DSA8300 Digital Serial Analyzer Specifications

Technical Reference

077-0571-00

Tektronix

DSA8300 Digital Serial Analyzer Specifications

Technical Reference

Warning

The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to all safety summaries prior to performing service.

www.tektronix.com

077-0571-00

Tektronix

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- In North America, call 1-800-833-9200.
- Worldwide, visit www.tektronix.com to find contacts in your area.

Warranty

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Parts, modules and replacement products used by Tektronix for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Tektronix.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

To Avoid Fire or Personal Injury

Use proper power cord. Use only the power cord specified for this product and certified for the country of use.

Connect and disconnect properly. Connect the probe output to the measurement instrument before connecting the probe to the circuit under test. Connect the probe reference lead to the circuit under test before connecting the probe input. Disconnect the probe input and the probe reference lead from the circuit under test before disconnecting the probe from the measurement instrument.

Ground the product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Ground the product. This product is indirectly grounded through the grounding conductor of the mainframe power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

The inputs are not rated for connection to mains or Category II, III, or IV circuits.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Power disconnect. The power switch disconnects the product from the power source. See instructions for the location. Do not block the power switch; it must remain accessible to the user at all times.

Do not operate without covers. Do not operate this product with covers or panels removed.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Use proper fuse. Use only the fuse type and rating specified for this product.

Wear eye protection. Wear eye protection if exposure to high-intensity rays or laser radiation exists.

Do not operate in wet/damp conditions.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry.

Provide proper ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

Terms in This Manual

These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

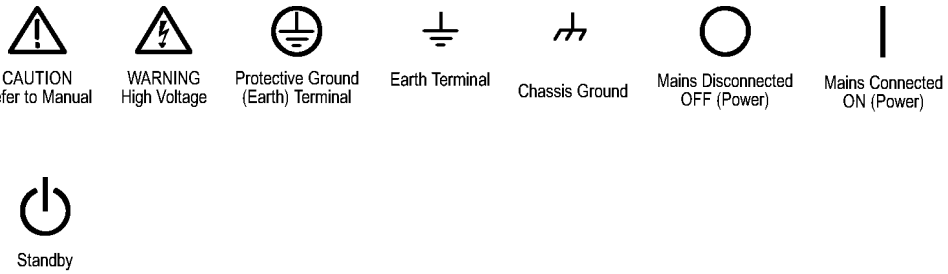
CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Symbols and Terms on the Product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

The following symbol(s) may appear on the product:



Service Safety Summary

Only qualified personnel should perform service procedures. Read this *Service Safety Summary* and the *General Safety Summary* before performing any service procedures.

Do Not Service Alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect Power. To avoid electric shock, switch off the instrument power, then disconnect the power cord from the mains power.

Use Care When Servicing With Power On. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

To avoid electric shock, do not touch exposed connections.

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.

Safety

Symbols and terms related to safety appear in the *General Safety Summary* found at the beginning of this manual.

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 Online 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.
- *80E07, 80E08, 80E09, and 80E10 Electrical Sampling Remote Modules User Manual.* Tektronix part number 071-2038-XX.
- *80C00 Series Optical Sampling Modules User Manual.* Tektronix part number 071-0435-XX.
- *80C12B Optical Sampling Modules User Manual.* Tektronix part number 071-2994-XX.
- *80C14 Optical Sampling Modules User Manual.* Tektronix part number 071-2955-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

Specifications

System Specifications

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

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

The 82A04 Phase Reference module affects the DSA8300 mainframe specifications; therefore, there is no separate specification section for the 82A04 module.

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 1-1: System - Signal acquisition

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.
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.

Table 1-1: System - Signal acquisition (cont.)

Description	Characteristics
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 slot 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 1-2: System - Timebase

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	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 300kHz.
Mainframe with 82A04 (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 are supported.
Horizontal position range	
Mainframe	50 ms maximum.
Mainframe with 82A04	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.

Table 1-2: System - Timebase (cont.)

Description	Characteristics
Time interval accuracy	Strobe placement accuracy for a given horizontal interval and position. (Contribution from 80E04 sampling module is included in specification.)
✓ Edge triggered mode, front panel edge trigger source	For 100 or more tests performed over specified interval, Horizontal scale > 20 ps/div, rightmost 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, rightmost 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, rightmost 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, rightmost 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, rightmost 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, rightmost point of measurement interval <150 ns: Mean accuracy = 0.01% of specified interval
Timing accuracy	Mainframe equipped with 82A04
Random phase corrected mode (typical)	Maximum timing deviation 0.1% 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
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
Horizontal deskew range and resolution	

Table 1-2: System - Timebase (cont.)

Description	Characteristics
Mainframe	–500 ps to +100 ns on any individual channel in 1 ps increments
Mainframe with 82A04	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 1-3: System - Trigger

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	A phase reference signal may be applied to the instrument, when equipped with an 82A04 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. Two bandwidth options are available for the 82A04 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
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

Table 1-3: System - Trigger (cont.)

Description	Characteristics
✓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 Prescale ratio selectable from divide-by-1,2,4,8 62.5 fs minimum. 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 ≤ fCLOCK < 1.25 GHz: 900 fs RMS or better 1.25 GHz ≤ fCLOCK < 11.2 GHz: 500 fs RMS or better 11.2 GHz ≤ fCLOCK < 15 GHz: 600 fs RMS or better
Delay jitter, Clock Eye mode, typical	150 MHz ≤ fCLOCK < 400 MHz: 900 fs RMS or better 400 MHz ≤ fCLOCK < 800 MHz: 800 fs RMS or better 800 MHz ≤ fCLOCK < 1.25 GHz: 720 fs RMS or better 1.25 GHz ≤ fCLOCK < 11.2 GHz: 375 fs RMS or better 11.2 GHz ≤ fCLOCK < 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 1-4: System - Trigger - Phase correction modes (mainframe with 82A04 Phase Reference module)

Description	Characteristics
Phase correction capabilities and conditions	A phase reference signal may be applied to a DSA8300 equipped with the 82A04 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 module. Up to three 82A04 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
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 (typical)	Triggered and Free Run Phase Corrected Modes, 8 GHz – 60 GHz clock, 600 mV – 1.8 V_{p-p} input: 200 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: 280 fs_{RMS} or better. The jitter increase between 8 GHz and 2 GHz is roughly inverse proportion to clock frequency. Operation of the phase reference clock at frequencies requiring extended bandwidth or signal conditioning may require an optional filter accessory.
Phase reference module compensation temperature range (typical)	±5 °C where compensation was performed. If compartment is changed on mainframe, or if sampling module extender is employed, or length of sampling module extender is changed, the Phase Reference module must be recompensated.
✓ Phase reference module input operating frequency	With 82A04: 8 GHz to 25 GHz With 82A04-60G: 8 GHz to 60 GHz

Table 1-4: System - Trigger - Phase correction modes (mainframe with 82A04 Phase Reference module) (cont.)

Description	Characteristics
Phase reference module input operating frequency (typical)	
With 82A04	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 82A04-60G	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 1-5: Display

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 1-6: 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	Five USB 2.0 high speed connectors (one on the front panel, four on the rear panel).
GPIB interface	Complies with IEEE 488.2.

Table 1-6: Ports (cont.)

Specifications	Characteristics
Internal clock trigger out	Square wave out 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 (typical)	0.1 mV + 0.1% into 50 Ω
✓ DC calibration output accuracy	0.2 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 1-7: 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 1-8: 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 1-8: 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 speed regulated by internal temperature sensors. A 2″ (51 mm) clearance must be maintained on the left side and right side of the instrument, and a 0.75″ (19 mm) clearance must be maintained on the bottom of the instrument for forced air flow. It should never be operated on a bench with the feet removed, nor have any object placed nearby where it may be drawn against the air vents. No clearance is required on the front, back, and top.

Table 1-9: 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 1-10: System – 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.)
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 ■ Up to 4 kV Contact Discharge ■ Up to 8 kV Air Discharge

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

Table 1-11: Mechanical – 82A04 Phase Reference module

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.).
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	80E04	80E08
80E02	80E06	80E09
80E03	80E07	80E10

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* chapter.

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 1-1, System Specifications.)*

Table 1-12: 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 80E06 and 82A04).	
Number of input channels	*Sampling module*	*Channels*
	80E06	1
	80E02, 80E03, 80E04, 80E07, 80E08, 80E09, 80E10	2

Table 1-12: 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, 80E10	1.85 mm (V) female connector [8]
	80E07, 80E08	2.92 mm (K) female SMA-compatible connector
✓ Input impedance	*Sampling module*	*Impedance*
	80E01, 80E02, 80E03, 80E04, 80E06	50 Ω ±0.5 Ω
	80E07, 80E08, 80E09, 80E10	50 Ω ±1 Ω
Vertical dynamic range	1 V_{pp} (offset ±500 mV)	
Vertical operating range [1], maximum	*Sampling module*	*Operating range*
	80E01, 80E02, 80E03, 80E04, 80E06	±1.6 V
	80E07, 80E08, 80E09, 80E10	±1.1 V
Vertical nondestruct range [2] (maximum input voltage)	*Sampling module*	*Maximum input*
	80E01, 80E06, 80E07, 80E08, 80E09, 80E10	±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, 80E08, 80E09, 80E10	10 mV to 1 V full scale
Offset range [1]	*Sampling module*	*Offset range*
	80E01, 80E02, 80E03, 80E04, 80E06	±1.6 V
	80E07, 80E08, 80E09, 80E10	±1.1 V
Compensation temperature range	±5 °C about temperature where compensation was performed. If the module is moved to another compartment on the mainframe, a sampling module extender is employed, or the length of the sampling module extender is changed, the channel(s) must be recompensated.	
✓ DC voltage accuracy, single point, within ±5 °C of compensated temperature	±2 mV <system offset> ±0.007 * (assigned offset) ±0.02 * (vertical value – assigned offset)	
✓ DC vertical voltage deviation from linear least squares fit	±10 mV	

Table 1-12: Electrical sampling modules – Signal acquisition (cont.)

Specifications	Characteristics		
✓ 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, 80E08		DC to 30 GHz, better than ±3 dB
	80E09		DC to 60 GHz, better than ±3 dB
	80E10		DC to 50 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, 80E08		20 GHz
	80E09, 80E10		30 GHz, 40 GHz
Rise time [4], typical	*Sampling module*	*Bandwidth setting*	*Rise time*
	80E01	N/A	≤7 ps
	80E02	N/A	≤28 ps
	80E03 and 80E04	N/A	≤17.5 ps
	80E06	N/A	≤5.0 ps
	80E07, 80E08	30 GHz	11.67 ps
		20 GHz	17.5 ps
	80E09	60 GHz	5.83 ps
		40 GHz	8.75 ps
		30 GHz	11.67 ps
	80E10	50 GHz	7 ps
		40 GHz	8.75 ps
		30 GHz	11.67 ps

Table 1-12: 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, 80E08	30 GHz	<410 μV_{RMS} <300 μV_{RMS}, typical
		20 GHz	<380 μV_{RMS} <280 μV_{RMS}, typical
	80E09	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	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

Table 1-12: Electrical sampling modules – Signal acquisition (cont.)

Specifications	Characteristics	
Step response aberrations [7], typical	*Sampling module*	*Aberrations, step transition* [6]
	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
	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
	80E06	+ 5% or less for the first 300 ps following step transition
	80E07, 80E08, 80E09, 80E10	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
Acquistion delay adjust resolution	*Sampling module*	*Delay adjust resolution*
	80E07, 80E08, 80E09, 80E10	135 fs

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, 80E08, 80E09, and 80E10 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 1-13: Electrical sampling modules (80E04, 80E08, and 80E10 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	≤22 ps, each polarity
		≤20 ps, each polarity, typical
	80E10	≤16 ps, each polarity
		≤15 ps, each polarity, typical
TDR incident edge amplitude	±250 mV step into 50 Ω each polarity, typical	
TDR system incident rise time, typical	*Sampling module*	*Incident rise time*
	80E04	≤28 ps
	80E08	≤18 ps, each polarity
	80E10	≤12 ps, each polarity

Table 1-13: Electrical sampling modules (80E04, 80E08, and 80E10 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
TDR incident edge delay adjust range, typical	*Sampling module*	*Incident edge delay adjust*
	80E08, 80E10	±250 ps, each channel and each plarity
TDR incident edge delay adjust resolution, typical	*Sampling module*	*Incident edge delay adjust resolution*
	80E08, 80E10	135 fs
TDR step maximum repetition rate	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 1-14: Electrical sampling modules – Timebase system

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

Table 1-15: 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
	80E08, 80E10	6.5 W

Table 1-16: Electrical sampling modules – Mechanical

Specifications	Characteristics		
Weight (unpackaged)	*Sampling module*	*Weight*	
	80E01, 80E02, 80E03, 80E04, 80E06	0.4 kg (13 oz.)	
	80E07, 80E08	861 gm (29.11 oz)	
	80E09, 80E10	868 gm (29.35 oz) including two 2.4 mm to 2.92 mm adapters	
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	Height:	25 mm (1.0 in)
		Width:	79 mm (3.1 in)
	80E07, 80E08, 80E09, 80E10 main module	Depth:	135 mm (5.3 in)
	80E07, 80E08, 80E09, 80E10 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 listed in unless noted otherwise. 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.
- 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 1-1, System Specifications.)*

Table 1-17: 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 for 622.08 Mb/s SONET/SDH standards
	OC-48/STM-16 for 2.488 Gb/s SONET/SDH standards
	OC-192/STM-64 for 9.953 Gb/s SONET/SDH standards

Table 1-17: 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 for 9.953 Gb/s Sonet/SDH standards
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:
	FC1063 for the 1.0625 Gb/s fibre channel standard
	GBE for the 1.25 Gb/s gigabit ethernet standard
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 for 9.953 Gb/s Sonet/SDH standards
	10.664 Gb/s ITU-T Recommendation G.975 standard
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 for 9.953 Gb/s Sonet/SDH standards
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-16
	OC-3/STM-1
	OC-12/STM-4

Table 1-17: 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
	OC-12 / STM-4
	OC-48 / STM-16
	ENET1250 / GBE
	ENET2500 / 2GBE
	INFINIBAND
	FC1063 / FC
	FC2125 / 2FC
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 9.95328 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 9.95328 Gb/s 10 Gb/s Ethernet standard
	10GBASE-R for 10.3125 Gb/s 10 Gb/s Ethernet FEC standard
	10GFC for 10.51875 Gb/s 10 Gb/s FibreChannel standard
	OC-192/STM-64 for 9.953 Gb/s Sonet/SDH standards
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:
	10GBASE-W for 9.95328 Gb/s 10 Gb/s Ethernet standard
	10GBASE-R for 10.3125 Gb/s 10 Gb/s Ethernet FEC standard
	10GBE FEC for 11.0957 Gb/s
	10GFC FEC for 11.317 Gb/s
	10GFC for 10.51875 Gb/s 10 Gb/s FibreChannel standard
	OC-192/STM-64 for 9.953 Gb/s Sonet/SDH standards
	or two data filters:
	G.975 FEC 10.66423 Gb/s
	G.709 FEC 10.709225 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 for 9.953 Gb/s Sonet/SDH standards
	10.709 Gb/s ITU-T Recommendation G.709 standard

Table 1-17: Optical modules – Descriptions (cont.)

Name	Characteristics
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 for 39.813 Gb/s Sonet/SDH standards
	43.018 Gb/s ITU-T Recommendation G.709 standard
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 for 39.813 Gb/s Sonet/SDH standards
	43.018 Gb/s ITU-T Recommendation G.709 standard
	40GBase-FR for 40 Gb Ethernet at 41.25 Gb/s
	Option F1 includes the following additional reference receiver filter rates:
	100GBase-R4 25.781 Gb/s
	100Gbase-R4 FEC 27.739 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 for 9.953 Gb/s Sonet/SDH standards
	10GBase-W for 10 Gb Ethernet 9.95338 Gb/s
	10GBase-R 10.3125
	10GBE FEC 11.0957
	10GFC FEC for 11.317 Gb/s
	10GFC for 10G Fibre Channel
	16GFC for 16G Fibre Channel 14.025 Gb/s
	G.975 FEC 10.66423 Gb/s
	G.709 FEC 10.709225 Gb/s

Table 1-17: Optical modules – Descriptions (cont.)

Name	Characteristics
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:
	FC1063 for 1.0623 Gb/s FibreChannel FC2125 for 2.125 Gb/s FibreChannel 10GBase-X4 for 3.125 Gb/s 10GFC-X4 for 3.188 Gb/s VSR-5 for 3.318 Gb/s FC4250 for 4.25 Gb/s Fibre Channel
	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:
	SONET/SDH OC-192/STM-64 10GBase-W, 10 Gb Ethernet (9.95338 Gb/s) 10GBase-R (10.3125 Gb/s) 10G Fibre Channel (10.51875 Gb/s) G.975 FEC (10.66 Gb/s) G.709 FEC (10.71 Gb/s) 10GBE FEC (11.0957 Gb/s) 10GFC FEC (11.317 Gb/s) >9.5 GHz full bandwidth
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, 155.52 Mb/s **Option F2**: OC-12/STM4, 622 Mb/s **Option F3**: FC1063, 1.0625 Gb/s FibreChannel **Option F4**: Gigabit Ethernet, 1.250 Gb/s **Option F5**: FC2125, 2.125 Gb/s FibreChannel **Option F6**: OC-48/STM-16, 2.488 Gb/s, 2GBE, 2.500 Gb/s, INF2500, 2.500 Gb/s **Option F7**: FEC2.666 Gb/s, 2.666 Gb/s **Option F8**: 10GBASE-X4, 3.125 Gb/s, FC3188, 3.188 Gb/s **Option F9**: FC4250, 4.250 Gb/s **Option F10**: INF5000, 5.0 Gb/s **Option F11**: OBSAI 6.144 Gb/s, 6.144 Gb/s **Option F12**: CPRI7.373 Gb/s, 7.373 Gb/s

Table 1-17: Optical modules – Descriptions (cont.)

Name	Characteristics
	Option F0: 12 GHz unfiltered bandwidth **Option 10GP**: FC-8500, 8.5 Gb/s 8GFC, 8.5 Gb/s OC-192/STM-64, 9.95328 Gb/s 10GBASE-W, 9.95328 Gb/s 10GBASE-R, 10.3125 Gb/s 40GBASE-R4, 10.3125 Gb/s 100GBASE-R10, 10.3125 Gb/s 10 GFC, 10.5188 Gb/s FEC10.66 Gb/s, 10.6642 Gb/s FEC10.71 Gb/s, 10.7092 Gb/s FEC11.10 Gb/s, 11.0957 Gb/s FC11317, 11.317 Gb/s 12 GHz
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, 8.5 Gb/s 8GFC, 8.5 Gb/s OC-192/STM-64, 9.95328 Gb/s 10GBASE-W, 9.95328 Gb/s 10GBASE-R, 10.3125 Gb/s 40GBASE-R4, 10.3125 Gb/s 100GBASE-R10, 10.3125 Gb/s 10 GFC, 10.5188 Gb/s FEC10.66 Gb/s, 10.6642 Gb/s FEC10.71 Gb/s, 10.7092 Gb/s FEC11.10 Gb/s, 11.0957 Gb/s FC11317, 11.317 Gb/s 12 GHz

Table 1-17: Optical modules – Descriptions (cont.)

Name	Characteristics
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, 8.5 Gb/s 8GFC, 8.5 Gb/s OC-192/STM-64, 9.95328 Gb/s 10GBASE-W, 9.95328 Gb/s 10GBASE-R, 10.3125 Gb/s 40GBASE-R4, 10.3125 Gb/s 40GBASE-R10, 10.3125 Gb/s 10 GFC, 10.5188 Gb/s FEC10.66 Gb/s, 10.6642 Gb/s FEC10.71 Gb/s, 10.7092 Gb/s FEC11.10 Gb/s, 11.0957 Gb/s FC11317, 11.317 Gb/s FEC12.5 Gb/s, 12.500 Gb/s 16GFC r6.1, 14.025 Gb/s INF14063, 14.0625 Gb/s 14 GHz
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 25.781 Gb/s 100Gbase-R4 FEC 27.739 Gb/s

Table 1-18: Optical modules: Inputs

Name		Characteristics
Number of input channels		1 optical
Internal fiber diameter [1]		
	80C01, 80C02, 80C04, 80C05, 80C06, 80C09, 80C10, 80C10B, 80C11, 80C25GBE	9 µm/125 µm single mode
	80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C, 80C12, 80C12B, 80C14	Multimode fiber, 62.5 µm core, 125 µm cladding
Fiber connector (all optical modules)		Rifocs UCI (universal connector interface) male connector
Optical return loss		

Table 1-18: Optical modules: Inputs (cont.)

Name	Characteristics
80C01, 80C02, 80C04, 80C05, 80C06, 80C09, 80C10, 80C10B, 80C11, 80C25GBE	>30 dB for single-mode fiber
80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C, 80C12,80C12B, 80C14	>14 dB for multimode fiber >24 dB for single-mode fiber
Absolute maximum nondestructive optical input [2]	
80C01, 80C02, 80C03, 80C04, 80C07, 80C07B, 80C09, 80C11	5 mW average power; 10 mW peak power at wavelength with highest relative responsivity.
80C05, 80C10, 80C10B, 80C25GBE	20 mW average power; 60 mW power at wavelength with highest relative responsivity.
80C06	20 mW average power; 60 mW power at wavelength with highest relative responsivity.
80C08, 80C08B, 80C08C, 80C12	1 mW average power; 10 mW peak power at wavelength with highest relative responsivity.
80C12B, 80C14	850 nm: 4 mW average power 1310/1550 nm: 2 mW average power 10 mW peak power for 60 ms at wavelength with highest relative responsivity (typically at 1310 nm)
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 at wavelength with highest relative responsivity.
80C06	0 mW to 60 mW displayed limits, including offset, which may be coerced to above 4 mW/div to be sure this is attained, and respecting that the signal limit is 15 mW average optical power, 30 mW displayed peak power at wavelength with highest relative responsivity.
80C08, 80C08B, 80C08C, 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 4 mW average power at 850 nm must be obeyed.
80C10, 80C10B	0 mW to 30 mW displayed limits, not including offset.

Table 1-18: Optical modules: Inputs (cont.)

Name		Characteristics
	80C10B-F1, 80C25GBE	0 mW to 20 mW displayed limits, not including offset.
	80C11	5 mW average power; 10 mW peak power at wavelength with highest relative responsivity. Optical input powers below non-destruct levels may exceed saturation and compression limits of the particular plug-in.

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 1-19: Optical modules: Effective wavelength range, typical [1]

Module	Characteristics
80C01, 80C02, 80C04, 80C09, 80C11	1100 nm to 1650 nm
80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C, 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

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

Table 1-20: Optical modules: Calibrated wavelengths

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

Table 1-21: 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/STM-4, OC-48/STM-16, OC-192/STM-64, 12.5 GHz	<10 µW ±2% (vertical offset)
	20 GHz	<10 µW ±4% (vertical offset)
80C02	OC-192/STM-64, 12.5 GHz	<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/STM-64, 10.66 Gb/s	<10 µW ±2% (vertical offset)
	20 GHz, 30 GHz	<10 µW ±4% (vertical offset)
80C05	OC-192/STM-64	<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)
80C09	OC-192/STM-64, 10.71 Gb/s	<10 µW ±2% (vertical offset)
	20 GHz, 30 GHz	<10 µW ±4% (vertical offset)
80C10, 80C10B, 80C25GBE	1550 nm	±[25 µW +4% × |vertical offset|]
	1310 nm	±[35 µW +4%× |vertical offset|]
80C11	OC-192, 10.71 Gb/s, 10.71 Gb/s, 10GBASE-W, 10GBASE-R, 10GBE FEC, 10GFC, 10GFC FEC	<10 µW ±2% (vertical offset)
	16GFC	<10 µW ±3% (vertical offset)
	20 GHz, 30 GHz	<10 µW ±4% (vertical offset)

Table 1-22: Optical modules: Main-instrument display vertical scale factors

	Maximum	Minimum
80C01, 80C02, 80C04, 80C09, 80C11	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

Table 1-22: Optical modules: Main-instrument display vertical scale factors (cont.)

	Maximum	Minimum
80C08, 80C08B, 80C08C, 80C12	200 µW per division	2 µW per division
80C12B, 80C14	300 µW per division	3 µW per division
80C10, 80C10B	3 mW per division	30 µW per division
80C10B-F1, 80C25GBE	2 mW per division	20 µW per division

Table 1-23: 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	±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	±15 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)
80C08, 80C08B, 80C08C, 80C12	±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)

Table 1-24: Optical modules: DC vertical accuracy, typical [1]

Module	Setting	Accuracy
80C01, 80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C, 80C12, 80C12B, 80C14	All settings	±25 µW ±2% of [(vertical value) – (vertical offset)]
80C02	12.5 GHz, OC-192/STM-64	±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)]

Table 1-24: Optical modules: DC vertical accuracy, typical [1] (cont.)

Module	Setting	Accuracy
80C04	10.66 Gb/s, OC-192/STM-64	±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/STM-64	±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/STM-64	±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/STM-256, 43 Gb/s (G.709), FEC43.02 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)]
	39 Gb/s OC-768/STM-256, 43 Gb/s (G.709), FEC43.02 Gb/s	±25 µW ±6% of [(vertical value) – (vertical offset)]
	40GBase-FR 41.25 Gb/s	±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)]
80C10B-F1	65 GHz	±25 µW ±8% of [(vertical value) – (vertical offset)]
	39 Gb/s OC-768/STM-256, 43 Gb/s (G.709), FEC43.02 Gb/s	±25 µW ±6% of [(vertical value) – (vertical offset)]
	40GBase-FR 41.25 Gb/s	±25 µW ±6% of [(vertical value) – (vertical offset)]
	100GBase-R4 25.781 Gb/s	±25 µW ±4% of [(vkertical value) – (vertical offset)]
	100GBase-R4 FEC 27.739 Gb/s	±25 µW ±4% of [(vertical value) – (vertical offset)]
80C25GBE	65 GHz	±25 µW ±8% of [(vertical value) – (vertical offset)]
	100GBase-R4 25.781 Gb/s	±25 µW ±4% of [(vertical value) – (vertical offset)]
	100GBase-R4 FEC 27.739 Gb/s	±25 µW ±4% of [(vertical value) – (vertical offset)]

Table 1-24: Optical modules: DC vertical accuracy, typical [1] (cont.)

Module	Setting	Accuracy
80C11	OC-192, 10.66Gb/s, 10.71Gb/s, 10Gbase-W, 10Gbase-R, 10GBE FEC, 10GFC, 10GFC FEC	±25 µW ±2% of [(vertical reading) – (vertical offset)]
	16GFC	±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)]

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 1-25: 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/STM-64, OC-48/STM-16, OC-12/STM-4	±2% of [difference reading]
	20 GHz	±4% of [difference reading]
80C02	12.5 GHz, OC-192/STM-64	±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/STM-64	±2% of [difference reading]
	20 GHz	±4% of [difference reading]
	30 GHz	±6% of [difference reading]
80C05	OC-192/STM-64	±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, 80C12, 80C12B, 80C14	All settings	±2% of [difference reading]
80C09	10.71 Gb/s, OC-192/STM-64	±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/STM-256, 43 Gb/s, FEC43.02	±6% of [difference reading]
	65 GHz	±8% of [difference reading]

Table 1-25: Optical modules: DC vertical difference accuracy, typical [1] (cont.)

Module	Setting	Accuracy
80C10B	30 GHz	±4% of [difference reading]
	39 Gb/s, OC-768/STM-256, 43 Gb/s, FEC43.02	±6% of [difference reading]
	40GBase-FR 41.25 Gb/s	±6% of [difference reading]
	65 GHz	±8% of [difference reading]
	80 GHz	±9% of [difference reading]
80C10B-F1	65 GHz	±8% of [difference reading]
	39 Gb/s, OC-768/STM-256, 43 Gb/s, FEC43.02	±6% of [difference reading]
	40GBase-FR 41.25 Gb/s	±6% of [difference reading]
	100GBase-R4 25.781 Gb/s	±4% of [difference reading]
	100GBase-R4 FEC 27.739 Gb/s	±4% of [difference reading]
80C25GBE	65 GHz	±8% of [difference reading]
	100GBase-R4 25.781 Gb/s	±4% of [difference reading]
	100GBase-R4 FEC 27.739 Gb/s	±4% of [difference reading]
80C11	OC-192, 10.66 Gb/s, 10.71 Gb/s, 10Gbase-W, 10Gbase-R, 10GBE FEC, 10GFC, 10GFC FEC	±2% of [difference reading]
	16GFC	±3% of [difference reading]
	20 GHz	±4% of [difference reading]
	30 GHz	±6% 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.

Table 1-26: Optical modules: Offset capabilities

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

Table 1-27: Optical modules: Minimum optical bandwidth [1], [2]

Module	Setting	✓Bandwidth, minimum	Bandwidth, typical
✓Optical bandwidth, minimum (-3dB)			
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)			

Table 1-27: Optical modules: Minimum optical bandwidth [1], [2] (cont.)

Module	Setting	✓Bandwidth, minimum	Bandwidth, typical
80C03 (≤200 μW_{pp} input signal)	2.5 GHz	>2.3 GHz	2.5 GHz
80C04	30 GHz	>28 GHz	>30 GHz
(≤2 mW_{pp} input signal)	20 GHz	>20 GHz	
80C04-CR1, 80C04-CR2 (≤2 mW_{pp} input signal)	30 GHz	>28 GHz	>29 GHz
80C05	20 GHz	>20 GHz	
	30 GHz	>30 GHz	
	40 GHz		>40 GHz
80C06	55 GHz [3]		>50 GHz
80C07, 80C07B (≤200 μW_{pp} input signal)	2.5 GHz	>2.3 GHz	2.5 GHz
80C08, 80C08B, 80C08C (≤500 μW_{pp} input signal)	10 GHz	>9 GHz	>10 GHz
80C09	30 GHz	>28 GHz	>30 GHz
(≤2 mW_{pp} input signal)	20 GHz	>20 GHz	
80C09-CR1 (≤2 mW_{pp} input signal)	30 GHz	>28 GHz	>29 GHz
80C09, 80C09-CR1 (≤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
80C11, 80C11-CR	20 GHz	>20 GHz	
	30 GHz	>28 GHz	>30 GHz
80C12 (≤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

Table 1-27: Optical modules: Minimum optical bandwidth [1], [2] (cont.)

Module	Setting	✓Bandwidth, minimum	Bandwidth, typical
80C12B (≤800 μW_{pp} input signal, 1310/1550 nm) (≤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
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

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 1-28: Optical modules: Rise time, typical

Module	Setting	Rise time
For peak optical signal input which creates <2 mW_{pp} modulation depth.		
80C01	OC-12/STM-4	750 ps ±50 ps
	OC-48/STM-16	187 ps ±15 ps
	OC-192/STM-64	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/STM-64	47 ps ±10 ps
80C04	30 GHz	<16 ps
	20 GHz	<25 ps
	10.66 Gb/s	44 ps ±10 ps
	OC-192/STM-64	47 ps ±10 ps
80C05	40 GHz	<12 ps
	30 GHz	<16 ps
	20 GHz	<25 ps
	OC-192/STM-64	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/STM-64	44 ps ±10 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 <10 mW_{pp} modulation depth.		
80C10	65 GHz	7.4 ps
	30 GHz	16 ps
	OC-768/STM-256	12 ps
	G.709 43 Gb/s	11.2 ps

Table 1-28: Optical modules: Rise time, typical (cont.)

Module	Setting	Rise time
80C10B	80 GHz	6 ps
	65 GHz	7.4 ps
	30 GHz	16 ps
	OC-768/STM-256	12 ps
	G.709 43 Gb/s	11.2 ps
	40GBase-FR	11.9 ps
80C10B-F1	65 GHz	7.4 ps
	OC-768/STM-256	12 ps
	G.709 43 Gb/s	11.2 ps
	40GBase-FR	11.9 ps
	100GBase-R4	19.2 ps
	100GBase-R4 FEC	19.2 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 mW_{pp} modulation depth.		
80C03	FC1063	440 ps ±35 ps
	ENET 1250 (GBE)	373 ps ±30 ps
	OC-48/STM-16	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
	ENET1250	373 ps ±30 ps
	FC1063	440 ps ±35 ps
	FC2125	220 ps ±18 ps
	OC-48, ENET2500, INFINIBAND, 2.5 GHz	187 ps ±15 ps

Table 1-28: 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/STM-64, 10GFC	47 ps ±10 ps
80C08C	10 GHz	<50 ps
	10GBASE-W, 10GBASE-R, OC-192/STM-64, 10GFC, 10GFC FEC, 10GBE FEC, 10.66 GB/s, 10.71 GB/s	47 ps ±10 ps
80C12	FC1063	440 ps ±35 ps
	FC2125	220 ps ±18 ps
	10GBase-4	150 ps ±12 ps
	10GFC-4	147 ps ±12 ps
	3.318 Gb/s	141 ps ±12 ps
	FC4250	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
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
	FC1063	439 ps ±35 ps
	1GbE	373 ps ±30 ps
	FC2125	220 ps ±18 ps
	OC48, INF2500, 2GBE	188 ps ±18 ps
	OC48, FEC	175 ps ±18 ps
	10GBase-X4	149 ps ±12 ps
	10GFC-X4	146 ps ±12 ps
	FC4250	110 ps ±9 ps
	INF5000	93 ps ±9 ps
	OBSAI6144	76 ps ±9 ps
	CPRI7373	63 ps ±9 ps
	12 GHz	<42 ps

Table 1-28: Optical modules: Rise time, typical (cont.)

Module	Setting	Rise time
80C12B-10G(P)	FC8500	55 ps ±9 ps
	8GFC, OC-192/STM-64, 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	FC8500	55 ps ±9 ps
	8GFC, OC-192/STM-64, 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
	FEC12.5Gb/s	35 ps ±8 ps
	FC14025, INF14063	33.5 ps ±7 ps
	14 GHz	<36 ps

Table 1-29: 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/STM-4, OC-48/STM-16	<5%
	OC-192/STM-64, 12.5 GHz	<10%
	20 GHz	<15%
80C02	OC-192/STM-64	<10%
	12.5 GHz	<15%
	20 GHz	<20%
	30 GHz	<30%
80C03	All settings	<5%
80C04	OC-192/STM-64, 10.66 Gb/s	<10%
	20 GHz	<20%
	30 GHz	<30%
80C07, 80C07B	All settings	<5%
80C09	OC-192/STM-64, 10.71 Gb/s	<10%
	20 GHz	<20%
	30 GHz	<30%

Table 1-29: Optical modules: Time domain vertical response aberrations, typical (cont.)

Name	Setting	Abberations
80C11	OC-192, 10.66 Gb/s, 10.71 Gb/s, 10GBase-W, 10GBase-R, 10GBE FEC, 10GFC, 10GFC FEC	<10%
	16GFC	<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 <2 mW_{p-p}.		
80C08, 80C08B, 80C08C	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, INF14063, FC14025, 14 GHz	<15%
For peak optical signal input <20 mW_{p-p}.		
80C10	OC-768/STM-256, FEC43.02 Gb/s, 30 GHz	<5% (maximum) <3% (typical)
	65 GHz	<10% (maximum) <5% (typical)
80C10B	OC-768/STM-256, FEC43.02 Gb/s, 30 GHz, 40GBase-FR	<5% (maximum) <3% (typical)
80C10B	65 GHz	<10% (maximum) <5% (typical)
	80 GHz	<12% (maximum) <7% (typical)

Table 1-29: Optical modules: Time domain vertical response aberrations, typical (cont.)

Name	Setting	Abberations
80C10B-F1	OC-768/STM-256, FEC43.02 Gb/s, 40GBase-FR	<5% (maximum) <3% (typical)
	65 GHz	<10% (maximum) <5% (typical)
	100GBase-R4, 100GBase-R4 FEC	<5% (maximum) <3% (typical)
80C25GBE	65 GHz	<10% (maximum) <5% (typical)
	100GBase-R4, 100GBase-R4 FEC	<5% (maximum) <3% (typical)

Table 1-30: Vertical equivalent optical noise (maximum and typical), 80C01 through 80C10 [1]

Module	Setting	Wavelength	✓ Maximum noise	Typical noise
80C01	OC-12/STM-4, OC-48/STM-16 OC-192/STM-64, 12.5 GHz		<12 μW_{rms}	<8 μW_{rms}
	20 GHz		<25 μW_{rms}	<15 μW_{rms}
80C01-CR	OC-12/STM-4, OC-48/STM-16 OC-192/STM-64, 12.5 GHz		<15 μW_{rms}	<10 μW_{rms}
	20 GHz		<25 μW_{rms}	<15 μW_{rms}
80C02	OC-192/STM-64, 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/STM-64, 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	FC1063, ENET 1250 (GBE)		<1 μW_{rms}	<0.75 μW_{rms}
	OC-48/STM-16		<1.5 μW_{rms}	<1 μW_{rms}
80C04	OC-192/STM-64, FEC 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/STM-64		<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/STM-64		<15 μW_{rms}	<10 μW_{rms}
	20 GHz		<25 μW_{rms}	<15 μW_{rms}

Table 1-30: Vertical equivalent optical noise (maximum and typical), 80C01 through 80C10 [1] (cont.)

Module	Setting	Wavelength	✓ Maximum noise	Typical noise
	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}
80C07	OC-3/STM-1, OC-12/STM-4		<1 μW_{rms}	<0.50 μW_{rms}
	OC-48/STM-16		<1.5 μW_{rms}	<0.70 μW_{rms}
80C07B	OC-3/STM-1, OC-12/STM-4, ENET1250, FC1063		<1 μW_{rms}	<0.50 μW_{rms}
	FC2125		<1.5 μW_{rms}	<0.85 μW_{rms}
	OC-48/STM-4, ENET2500, INFINIBAND, 2.5 GHz		<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 (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, 80C08C-CR2 80C08C-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/STM-64, 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/STM-64, 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/ STM-256, 43.02 Gb/s FEC	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 1-30: Vertical equivalent optical noise (maximum and typical), 80C01 through 80C10 [1] (cont.)

Module	Setting	Wavelength	✓ Maximum noise	Typical noise
80C10B	OC-768/ STM-256, 43.02 Gb/s FEC, 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/ STM-256, 43.02 Gb/s FEC, 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}

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 1-31: 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	FC1063, FC2125, FC4250, 10GBase-4, 10GFC-4, 3.318 Gb/s	1310 nm, 1550 nm	<2.5 μW_{rms}	<1.3 μW_{rms}
		850 mm	<4.0 μW_{rms} (maximum)	<2.1 μW_{rms}

Table 1-31: Optical modules: Vertical equivalent optical noise (maximum and typical), 80C11 through 80C25BGE (cont.)

Module	Setting	Wavelength	✓ Maximum Noise	Typical Noise
	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}
80C12B (Options F0-F12, 10GP)	OC-3/STM-1, OC-12/STM-4, FC1063, 1GBE	1310 nm, 1550 nm	<1.3 μW_{RMS}	0.7 μW_{RMS}
		850 mm	<2.1 μW_{RMS}	1.1 μW_{RMS}
	FC2125, OC-48/STM-16, INF2500, 2GBE, OC48 FEC, 2.666 Gb/s, 10GBASE-4, FC-3188, FC4250	1310 nm, 1550 nm	<1.5 μW_{RMS}	0.9 μW_{RMS}
		850 mm	<2.4 μW_{RMS}	1.5 μW_{RMS}
	INF5000, OBSAI6 144 Gb/s CPRI 7.373 Gb/s	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 ORRs, FC8500 – FC11317	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}
80C14	FC-8500, 8GFC, OC-192/STM-64, 10GBASE-W, 10GBASE-R, 40GBASE-R4, 100GBASE-R10, 10 GFC, FEC10.66 Gb/s, FEC10.71 Gb/s, FEC11.10 Gb/s, FC11317	1310 nm, 1550 nm	<2.4 μW_{RMS}	1.3 μW_{RMS}
		850 mm	<4.0 μW_{RMS}	2.2 μW_{RMS}
	FEC12.5 Gb/s	1310 nm, 1550 nm	<2.9 μW_{RMS}	1.7 μW_{RMS}
		850 mm	<4.8 μW_{RMS}	2.9 μW_{RMS}
	16GFC r6.1, INF14063, 14 GHz	1310 nm, 1550 nm	<3.7 μW_{RMS}	2.3 μW_{RMS}
		850 mm	<6.0 μW_{RMS}	3.8 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}

Table 1-32: 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 1-32: 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 1-32: 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 1-32: 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
✓ 100GBASE-R4 (25.781 Gb/s, ENET25781) 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

Table 1-32: 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 1-32: 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 1-32: 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 1-32: 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 1-32: 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

Table 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics			
✓16GFC (14.025 Gb/s) Reference Receiver setting frequency response	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 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics			
✓ 16GFC r6.1 (FC14025) Data Filter setting frequency response	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 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics			
✓ INF14063 Data Filter setting frequency response	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 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics			
✓ FEC12.50 Gb/s (FEC12500) Reference Receiver setting frequency response	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
✓ FEC 43.02 Gb/s Reference Receiver setting frequency response [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

Table 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics			
✓ ENET2500 (2 GBE) 2.50 Gb/s Reference Receiver setting frequency response [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

Table 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics			
✓ INF2500, INFINIBAND (2.5 Gb/s) Reference Receiver setting frequency response	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
✓INF5000 (5.0 Gb/s) Reference Receiver setting frequency response	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 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics			
✓ ENET1250 (GBE) 1.25 Gb/s Reference Receiver setting frequency response [1]	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
✓ FC1063 (1.0625 Gb/s) Reference Receiver setting frequency response [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

Table 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics			
✓ FC2125 (2.125 Gb/s) Reference Receiver setting frequency response [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
✓ FC4250 (4.25 Gb/s) Reference Receiver setting frequency response [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

Table 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics			
✓FC8500 (8.5Gb/s) Filter setting frequency response	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 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics			
✓FC8500FINAL (8.5Gb/s) Reference Receiver setting frequency response	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 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics
✓ VSR-5 (3.318 Gb/s) Reference Receiver setting frequency response [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

Table 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics			
✓OBSAI 6.144 Gb/s (OBSAI6144) Reference Receiver setting frequency response	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 1-32: Optical modules: Reference receiver frequency response (cont.)

Name	Characteristics			
✓CPRI 7.373 Gb/s (CPRI7373) Reference Receiver setting frequency response	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

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.

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.

Table 1-33: Optical power meter

Name		Characteristics
Optical power meter range		
	80C01, 80C02, 80C03, 80C04, 80C07, 80C07B, 80C09, 80C11	+4 dBm to –30 dBm, typical
	80C05, 80C06, 80C10, 80C10B, 80C25GBE	+13 dBm to –21 dBm, typical
	80C08, 80C08B, 80C08C, 80C12, 80C12B, 80C14	+0 dBm to –30 dBm, typical
Optical power meter accuracy, typical		5% of reading + connector uncertainty (typical): 780 nm ±20 nm (80C07B, 80C08C) 850 nm ±20 nm (80C07B, 80C08C, 80C12, 80C12B, 80C14) 1310 nm ±20 nm and 1550 nm ±20 nm (80C01, 80C02, 80C07B, 80C08C, 80C10, 80C10B, 80C11, 80C12, 80C12B, 80C14, 80C25GBE)

Table 1-34: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4)

Name		Characteristics
Effective wavelength range (clock recovery path)		
	80C01, 80C02, 80C04, 80C09	1270 nm to 1600 nm
	80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C, 80C12, 80C12B, 80C14	700 nm to 1650 nm
	80C11	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)

Table 1-34: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (cont.)

Name	Characteristics
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	9.95328 Gb/s ±1000 ppm (10GBASE-W)
	10.3125 Gb/s ±1000 ppm (10GBASE-R)
80C08B-CR1	9.95328 Gb/s ±1000 ppm (10GBASE-W)
	10.3125 Gb/s ±1000 ppm (10GBASE-R)
80C08B-CR2	10.3125 Gb/s ±1000 ppm (10GBASE-R)
	10.51875 Gb/s ±1000 ppm (10GFC)
80C08C-CR1	9.95328 Gb/s ±1000 ppm (10GBASE-W)
	10.3125 Gb/s ±1000 ppm (10GBASE-R)
80C08C-CR2	10.3125 Gb/s ±1000 ppm (10GBASE-R)
	10.51875 Gb/s ±1000 ppm (10GFC)
80C08C-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	9.95328 Gb/s ±1000 ppm (OC-192/STM-64)
80C11-CR2	9.95328 Gb/s ±1000 ppm (OC-192/STM-64)
	10.66423 Gb/s ±1000 ppm (10Gb FEC)
80C11-CR3	9.95328 Gb/s ±1000 ppm (OC-192/STM-64)
	10.70922 Gb/s ±1000 ppm (G.709 FEC)
80C11-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)
80C10B Opt. CRTP, 80C12, 80C12B, 80C14, 80C25GBE Opt CRTP	Clock recovery provided with the use of the 80A05, 80A07, CR125A, CR175A, or CR286A Electrical Clock Recovery module.

Table 1-34: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (cont.)

Name	Characteristics		
	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]		
✓ 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-CR1/CR2 80C08B-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	+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 / -7.8 dBm typical -8.5 dBm warranted [6] / -6.8 dBm warranted [6]

Table 1-34: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (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 1-34: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (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

Table 1-34: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (cont.)

Name	Characteristics	
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
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	Serial CLOCK output	1.0 $V_{pp,}$ typical
	1/16th CLOCK output	600 $mV_{pp,}$ typical
80C08B	Serial CLOCK output	1.0 $V_{pp,}$ typical
	1/16th CLOCK output	600 $mV_{pp,}$ typical
80C08C-CR1/ -CR2	Serial CLOCK output	1.0 $V_{pp,}$ typical
	1/16th CLOCK output	600 $mV_{pp,}$ typical
80C08C-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	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	Serial CLOCK output	1.5 $V_{pp,}$ typical
	1/16th CLOCK output	600 $mV_{pp,}$ typical
80C11-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 1-34: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (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	Serial CLOCK output	<30 ps
	80C08B 80C08C	1/16th CLOCK output	<300 ps
	80C09	Serial CLOCK output	<30 ps
		1/16th CLOCK output	<300 ps
	80C11	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 1-34: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (cont.)

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

Table 1-34: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (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	<2.0 ps $_{rms}$ maximum	
	<1.0 ps $_{rms}$ typical [5]	
80C09	<2.0 ps $_{rms}$ maximum	
	<1.0 ps $_{rms}$ typical [5]	
80C11	<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 1-35: 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, 80C08B, 80C08C, 80C09, 80C11	0.95 kg (2.10 lbs) 1.22 kg (2.70 lbs) (with clock recovery)
80C05, 80C06, 80C08	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)
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)
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)

NOTE. *For environmental specifications, refer to the documentation for your main instrument.*

Table 1-36: Optical modules - 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 1-37: 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 1-38: 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 1-38: 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 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 1-39: 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 1-39: 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 1-39: 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 1-40: 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 1-41: 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 1-42: Product family electromagnetic compatibility (EMC)

Refer to Mainframe Specification for the modular family specifications

Table 1-43: Product family dynamics

Refer to Mainframe Specification for the modular family specifications

Table 1-44: Product family atmospherics

Refer to Mainframe Specification for the modular family specifications