9	–2.36	–1.86	–1.36
797.4	–3.50	–3.00	–2.50
956.8	–5.67	–4.51	–3.35
1063	–7.25	–5.71	–4.17
1116	–8.08	–6.37	–4.66
1275	–10.74	–8.54	–6.35
1435	–13.55	–10.93	–8.31
1595	–16.41	–13.41	–10.41

[1] This specification is limited to the instrument operating in an ambient temperature between +20 °C and +30 °C. Nominal freq response is specified for optical input signals of modulation magnitude such that 2 mW_{pp} (200 μW_{pp} for 80C03 and 80C07; 500 μW_{pp} for 80C08 and 80C12) or less signal is applied at the sampler input.

Table 51: FC2125 (2.125 Gb/s) reference receiver setting frequency response, warranted

Description [1]

In FC2125 setting, scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits.

2G FiberChannel frequency response boundary limits are described in ANSI FC-PC. For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function and listed below:

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.000	–0.50	0.00	0.50
318.8	–0.61	–0.11	0.39
637.5	–0.95	–0.45	0.05
956.3	–1.52	–1.02	–0.52
1275	–2.36	–1.86	–1.36
1594	–3.50	–3.00	–2.50
1913	–5.67	–4.51	–3.35
2125	–7.25	–5.71	–4.17
2231	–8.08	–6.37	–4.65
2550	–10.74	–8.54	–6.35
2869	–13.55	–10.93	–8.31
3188	–16.41	–13.41	–10.41

[1] This specification is limited to the instrument operating in an ambient temperature between +20 °C and +30 °C. Nominal freq response is specified for optical input signals of modulation magnitude such that 2 mW_{pp} (200 μW_{pp} for 80C03 and 80C07; 500 μW_{pp} for 80C08 and 80C12) or less signal is applied at the sampler input.

Table 52: FC4250 (4.25 Gb/s) reference receiver setting frequency response, warranted

Description [1]

In FC4250 setting, scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits.

4G FiberChannel frequency response boundary limits are described in ANSI FC-PC. For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function and listed below:

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.000	–0.50	0.00	0.50
637.5	–0.61	–0.11	0.39
1275	–0.95	–0.45	0.05
1913	–1.52	–1.02	–0.52
2550	–2.36	–1.86	–1.36
3188	–3.50	–3.00	–2.50
3826	–5.67	–4.51	–3.35
4250	–7.25	–5.71	–4.17
4462	–8.08	–6.37	–4.65
5100	–10.74	–8.54	–6.35
5738	–13.55	–10.93	–8.31
6375	–16.41	–13.41	–10.41

[1] This specification is limited to the instrument operating in an ambient temperature between +20 °C and +30 °C. Nominal freq response is specified for optical input signals of modulation magnitude such that 2 mW_{pp} (200 μW_{pp} for 80C03 and 80C07; 500 μW_{pp} for 80C08 and 80C12) or less signal is applied at the sampler input.

Table 53: FC8500 (8.5Gb/s) Filter setting frequency response, warranted

Description

In the FC8500 setting, scalar frequency response falls within Bessel-Thompson reference receiver boundary limits as described in early-drafts of the 8xFibreChannel standard (8.5 Gb/s) (prior to FC-PI-4 rev 8.0).

Early drafts of ANSI FC-PI-4 prior to rev8.00 specified the use of a 0.75*8.5 GHz= 6.375 GHz (-3 dB) fourth-order ideal Bessel-Thomson response for this rate with upper and lower tolerances scaled in frequency by 8.5/10.0 from the 10GFC tolerance rails.

The nominal scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function for 4xFibreChannel (FC4250) frequency response described in ANSI FC-PC-4 and scaled in frequency to 8.5 Gb/s as listed below:

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.00	–0.85	0.00	0.85
1275	–0.96	–0.11	0.74
2550	–1.30	–0.45	0.40
3825	–1.87	–1.02	–0.17
5100	–2.71	–1.86	–1.01
6375	–3.86	–3.00	–2.16
7650	–6.19	–4.51	–2.83
8500	–7.87	–5.71	–3.55
8925	–8.75	–6.37	–3.99
10200	–11.53	–8.54	–5.56
11475	–14.45	–10.93	–7.41
12750	–17.41	–13.41	–9.41

Table 54: FC8500FINAL (8.5Gb/s) reference receiver setting frequency response, warranted

Description

In the FC8500Final setting, scalar frequency response falls within Industry Standard, Bessel-Thompson reference receiver boundary limits for the 8xFibreChannel data rate (8.5 Gb/s) according to the final ratified ANSI FC-PI-4 rev 8.00 standard document.

Early drafts of ANSI FC-PI-4 prior to rev8.00 specified the use of a 0.75*8.5 GHz= 6.375 GHz (-3 dB) fourth-order ideal Bessel-Thomson response for this rate with upper and lower tolerances scaled in frequency by 8.5/10.0 from the 10GBASE-R tolerance rails.

In 07/2008 ANSI FC-PI-4 rev8.00 changed the filter -3dB bandwidth specification to 7.5 GHz which is identical to the 10GFC reference receiver.

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.0	–0.85	0.00	0.85
1500	–0.96	–0.11	0.74
3000	–1.30	–0.45	0.40
4500	–1.87	–1.02	–0.17
6000	–2.71	–1.86	–1.01
7500	–3.86	–3.00	–2.16
9000	–6.19	–4.51	–2.83
10000	–7.87	–5.71	–3.55
10500	–8.75	–6.37	–3.99
12000	–11.53	–8.54	–5.56
13500	–14.45	–10.93	–7.41
15000	–17.41	–13.41	–9.41

Table 55: VSR-5 (3.318 Gb/s) reference receiver setting frequency response, warranted

Description [1]

In 3.318 Gb/s setting, scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits.

At the time of publishing this document, a standard for VSR-5 frequency response boundary limits has not been defined. The scalar frequency response curve and tolerance boundaries used for 10GBASE-4 scaled to the VSR-5 bit rate will be used for this rate until a standard has been defined.

The exact bit rate is given by the formula:

$$\frac{768 \times 51.84\,Mb/s}{12} = 3317.76\,Mb/s$$

For convenience, the scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function and listed below:

(MHz) Frequency	(dB) Lower	(dB) Nominal	(dB) Upper
0.000	–0.50	0.00	0.50
497.7	–0.61	–0.11	0.39
995.3	–0.95	–0.45	0.05
1493	–1.52	–1.02	–0.52
1991	–2.36	–1.86	–1.36
2488	–3.50	–3.00	–2.50
2986	–5.67	–4.51	–3.35
3318	–7.25	–5.71	–4.17
3484	–8.08	–6.37	–4.65
3981	–10.74	–8.54	–6.35
4479	–13.55	–10.93	–8.31
4977	–16.41	–13.41	–10.41

1 This specification is limited to the instrument operating in an ambient temperature between +20 °C and +30 °C. Nominal freq response is specified for optical input signals of modulation magnitude such that 2 mW_{pp} (200 μW_{pp} for 80C03 and 80C07; 500 μW_{pp} for 80C08 and 80C12) or less signal is applied at the sampler input.

Table 56: OBSAI 6.144 Gb/s (OBSAI6144) reference receiver setting frequency response, warranted

Description
In OBSAI6144 setting, scalar frequency response falls within Industry Standard, Bessel-Thompson reference receiver boundary limits for a 6.144 Gb/s baud rate.
Tolerances have been derived from frequency response boundary limits as described in ITU G.957 for OC192. The scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function and listed below

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.00	–0.85	0.00	0.85
922	–0.96	–0.11	0.74
1843	–1.30	–0.45	0.40
2765	–1.87	–1.02	–0.17
3686	–2.71	–1.86	–1.01
4608	–3.86	–3.00	–2.16
5530	–6.19	–4.51	–2.83
6144	–7.87	–5.71	–3.55
6451	–8.75	–6.37	–3.99
7373	–11.53	–8.54	–5.56
8234	–14.45	–10.93	–7.41
9216	–17.41	–13.41	–9.41

Table 57: CPRI 7.373 Gb/s (CPRI7373) reference receiver setting frequency response, warranted

Description

In CPRI7373 setting, scalar frequency response falls within Industry Standard, Bessel-Thompson reference receiver boundary limits for a 7.373 Gb/s baud rate.

Tolerances have been derived from frequency response boundary limits as described in ITU G.957 for OC192. The scalar frequency response of the output amplitude (for sinusoidal swept optical input) has been interpreted from the published Bessel-Thompson transfer function and listed below:

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.0	–0.85	0.00	0.85
1106	–0.96	–0.11	0.74
2212	–1.30	–0.45	0.40
3318	–1.87	–1.02	–0.17
4423	–2.71	–1.86	–1.01
5767	–3.86	–3.00	–2.16
6636	–6.19	–4.51	–2.83
7373	–7.87	–5.71	–3.55
7741	–8.75	–6.37	–3.99
8848	–11.53	–8.54	–5.56
9881	–14.45	–10.93	–7.41
11059	–17.41	–13.41	–9.41

Table 58: 32 GHz reference receiver setting frequency response for 32 Gb/s NRZ, warranted

Description

At the time of this writing no standard for 32.0 Gb/s NRZ signaling exists. Tektronix anticipates a future need for transmitter testing of OTU4 transceivers with ~14% FEC overhead (for example, 27.952 Gb/s x 1.14 =~32 Gb/s). The 32 GHz setting is therefore defined as a generic filter optimized for 32 Gb/s mask testing. The frequency response follows a 4th-order Bessel-Thompson filter response derived by frequency scaling the ORR filter specified for 100GBASE-R4 per IEEE P803.2ag from 25.7815 Gb/s to 32.0 Gb/s.

The response follows a standard 4th-order Bessel-Thompson Scalar Frequency Response with a -3 dB reference frequency of 0.75x(data rate). For example, 0.75 x 32.0 GHz = 24.0 GHz.

Tolerances are the same as specified for 100GBASE-R4 in IEEE802.3ba. The table lists the nominal curve and tolerances at various frequencies, based on ±0.85 dB DC to 0.75x(data rate) and expanding to ±4.0 dB at 1.5x(data rate).

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.00	–0.85	0.00	0.85
4800	–0.96	–0.11	0.74
9600	–1.30	–0.45	0.40
14400	–1.87	–1.02	–0.17
19200	–2.71	–1.86	–1.01
24000	–3.86	–3.00	–2.16
28800	–6.19	–4.51	–2.83
32000	–7.87	–5.71	–3.55
33600	–8.75	–6.37	–3.99
38400	–11.53	–8.54	–5.56
43200	–14.45	–10.93	–7.41
48000	–17.41	–13.41	–9.41

Table 59: 28.05 GHz reference receiver setting frequency response for 28.05 Gb/s NRZ, warranted

Description

At the time of this writing ANSI T11.2 standard document FC-PC-6 (draft 1.0) does not contain a specification for an optical reference receiver filter for 32xFC testing at 28.05 Gb/s. Tektronix anticipates use of a 4th-order Bessel-Thompson filter derived by frequency scaling the ORR filter specified for 100GBASE-R4 per IEEE P803.2ag from 25.7815 Gb/s to 28.05 Gb/s.

The response follows a standard 4th-order Bessel-Thompson Scalar Frequency Response with a -3 dB reference frequency of 0.75x(data rate) For example, 0.75 x 28.05 GHz = 21.0375 GHz. Tolerances are the same as specified for 100GBASE-R4 in IEEE802.3ba. The table below lists the nominal curve and tolerances at various frequencies; based on ±0.85 dB DC to 0.75x(data rate) and expanding to ±4.0dB at 1.5x(data rate).

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.00	–0.85	0.00	0.85
4209	–0.96	–0.11	0.74
8415	–1.30	–0.45	0.40
12623	–1.87	–1.02	–0.17
16831	–2.71	–1.86	–1.01
21039	–3.86	–3.00	–2.16
25246	–6.19	–4.51	–2.83
28050	–7.87	–5.71	–3.55
29453	–8.75	–6.37	–3.99
33660	–11.53	–8.54	–5.56
37868	–14.45	–10.93	–7.41
42075	–17.41	–13.41	–9.41

Table 60: OTU-4 (OTU27952) reference receiver Setting Frequency Response for 27.952 Gb/s, warranted (excludes 80C20, 80C21)

Description
The OTU-4 reference receiver for 27.952 Gb/s NRZ eye diagram testing is derived from the 100GBASE-R4 reference receiver as specified in IEEE P802.3ba by frequency scaling the filter bandwidth and response tolerances from 25.78125 Gb/s to 27.952 Gb/s. The response follows a standard 4th-order Bessel-Thompson Scalar Frequency Response with a -3 dB reference frequency of 0.75x(data rate). For example, 0.75 x 27.952 GHz = 20.694 GHz. Tolerances are as specified for 100GBASE-R4 in IEEE802.3ba. The table below lists the nominal curve and tolerances at various frequencies; based on ±0.85 dB DC to 0.75x(data rate) and expanding to ±4.0 dB at 1.5x(data rate).

Frequency (MHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.00	–0.85	0.00	0.85
4193	–0.96	–0.11	0.74
8386	–1.30	–0.45	0.40
12579	–1.87	–1.02	–0.17
16773	–2.71	–1.86	–1.01
20966	–3.86	–3.00	–2.16
25159	–6.19	–4.51	–2.83
27952	–7.87	–5.71	–3.55
29350	–8.75	–6.37	–3.99
33542	–11.53	–8.54	–5.56
37736	–14.45	–10.93	–7.41
41928	–17.41	–13.41	–9.41

Table 61: OTU-4 (OTU27952) reference receiver Setting Frequency Response for 28.6416 Gb/s, warranted (80C20, 80C21)

Description

The OTU-4 reference receiver for 28.6416 Gb/s NRZ eye diagram testing is derived from the 100GBASE-R4 reference receiver as specified in IEEE P802.3ba by frequency scaling the filter bandwidth and response tolerances from **25.78125** Gb/s to 28.6416 Gb/s.

The response follows a standard 4th-order Bessel-Thompson Scalar Frequency Response with a -3 dB reference frequency of 0.75x(data rate). For example, 0.75 x 27.952 GHz = 20.694 GHz. Tolerances are as specified for 100GBASE-R4 in IEEE802.3ba. The table below lists the nominal curve and tolerances at various frequencies; based on ±0.85 dB DC to 0.75x(data rate) and expanding to ±4.0 dB at 1.5x(data rate).

Frequency (MHz)	*Lower (dB)*	*Upper (dB)*
0.200	0.850	–0.850
1.00	0.844	–0.856
3.4	0.777	–0.923
10.2	0.183	-0.152
24.6	–2.71	–5.86
32.4	–5.10	–10.8
34.8	–6.09	–12.4
40.2	–8.57	–16.2
41.8	–9.34	–17.3
42.0	0.00	0.00

Table 62: INF25781 reference receiver Setting Frequency Response, warranted (80C20, 80C21)

Description

Frequency (MHz)	*Lower (dB)*	*Upper (dB)*
0.200	0.850	–0.850
1.00	0.843	–0.857
3.4	0.764	–0.936
10.2	0.634	–1.64
24.6	–3.20	–7.08
32.4	–6.23	–12.6
33.4	–6.71	–13.4

Table 63: ENET/PAM4 51.3 Gb/s reference receiver Setting Frequency Response, warranted (80C20, 80C21)

Description		
Frequency (MHz)	*Lower (dB)*	*Upper (dB)*
0.200	–0.850	0.850
1.00	–0.854	0.846
3.4	–0.895	0.805
10.2	–1.26	0.437
24.0	–3.27	–1.57
32.4	–6.43	–2.92
46.4	–13.7	–6.89
52.8	–17.2	–9.28

Table 64: 32GFCr0 reference receiver Setting Frequency Response, warranted (80C20, 80C21)

Description		
Frequency (MHz)	*Lower (dB)*	*Upper (dB)*
0.200	–0.850	0.850
1.00	–0.856	0.844
3.4	–0.923	0.777
10.2	–1.52	0.183
24.0	–5.52	–2.59
32.4	–10.8	–5.10
41.0	–16.8	–8.96
41.6	–17.2	–9.25
42.0	0.00	0.00

Table 65: 22 GHz filter setting frequency response for 28.05 Gb/s NRZ (OTU-4, 32GFC), warranted (80C15 only)

Description			
The 22 GHz setting is a generic filter optimized for 22 Gb/s mask testing (80C15 only).			
Frequency (GHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.00	–0.60	–0.05	0.50
3.0	–0.87	–0.25	0.36
6.0	–1.15	–0.46	0.23
9.0	–1.42	–0.66	0.09
12.0	–1.69	–0.87	–0.05
15.0	–1.96	–1.07	–0.18
18.0	–2.24	–1.28	–0.32
21.0	–3.27	–1.86	–0.45
24.0	–5.45	–3.02	–0.59
27.0	–7.64	–5.14	–2.64
30.0	–9.82	–7.32	–4.82
33.0	–12.00	–9.50	–7.00

Table 66: 25.781 GHz filter setting frequency response for 28.05 Gb/s NRZ (100GBASE-xR4, INF25781), warranted (80C15 only)

Description			
The 25.781 setting is a generic filter optimized for 25.781 Gb/s mask testing (80C15 only).			
Frequency (GHz)	*Lower (dB)*	*Nominal (dB)*	*Upper (dB)*
0.00	–0.80	–0.15	0.50
3.52	–0.99	–0.28	0.43
7.03	–1.19	–0.41	0.36
10.55	–1.38	–0.54	0.30
14.06	–1.57	–0.67	0.23
17.58	–1.76	–0.80	0.16
21.09	–1.96	–0.93	0.09
24.61	–3.77	–1.87	0.02
28.12	–6.08	–3.67	–1.27
31.64	–8.38	–5.78	–3.18
35.16	–10.69	–7.89	–5.09
38.67	–13.00	–10.00	–7.00

Table 67: Optical power meter (typical)

Name		Characteristics
Optical power meter range		
	80C01, 80C02, 80C03, 80C04, 80C07, 80C07B, 80C09, 80C11, 80C11B	+4 dBm to –30 dBm
	80C05, 80C06, 80C10, 80C10B, 80C10C, 80C15, 80C25GBE	+13 dBm to –21 dBm
	80C08, 80C08B, 80C08C, 80C08D, 80C12, 80C12B, 80C14	+0 dBm to –30 dBm
	80C17, 80C18	1310 – 1550 nm: –38 dBm to –3 dBm 850 nm: –38 dBm to –6 dBm
	80C20, 80C21	–27 dBm to 6 dBm
Optical power meter accuracy		5% of reading + connector uncertainty (typical): 780 nm ±20 nm (80C07B, 80C08C, 80C08D) 850 nm ±20 nm (80C07B, 80C08C, 80C08D, 80C12, 80C12B, 80C14, 80C15) 1310 nm ±20 nm and 1550 nm ±20 nm (80C01, 80C02, 80C07B, 80C08C, 80C08D, 80C10, 80C10B, 80C10C, 80C11, 80C11B, 80C12, 80C12B, 80C14, 80C17, 80C18, 80C20, 80C21, 80C25GBE) 20 °C to 30 °C ambient temperature

Table 68: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, CR4, CRTP)

Name	Characteristics
Effective wavelength range (clock recovery path)	
80C01, 80C02, 80C04, 80C09	1270 nm to 1600 nm
80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C, 80C08D, 80C12, 80C12B, 80C14	700 nm to 1650 nm
80C11, 80C11B	1270 nm to 1600 nm
Operating data rates [5]	
80C01-CR	622.08 Mb/s ±1000 ppm (OC-12/STM-4)
	2.48832 Gb/s ±1000 ppm (OC-48/STM-16)
80C02-CR	9.95328 Gb/s ±1000 ppm (OC-192/STM-64)
80C03-CR	1.0625 Gb/s ±1000 ppm (FC1063)
	1.2500 Gb/s ±1000 ppm (GBE)
	2.48832 Gb/s ±1000 ppm (OC-48/STM-16)
	2.5000 Gb/s ±1000 ppm (2 GBE)
80C04-CR1	9.95328 Gb/s ±1000 ppm (OC-192/STM-64)
80C04-CR2	9.95328 Gb/s ±1000 ppm (OC-192/STM-64)
	10.664 Gb/s ±1000 ppm (OC-192 FEC)
80C07-CR1	155.52 Mb/s ±1000 ppm (OC-3/STM-1)
	622.08 Mb/s ±1000 ppm (OC-12/STM-4)
	2488.32 Mb/s ±1000 ppm (OC-48/STM-16)
80C07B-CR1	155.52 Mb/s ±1000 ppm (OC-3/STM-1)
	622.08 Mb/s ±1000 ppm (OC-12/STM-4)
	1062.5 Mb/s ±1000 ppm (FC1063/FC)
	1250 Mb/s ±1000 ppm (ENET1250/GBE)
	2125 Mb/s ±1000 ppm (FC2125/2FC)
	2488.32 Mb/s ±1000 ppm (OC-48/STM-16)
	2500 Mb/s ±1000 ppm (ENET2500/2GBE)
	2500 Mb/s ±1000 ppm (Infiniband)
	2666.06 Mb/s ±1000 ppm (OC-48-FEC)
80C08-CR1, 80C08B-CR1, 80C08C-CR1, 80C08D-CR1	9.95328 Gb/s ±1000 ppm (10GBASE-W) 10.3125 Gb/s ±1000 ppm (10GBASE-R)
80C08B-CR2, 80C08C-CR2, 80C08D-CR2	10.3125 Gb/s ±1000 ppm (10GBASE-R) 10.51875 Gb/s ±1000 ppm (10GFC)

Table 68: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, CR4, CRTP) (cont.)

Name	Characteristics
80C08C-CR4, 80C08D-CR4	Continuous from 9.8 Gb/s to 12.6 Gb/s User must enter the bit rate into the main instrument with an accuracy better than 1000 ppm Pre-defined selections at 9.95338 Gb/s, 10.3125 Gb/s, 10.51875 Gb/s, 10.66423 Gb/s, 10.709225 Gb/s, 11.0957 Gb/s The input bit rate must be within 1000 ppm of the selected rate
80C09-CR1	9.95328 Gb/s ±1000 ppm (OC-192/STM-64) 10.709 Gb/s ±1000 ppm (FEC)
80C11-CR1, 80C11B-CR1	9.95328 Gb/s ±1000 ppm (OC-192/STM-64)
80C11-CR2, 80C11B-CR2	9.95328 Gb/s ±1000 ppm (OC-192/STM-64) 10.66423 Gb/s ±1000 ppm (10Gb FEC)
80C11-CR3, 80C11B-CR2	9.95328 Gb/s ±1000 ppm (OC-192/STM-64) 10.70922 Gb/s ±1000 ppm (G.709 FEC)
80C11-CR4, 80C11B-CR2	Continuous from 9.8 Gb/s to 12.6 Gb/s User must enter the bit rate into the main instrument with an accuracy better than 1000 ppm Pre-defined selections at 9.95338 Gb/s, 10.3125 Gb/s, 10.51875 Gb/s, 10.66423 Gb/s, 10.709225 Gb/s, 11.0957 Gb/s The input bit rate must be within 1000 ppm of the selected rate
80C10B Opt. CRTP, 80C12, 80C12B, 80C14, 80C15 Opt. CRTP, 80C25GBE Opt CRTP	Clock recovery provided with the use of the 80A05, 80A07, CR125A, CR175A, or CR286A Electrical Clock Recovery module.
80C10C	1 Gb/s to 44.5 Gb/s NRZ Supported data rates are limited by the bandwidth of the pickoff photoreceiver and the signal loss in the coaxial cable paths.

For the 80C02-CR and 80C04-CR1 modules, the incoming data stream must be of non-return-to-zero format (NRZ) and must have a data sequence content which provides both isolated 1s and multi-consecutive mark sequences (that is 2,3,4 and so forth logical 1s in a consecutive row).

NOTE. *A fixed pattern of 10101010. . . does not meet the data sequence content:. The 80C02-CR and 80C04-CR1 clock recovery functions may not properly lock to such a pattern. The 80C02-CR and 80C04-CR1 will, however, typically lock to a 11001100. . . pattern (this is equivalent to a 2.48832 GHz optical square wave).* [5]

Table 68: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, CR4, CRTP) (cont.)

Name	Characteristics		
✓ Optical sensitivity range, clock recovery (optical input power) [1]	*Maximum*	*Minimum*	
80C01	+ 5.0 dBm (3.16 mW), typical	-10.0 dBm (100 µW), typical	
80C02	+7.0 dBm (5.0 mW), typical	-10.0 dBm (100 µW), typical -7.5 dBm, warranted	
80C03	-4.0 dBm (400 µW), warranted	-16.0 dBm (25 µW), warranted	
80C04	+7.0 dBm (5.0 mW), typical	-10.0 dBm (100 µW), typical -7.5 dBm, warranted	
80C07	-4.0 dBm (400 µW), warranted	-16.0 dBm (25 µW), warranted	
80C08, 80C08B, 80C08C, 80C08D-CR1/CR2	+0.0 dBm (1.0 mW, all wavelengths), warranted	-13.0 dBm (50 µW, 1310 nm, 1550 nm), warranted -15.0 dBm (32 µW, 1310 nm, 1550 nm), typical -12.0 dBm (64 µW, 780 nm, 850 nm), typical	
80C08C-CR4, 80C08D-CR4	+0.0 dBm (1.0 mW), typical	1550 nm, 1310 nm Bit Rate: 9.8 Gb/s to 11.25 Gb/s	
		AOP @ ER ≥8.2 dB [7]	*(OMA)* [8]
		-15 dBm typical	-12.3 dBm typical
		-13 dBm warranted [6]	-11.3 dBm warranted [6]
		1550 nm, 1310 nm Bit Rate: 11.25 Gb/s to 12.6 Gb/s	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-12.5 dBm typical	-10.8 dBm typical
		-11.5 dBm warranted [6]	-9.8 dBm warranted [6]
		850 nm, 780 nm Bit Rate: 9.8 Gb/s to 11.25 Gb/s	
		AOP @ ER ≥8.2 dB [7]	*(OMA)* [8]
		-12 dBm typical	-9.3 dBm typical
		-10 dBm warranted [6]	-8.3 dBm warranted [6]
		850 nm, 780 nm Bit Rate: 11.25 Gb/s to 12.6 Gb/s	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-9.5 dBm typical -8.5 dBm warranted [6]	-7.8 dBm typical -6.8 dBm warranted [6]

Table 68: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, CR4, CRTP) (cont.)

Name	Characteristics		
80C09	+7 dBm (5.0 mW), typical	-10.0 dBm (100 µW), typical -7.5 dBm, warranted	
80C11-CR1/-CR2/-CR3	+7 dBm (5.0 mW), typical	-10.0 dBm (100 µW), typical -7.5 dBm, warranted [6]	
80C11-CR4	+7 dBm (5.0 mW), typical	Bit Rate: 9.8 Gb/s to 11.25 Gb/s	
		AOP @ ER ≥8.2 dB [7]	*(OMA)* [8]
		-12 dBm typical -9 dBm warranted [6]	-10.3 dBm typical -7.3 dBm warranted [6]
		Bit Rate: 11.25 Gb/s to 12.6 Gb/s	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-10.5 dBm typical -7.5 dBm warranted [6]	-8.8 dBm typical -5.8 dBm warranted [6]
80C12 Clock recovery provided by 80A05 module	0 dBm (1.0 mW), typical	Bit Rate: 150 Mb/s to 2.7 Gb/s: 1550 nm, 1310 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-13.1 dBm (48.6 µW) warranted [6]	-11.5 dBm (71.4 µW) warranted [6]
		Bit Rate: 150 Mb/s to 2.7 Gb/s: 850 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-11.5 dBm (70.7 µW) typical [6]	-9.8 dBm (104 µW) typical [6]
		Bit Rate: 2.7 Gb/s to 11.19 Gb/s: 1550 nm, 1310 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-11.4 dBm (72.8 µW) warranted [6]	-9.7 dBm (107 µW) warranted [6]
		Bit Rate: 2.7 Gb/s to 11.19 Gb/s: 850 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-9.7 dBm (106 µW) typical	-8.1 dBm (156 µW) typical
		Bit Rate: 11.19 Gb/s to 12.5 Gb/s: 1550 nm, 1310 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-10.1 dBm (97.2 µW) warranted [6]	-8.5 dBm (143 µW) warranted [6]
		Bit Rate: 11.19 Gb/s to 12.5 Gb/s: 850 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-8.5 dBm (141 µW) typical	-6.8 dBm (208 µW) typical

Table 68: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, CR4, CRTP) (cont.)

Name	Characteristics		
80C12B-10G, 80C14, typical Clock recovery provided by Tektronix CR125A (up to 12.5 Gb/s), CR175A or CR286A clock recovery instruments	3 dBm (2 mW) maximum	Bit Rate: 8.5 Gb/s to 14.2 Gb/s: 1550 nm, 1310 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-14.7 dBm (33.8 µW) typical [6]	-13 dBm (50 µW) typical [6]
		Bit Rate: 8.5 Gb/s to 14.2 Gb/s: 850 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-12.4 dBm (57.5 µW) typical [6]	-10.7 dBm (85 µW) typical [6]
80C12B (Select Four Filters), typical Clock recovery provided by Tektronix CR125A (up to 12.5 Gb/s), CR175A or CR286A clock recovery instruments	3 dBm (2 mW) maximum	Bit Rate: 155.22 Mb/s to 1.25 Gb/s: 1550 nm, 1310 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-18.7 dBm (13.5 µW) typical [6]	-17 dBm (20 µW) typical [6]
		Bit Rate: Bit Rate: 155.22 Mb/s to 1.25 Gb/s: 850 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-16.4 dBm (22.9 µW) typical	-14.7 dBm (34 µW) typical
		Bit Rate: >1.25 Gb/s to 7.373 Gb/s: 1550 nm, 1310 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-15.1 dBm (30.9 µW) typical [6]	-13.5 dBm (45 µW) typical [6]
		Bit Rate: >1.25 Gb/s to 7.373 Gb/s: 850 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-12.9 dBm (51.3 µW) typical	-11.2 dBm (76 µW) typical
		Bit Rate: >7.373 Gb/s to 11.32 Gb/s: 1550 nm, 1310 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-14.1 dBm (39 µW) typical	-12.4 dBm (57.5 µW) typical
		Bit Rate: >7.373 Gb/s to 11.32 Gb/s: 850 nm	
		(AOP @ ER ≥8.2 dB) [7]	*(OMA)* [8]
		-11.8 dBm (66 µW) typical	-10.1 dBm (98 µW) typical
Clock and data electrical output amplitudes [2]			
80C01		>300 $mV_{pp,}$ typical	
80C02	Serial DATA output	>700 $mV_{pp,}$ typical	
	Serial CLOCK output	1.5 $V_{pp,}$ typical	
	1/16th CLOCK output	600 $mV_{pp,}$ typical	
80C03	Serial DATA output	>350 $mV_{pp,}$ typical	
	Serial CLOCK output	>350 $mV_{pp,}$ typical	

Table 68: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, CR4, CRTP) (cont.)

Name	Characteristics	
80C04-CR1	Serial DATA output	>700 $mV_{pp,}$ typical
	Serial CLOCK output	1.5 $V_{pp,}$ typical
	1/16th CLOCK output	600 $mV_{pp,}$ typical
80C04-CR2	Serial CLOCK output	1.5 $V_{pp,}$ typical
	1/16th CLOCK output	600 $mV_{pp,}$ typical
80C07, 80C07B	Serial CLOCK output	450 $mV_{pp,}$ typical
	Serial DATA output	450 $mV_{pp,}$ typical
80C08, 80C08B, 80C08C, 80C08D 80C08C, 80C08D-CR1/CR2	Serial CLOCK output	1.0 $V_{pp,}$ typical
	1/16th CLOCK output	600 $mV_{pp,}$ typical
80C08C, 80C08D-CR4	Serial CLOCK output	800 $mV_{pp,}$ typical
	1/16th CLOCK output	600 $mV_{pp,}$ typical
80C09	Serial CLOCK output	1.5 $V_{pp,}$ typical
	1/16th CLOCK output	600 $mV_{pp,}$ typical
80C11-CR1 80C11B-CR1	Serial DATA output	>700 $mV_{pp,}$ typical
	Serial CLOCK output	900 $mV_{pp,}$ typical
	1/16th CLOCK output	600 $mV_{pp,}$ typical
80C11-CR2/CR3 80C11B-CR2/ -CR3	Serial CLOCK output	1.5 $V_{pp,}$ typical
	1/16th CLOCK output	600 $mV_{pp,}$ typical
80C11-CR4 80C11B-CR4	Serial CLOCK output	800 $mV_{pp,}$ typical
	1/16th CLOCK output	600 $mV_{pp,}$ typical
80C12	ELECTRICAL SIGNAL OUT	400 $mV_{pp,}$ maximum (dependent on optical input amplitude)
80C12B, 80C14	ELECTRICAL SIGNAL OUT	400 $mV_{pp,}$ differential, typical

Table 68: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, CR4, CRTP) (cont.)

Name	Characteristics	
Clock and data rise time and fall times [2]		
80C01	Serial DATA output	<30 ps
	Serial CLOCK output	<30 ps
80C02	Serial DATA output	<30 ps
	Serial CLOCK output	<30 ps
	1/16th CLOCK output	<300 ps
80C03	Serial DATA output	<30 ps
	Serial CLOCK output	<30 ps
80C04	Serial DATA output	<30 ps
	Serial CLOCK output	<30 ps
	1/16th CLOCK output	<300 ps
80C04-CR2	Serial CLOCK output	<30 ps
	1/16th CLOCK output	<300 ps
80C07	Serial DATA output	<30 ps
	Serial CLOCK output	<30 ps
80C07B	Serial DATA output	<150 ps
	Serial CLOCK output	<150 ps
80C08, 80C08B, 80C08C, 80C08D	Serial CLOCK output	<30 ps
	1/16th CLOCK output	<300 ps
80C09	Serial CLOCK output	<30 ps
	1/16th CLOCK output	<300 ps
80C11, 80C11B	Serial DATA output (80C11B-CR1 only)	<30 ps
	Serial CLOCK output	<30 ps
	1/16th CLOCK output	<300 ps
80C12B, 80C14	ELECTRICAL SIGNAL OUT	80C12B Filter F1–F4: <110 ps maximum (60 ps typical) All other filter, bandwidth settings: <38 ps maximum (<28 ps typical)

Table 68: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, CR4, CRTP) (cont.)

Name	Characteristics
Jitter Transfer Bandwidth [5]	
80C04-CR2	8 MHz maximum
80C09-CR1	5 MHz minimum
80C11-CR1	7 MHz typical
80C11-CR2	
80C11-CR3	
80C08B-CR1, 80C08B-CR2	4 MHz maximum
80C08C-CR1, 80C08C-CR2	2 MHz minimum
80C08D-CR1, 80C08D-CR2	
80C08C-CR4, 80C08D-CR4	4 MHz maximum
	1 MHz minimum
	2 MHz typical
80C11-CR4, 80C11B-CR4	4 MHz maximum
	1 MHz minimum
	2 MHz typical

Table 68: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, CR4, CRTP) (cont.)

Name	Characteristics	
✓Recovered clock timing jitter [3], [4]		
80C01	<8.0 ps $_{rms}$ maximum	
	<4.0 ps $_{rms}$ typical	
80C02	<2.0 ps $_{rms}$ maximum	
	<1.0 ps $_{rms}$ typical [5]	
80C03	<8.0 ps $_{rms}$ maximum	
	<4.0 ps $_{rms}$ typical	
80C04	<2.0 ps $_{rms}$ maximum	
	<1.0 ps $_{rms}$ typical [5]	
80C07	OC-3 setting	<32.0 ps $_{rms}$ maximum
		<12.0 ps $_{rms}$ typical [5]
	OC-12 setting	<8.0 ps $_{rms}$ maximum
		<4.0 ps $_{rms}$ typical [5]
	OC-48 setting	<4.0 ps $_{rms}$ maximum
		<2.2 ps $_{rms}$ typical [5]
80C07B	OC-3 setting	<32.0 ps $_{rms}$ maximum
		<12.0 ps $_{rms}$ typical
	OC-12 setting FC1063 (FC) setting ENET1250 (GBE) setting	<8.0 ps $_{rms}$ maximum <4.0 ps $_{rms}$ typical
	FC2125 (2FC) setting	<6.0 ps $_{rms}$ maximum
		<3.0 ps $_{rms}$ typical
	OC-48 setting OC-48-FEC setting ENET2500 (2GBE) setting INFINIBAND setting	<4.0 ps $_{rms}$ maximum <2.2 ps $_{rms}$ typical
80C08, 80C08B, 80C08C, 80C08D	<2.0 ps $_{rms}$ maximum	
	<1.0 ps $_{rms}$ typical [5]	
80C09	<2.0 ps $_{rms}$ maximum	
	<1.0 ps $_{rms}$ typical [5]	
80C11, 80C11B	<2.0 ps $_{rms}$ maximum	
	<1.0 ps $_{rms}$ typical [5]	

1 These powers are the average optical input coupled into the external Optical Sampling Module optical input connector. The range is defined for recovered clock, a 50% duty cycle of the incoming NRZ data (also referred to as 50% mark density), a PRBS pattern of 2^{23-1}, and an extinction ratio of ≥8.2 dB (at eye center).

2 Output is 50 Ω AC coupled: specification is for output amplitude at the bulkhead outputs and does not include RF loss of attached cables.

3 The clock jitter is applicable to both the external electrical output and the system jitter experienced when the recovered clock is the source of the waveform trigger for the system.

4 Jitter performance of the system while using the optical module clock recovery as the trigger source is warranted only while no active signal is applied to the main instrument's External Trigger (or Prescaler) input.

5 Internal use for trigger results in a total system jitter of

$$\geq \sqrt{sum\ of\ square}$$

therefore, the displayed waveform may normally exhibit:

$$\sqrt{(mainframe\ jitter^2 + OCR\ jitter^2)}$$

6 Sensitivity is only warranted for operating ambient temperatures below +30 °C.

7 The AOP (Average Optical Power) range is defined for recovered clock that has a resulting jitter that is less than the specified maximum, a 50% duty cycle of the incoming data (also referred to as 50% mark density), a PRBS pattern of 2^{23} -1, and an extinction ratio of ≥8.2 dB (at eye center).

8 The OMA (Optical Modulation Amplitude) input level is defined as (P_{HIGH} - P_{LOW}). For an extinction ratio of 8.2, the OMA is 1.47 AOP or AOP(dBm) + 1.68 dB.

9 The acceptable signal types and patterns for the specified modules are:

Module	NRZ	RZ	1010 . . .
80C02-CR, 80C04-CR1	Y	N	N
80C03-CR, 80C07-CR, 80C07B-CR1	Y	N	Y
80C04-CR2, 80C08-CR1, 80C08B-CR1, 80C08B-CR2, 80C09-CR1	Y	Y	Y

Table 69: Optical modules - Mechanical

Name	Characteristics
Construction material	Chassis parts constructed of aluminum alloy; front panel constructed of plastic laminate; circuit boards constructed of glass-laminate. Cabinet is aluminum.
Weight	
80C01, 80C03, 80C07	1.13 kg (2.50 lbs) 1.34 kg (2.95 lbs) (with clock recovery)
80C02, 80C04, 80C08, 80C08B, 80C08C, 80C08D, 80C09, 80C11, 80C11B	0.95 kg (2.10 lbs) 1.22 kg (2.70 lbs) (with clock recovery)
80C05, 80C06	0.95 kg (2.10 lbs)
80C07B	0.95 kg (2.10 lbs) 1.36 kg (3.0 lbs) (with clock recovery)
80C10, 80C10B, 80C25GBE	0.95 kg (2.10 lbs)
80C10C, 80C15, 80C17, 80C18, 80C20, 80C21	0.85 kg (1.88 lbs) 80C10C with Option CRTP and HSRP: 0.92 kg (2.03 lbs) 80C15 with Option CRTP: 0.92 kg (2.03 lbs)
80C12	1.31 kg (2.89 lbs) (F1, F2, F3, F4, F5, F6, FC) 0.98 kg (2.16 lbs) (option 10G)
80C12B	80C12B: 1.56 kg (3.44 lbs) (with four filters installed) 80C12B-10G: 1.02 kg (2.25 lbs)

Table 69: Optical modules - Mechanical (cont.)

Name	Characteristics
80C14	1.02 kg (2.25 lbs)
Overall dimensions (all optical modules)	Height: 25.6 mm (1.0 in) Width: 166.7 mm (6.5 in) Depth: 307.7 mm (12.0 in)

Table 70: Optical modules (all) - Environmental

Name	Characteristics	
Temperature	Installed and operating	+10 °C to +40 °C
	Reference receivers frequency response tolerances, 30 GHz mode, and optical power meter accuracy	+20 °C to +30 °C
	Installed and non-operating	–22 °C to +60 °C
Humidity	Installed and operating	20% to 80% relative humidity with a maximum wet bulb temperature of 29 °C at or below +40 °C, (upper limit derates to 45% relative humidity at +40 °C) non-condensing.
	Reference receivers frequency response tolerances	+20 °C to +30 °C
	Optical power meter accuracy	+20 °C (80% RH) to +30 °C (80% RH)
	Installed and non-operating	5% to 90% relative humidity with a maximum wet bulb temperature of 29 °C at or below +60 °C, (upper limit derates to 20% relative humidity at +60 °C) non-condensing.
Altitude: installed	Operating	3,048 m (10,000 feet)
	Non-operating	12,190 m (40,000 feet)

80A02 EOS/ESD protection module specifications

This section contains specifications for the 80A02 EOS/ESD Protection Module. All specifications are guaranteed unless noted as "typical." To meet specifications, three conditions must first be met:

- The instrument must have been calibrated/adjusted at an ambient temperature between +20 °C and +30 °C.
- The instrument must have been operating continuously for 20 minutes within the operating temperature range specified.
- The instrument must be in an environment with temperature, altitude, humidity, and vibration within the operating limits described in these specifications.

Table 71: 80A02 - Electrical

Characteristic	Specification
Number of channels	One
Channel connectors	Precision 26 GHz SMA female connectors
Interface connector	Stereophonic mini plug with the center conductor designated as the manual probe interface and outer conductor as the logic control interface
Input impedance	50 Ω
Absolute maximum input signal level (RF signals)	±2V peak
Module analog bandwidth	DC to 26 GHz
Manual control threshold (Auto control terminal unpowered)	Module engaged when manual control input has a resistive path to ground of <100 kΩ, open circuit for stand-by protection mode
Automated logic control threshold (Manual control terminal open)	<0.3 V: stand-by protection mode >1.0 V: Measurement engaged mode
Pilot lights	Power and engaged LED pilot lights indicate the corresponding states
Module switching time	20 ms typical 40 ms maximum

Table 72: 80A02 - Environmental and mechanical

Characteristic		Specification
Weight		0.4 kg (0.6 lbs)
Dimensions		
	Height	25 mm (1.0 in)
	Width	79 mm (3.1 in)
	Depth	135 mm (5.3 in)
Environmental conditions		Refer to the host instrument specifications

Table 72: 80A02 - Environmental and mechanical (cont.)

Characteristic		Specification
Temperature		
	Operating	+10 °C to + 40 °C Upper rating derates to +35 °C for all sampling modules on 2 meter extender cable
	Non-operating	–22 °C to +60 °C
Humidity		
	Operating	20% to 80% relative humidity with a maximum wet bulb temperature of +29 °C at or below +40 °C, non-condensing. (Upper limit derates to 45% relative humidity at +40 °C.)
	Non-operating	5% to 90% relative humidity with a maximum wet bulb temperature of +29 °C at or below +60 °C, non-condensing. (Upper limit de-rates to 20% relative humidity at +60 °C.)
Altitude		
	Operating	3,000 m (9,842 ft)
	Non-operating	12,190 m (40,000 ft)
Electromagnetic Compatibility		Refer to the host instrument (DSA8300) specifications for modular specifications

80A05 Electrical Clock Recovery module specifications

This section contains specifications for the 80A05 Electrical Clock Recovery Module. All specifications are guaranteed unless noted as "typical." To meet specifications, three conditions must first be met:

- The instrument must have been calibrated/adjusted at an ambient temperature between +20 °C and +30 °C.
- The instrument must have been operating continuously for 20 minutes within the operating temperature range specified.
- The instrument must be in an environment with temperature, altitude, humidity, and vibration within the operating limits described in these specifications.

Table 73: 80A05 - Module characteristics

Specifications	Characteristics
Mainframe interface	Tekprobe sampling, level 3. hot switching is not permitted.
Number of inputs	2
Input and output connectors	SMA
Data input/output coupling	DC
Maximum non-destruct range	Either inputs: 2.5 V_{p-p}
Maximum operating range	Single-ended operation: Either input: 2.0 V_{pk-pk}
Maximum operating range	Complementary operation: Each input: 1 V_{p-p}
Maximum DC offset	±2.0 VDC
Electrical Return Loss	Data in+, data in–, data out+, data out–: 15 dB or better DC to 10 GHz Data in+, data in-,data out+, data out-: 10 dB or better 10 GHz to 20 GHz
Electrical data attenuation	DC to 12.5 GHz: 6.6 dB ±0.6 dB
Propagation delay	Either inputs: 875 ps
Propagation Delay mismatch	Either inputs: <15 ps
Input/output impedance	50 Ω
Step response aberrations	±2% or less over zone 10 ns to 20 ps before step transition ±10% or less for the first 300 ps following step transition +1% –5% or less over zone 300 ps to 3 ns following step transition +1% –3% or less over zone 3 ns to 100 ns following step transition ±0.5% after 100 ns following step transition
Analog bandwidth	±3 dB, DC to 20 GHz

Table 73: 80A05 - Module characteristics (cont.)

Specifications	Characteristics	
Front panel output amplitudes	Trigger clock output:	400 mV_{p-p}
	10G clock output:	500 mV_{p-p}
Front panel rise and fall times	Trigger clock output:	300 ps
	10G clock output:	30 ps
✓ Recovered clock timing jitter	50 Mb/s to 2.7 Gb/s:	<1.0% of unit interval
	2.7 Gb/s to 6.375 Gb/s:	<2.5 ps $_{RMS}$
	9.8 Gb/s to 12.6 Gb/s:	<2.0 ps $_{RMS}$
✓ Minimum clock recovery sensitivity	Single-ended operation:	10 mV_{p-p}
	150 Mb/s to 2.7 Gb/s:	15 mV_{p-p}
	2.7 Gb/s to 11.19 Gb/s:	20 mV_{p-p}
	11.19 Gb/s to 12.5 Gb/s	
	Complementary operation:	8 mV_{p-p}
	150 Mb/s to 2.7 Gb/s:	12 mV_{p-p}
	2.7 Gb/s to 11.19 Gb/s:	15 mV_{p-p}
	11.19 Gb/s to 12.5 Gb/s	
Supported data rates and formats (without Option 10G)	OC3/SMT1	155.52 Mb/s
	OC12/STM4	622.08 Mb/s
	FibreChannel	1.063 Gb/s
	Gigabit Ethernet	1.25 Gb/s
	Serial ATA Gigabit	1.5 Gb/s
	2 FibreChannel	2.125 Gb/s
	OC48/STM16	2.488 Gb/s
	2 Gigabit Ethernet	2.5 Gb/s
	InfiniBand	2.5 Gb/s
	PCI Express	2.5 Gb/s
	2.5G G.709 FEC	2.666 Gb/s
	Serial ATA	3.0 Gb/s
	XAUI	3.125 Gb/s
	FibreChannel	3.188 Gb/s
	VSR5	3.318 Gb/s
	4 Gigabit FibreChannel	4.25 Gb/s
Supported user selected clock recovery (without Option 10G)	50 Mb/s to 2.7 Gb/s	
	3.000 Gb/s to 3.188 Gb/s	

Table 73: 80A05 - Module characteristics (cont.)

Specifications	Characteristics	
Supported data rates and formats added with Option 10G	Serial ATA	6.0 Gb/s
	XAUI	6.25 Gb/s
	OC192/STM64	9.953 Gb/s
	10GBASE-W	9.953 Gb/s
	10GBASE-R	10.31 Gb/s
	10G FibreChannel	10.51 Gb/s
	G.975 FEC	10.66 Gb/s
	G.709 FEC	10.71 Gb/s
	10GbE w/FEC	11.10 Gb/s
	Super FEC	12.50 Gb/s
Supported user selected clock recovery with Option 10G	50 Mb/s to 3.188 Mb/s	
	3.267 Gb/s to 4.250 Gb/s	
	4.900 Gb/s to 6.375 Gb/s	
	9.800 Gb/s to 12.60 Gb/s	

Table 74: 80A05 - Environmental specifications

Specification	Characteristics
Temperature	Operating: +10 °C to +40 °C
Humidity	Non-operating: 5% to 90% relative humidity
	Operating: 20% to 80% relative humidity

Table 75: 80A05 - Mechanical specifications

Specification	Characteristics	
Weight	1.22 kg (2.70 lbs.)	
Overall dimensions	Height:	2.5 cm (1.0 in)
	Width:	16.5 cm (6.5 in)
	Depth:	30 cm (12 in)
	Does not include connectors, connector savers, connector covers, push buttons, or lock-down hardware protruding from the front or rear panels.	
Construction material	Chassis	aluminum alloy
	Front panel	plastic laminate
	Circuit boards	glass-laminate
	Cabinet sleeve	aluminum
	Cabinet end covers	aluminum

Table 76: 80A05 - Product family electromagnetic compatibility (EMC)

Refer to Mainframe (DSA8300) specification for the modular family specifications

Table 77: 80A05 - Product family dynamics

Refer to Mainframe (DSA8300) specification for the modular family specifications

Table 78: 80A05 - Product family atmospherics

Refer to Mainframe (DSA8300) specification for the modular family specifications