User Manual

Tektronix

**80C00 Series
Optical Sampling Modules**

071-0435-06

www.tektronix.com

WARRANTY

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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.

While using this product, you may need to access other parts of the system. Read the *General Safety Summary* in other system manuals for warnings and cautions related to operating the system.

To Avoid Fire or Personal Injury

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.

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

Do Not Operate Without Covers. Do not operate this product with covers or panels removed.

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

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

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

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.

Symbols and Terms **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.*

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.

Symbols on the Product. The following symbols may appear on the product:

CAUTION
Refer to Manual

Protective Ground
(Earth) Terminal

Preface

This is the user manual for the 80C00 Series Optical Modules and their available options. It includes the following information:

- Describes the capabilities of the modules and how to install them

- Explains how to operate the modules: how to control acquisition, processing, and input/output of information

- Lists specifications of the modules

You may want to visit the Tektronix Website at http://www.tektronix.com for the latest revision of the user documentation. Select the Manuals link, then enter the part number or product name to locate the document.

A printed version of this manual is also orderable (see *Optional Accessories* on page 9).

Manual Structure

This manual is composed of the following chapters:

- *Getting Started* shows you how to configure and install your optical module.

- *Operating Basics* describes controlling the module using the front panel and the instrument user interface.

- *Reference* provides information on wavelength selection, clock recovery and optical bandwidth.

- *Specifications* contains specifications for the 80C00 Series Optical Modules.

Related Manuals

This document covers installation and usage of the sampling module and its features. For information of the main instrument in which the sampling module is used, refer to the user documents and online help provided with your 8000-series main instrument.

Contacting Tektronix

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Sales support	1-800-833-9200, select option 1*
Service support	1-800-833-9200, select option 2*
Technical support	Email: techsupport@tektronix.com
	1-800-833-9200, select option 3*
	6:00 a.m. – 5:00 p.m. Pacific time

***   This phone number is toll free in North America. After office hours, please leave a
voice mail message.
Outside North America, contact a Tektronix sales office or distributor; see the
Tektronix web site for a list of offices.**

Getting Started

The 80C00 Series Optical Modules and their available options are high-performance optical modules that support high bandwidth telecom and datacom standards. These modules can be installed in the CSA8000, CSA8000B, TDS8000, and TDS8000B instruments.

Proper operation of the optical sampling modules requires that the appropriate TDS8000 and CSA8000 application software is installed on the main instrument. Table 1 lists the application software versions and the optical modules supported.

To display the version installed, select *About TDS/CSA8000* from the Help menu of the main instrument.

Table 1: Application software version required

TDS/CSA8000 application software versions	Modules supported
1.0.0 or greater[1]	80C01, 80C01-CR, 80C02, 80C02-CR, 80C03, 80C03-CR (superseded by the 80C11)
1.1.0 or greater[1]	80C04, 80C04-CR1
1.2.0 or greater[1]	80C04-CR2 (superseded by the 80C10), 80C05 (superseded by the 80C10), 80C06 (superseded by the 80C10)
1.3.0 or greater[1]	80C07, 80C07-CR1 (superseded by the 80C07B), 80C08, 80C08-CR1 (superseded by the 80C08C), 80C09, 80C09-CR1 (superseded by the 80C11)
1.4.0 or greater[1]	80C08B, 80C08B-CR1, 80C08B-CR2 (superseded by the 80C08C), 80C10
1.5.0 or greater[1]	80C07B, 80C07B-CR1 80C08C, 80C08C-CR1, 80C08C-CR2, 80C08C-CR4, 80C11, 80C11-CR1, 80C11-CR2, 80C11-CR3, 80C11-CR4,
2.0.0 or greater[2]	Supports all currently available modules

[1] **Product application software version 1.x.x requires the Windows 98 operating system.**

[2] **Product application software version 2.x.x requires the Windows 2000 operating system.**

Product Description

The optical modules provide the features shown in Tables 2 through 6. Table 11 on page 27 provides wavelength selections, filter, and bandwidth specifications for each module. Figure 1 shows the optical module controls, connectors, and indicators.

Table 2: Optical module features (80C01, 80C02 and 80C03)

Feature	80C01[1]	80C02[1]	80C03[1]
Number of input channels	1		
Effective wavelength range	1100 nm to 1650 nm		700 nm to 1650 nm
Supported standards or data filtering rates	OC-12/STM-4, OC-48/STM-16, OC-192/STM-64	OC-192/STM-64	FC1063, GBE, 2.50 Gb/s, OC-48/STM-16
Clock recovery, option	OC-12/STM-4, OC-48/STM-16	OC-192/STM-64	FC1063, GBE, 2.50 Gb/s, OC-48/STM-16
Absolute maximum nondestructive optical input[2]	5 mW average power; 10 mW peak power at wavelength with highest relative responsivity.		
Internal Fiber Diameter	9 μm/125 μm single mode		62.5 μm/125 μm multimode[3]
Optical return loss	> 30 dB	> 30 dB typical	> 14 dB for multimode fiber > 28 dB for single-mode fiber
Minimum optical bandwidth at optical connector	> 20 GHz	> 30 GHz	> 2.3 GHz
Output zero	< 10 μW immediately after dark calibration		< 500 nW immediately after dark calibration
Independent channel deskew	Standard		
Offset capability at front of module	Standard		
Power meter	Standard		

[1]   **Some values in the table are typical.**

[2]   **The optical input powers below non-destructive levels may exceed saturation and compression limits of the module.**

[3]   **Compatible with single-mode fiber of equal or smaller diameter.**

Table 3: Optical module features (80C04, 80C05, and 80C06)

Feature	80C04[1]	80C05[1]	80C06[1]
Number of input channels	1		
Effective wavelength range	1100 nm to 1650 nm	1520 nm to 1580 nm	
Supported standards or data filtering rates	OC-192/STM-64, FEC10.6646Gb/s	OC-192/STM-64	None
Clock recovery option	OC-192/STM-64, FEC10.6646Gb/s	None	

Table 3: Optical module features (80C04, 80C05, and 80C06) (cont.)

Feature	80C04[1]	80C05[1]	80C06[1]
Absolute maximum nondestructive optical input[2]	5 mW average power; 10 mW peak power at wavelength with highest relative responsivity.	10 mW average power; 30 mW peak power at wavelength with highest relative responsivity.	20 mW average power; 60 mW peak power at wavelength with highest relative responsivity.
Internal fiber diameter	9 μm/125 μm single mode[3]		
Optical return loss	> 30 dB typical	> 30 dB	
Minimum optical bandwidth at optical connector	> 30 GHz	> 40 GHz	> 55 GHz, typical
Output zero	< 10 μW immediately after dark calibration	< 30 μW immediately after dark calibration	
Independent channel deskew	Standard		
Offset capability at front of module	Standard		
Power meter	Standard		

[1] **Some values in the table are typical.**

[2] **The optical input powers below non-destructive levels may exceed saturation and compression limits of the module.**

[3] **Compatible with single-mode fiber of equal or smaller diameter.**

Table 4: Optical module features (80C07 and 80C07B)

Feature	80C07[1]	80C07B[1]
Number of input channels	1	
Effective wavelength range	700 nm to 1650 nm	
Supported standards or data filtering rates	OC-3/STM-1, OC-12/STM-4, OC-48/STM-16	Standard: OC-48 / STM-16, 2 Gigabit Ethernet (ENET2500/2GBE), Infiniband Optional:[3] OC-3 / STM-1, OC-12 / STM-4, FibreChannel (FC1063 / FC), Gigabit Ethernet (ENET1250 / GBE), 2G FibreChannel (FC2125 / 2FC)

Table 4: Optical module features (80C07 and 80C07B) (cont.)

Feature	80C07[1]	80C07B[1]
Clock recovery option	OC-3/STM-1, OC-12/STM-4, OC-48/STM-16	155.52 Mb/s (OC-3/STM-1), 622.08 Mb/s (OC-12/STM-4), 1062.5 Mb/s (FC1063/FC), 1250 Mb/s (ENET1250/GBE), 2125 Mb/s (FC2125/2FC), 2488.32 Mb/s (OC-48/STM-16), 2500 Mb/s (ENET2500/2GBE), 2500 Mb/s (Infiniband), 2666.06 Mb/s (OC-48-FEC)
Absolute maximum nondestructive optical input[2]	5 mW average power; 10 mW peak power at wavelength with highest relative responsivity.	
Internal fiber diameter	62.5 μm/125 μm multimode mode[4]	
Optical return loss	> 14 dB for multimode fiber > 24 dB for single-mode fiber	
Minimum optical bandwidth at optical connector	> 2.3 GHz	
Output zero	< 500 nW immediately after dark calibration ± 2% (vertical offset)	
Independent channel deskew	Standard	
Offset capability at front of module	Standard	
Power meter	Standard	

[1] **Some values in the table are typical.**

[2] **The optical input powers below non-destructive levels may exceed saturation and compression limits of the module.**

[3] **The 80C07B is shipped with five reference receiver filters. Three are standard, with the two remaining configured at the time of purchase. See Table 7 on page 7 for the optional configurations.**

[4] **Compatible with single-mode fiber of equal or smaller diameter.**

Table 5: Optical module features (80C08, 80C08B, and 80C08C)

Feature	80C08[1]	80C08B[1]	80C08C[1]
Number of input channels	1		
Effective wavelength range	700 nm to 1650 nm		
Supported standards or data filtering rates	9.95328 Gb/s (10GBASE-W), 10.3125 Gb/s (10GBASE-R)	9.95328 Gb/s (10GBASE-W), 9.95328 Gb/s (OC-192/STM64), 10.3125 (10GBASE-R), 10.51875 (10GFC)	9.95328 Gb/s (10GBASE-W), 9.95328 Gb/s (OC-192/STM64), 10.3125 (10GBASE-R), 10.51875 (10GFC), 11.10 Gb/s (10GbE FEC), 10.66423 Gb/s (G.975 FEC), 10.709225 Gb/s (G.709 FEC)

Table 5: Optical module features (80C08, 80C08B, and 80C08C) (cont.)

Feature	80C08[1]	80C08B[1]	80C08C[1]
Clock recovery option	9.95328 Gb/s (10GBASE-W) 10.3125 Gb/s (10GBASE-R)	9.95328 Gb/s (10GBASE-W/ OC-192/STM-64) (CR-1), 10.3125 Gb/s (10GBASE-R) (CR-1 & CR-2), 10.51875 Gb/s (10GFC) (CR-2 only)	9.95328 Gb/s (10GBASE-W/ OC-192/STM-64) (CR-1), 10.3125 Gb/s (10GBASE-R) (CR-1 & CR-2), 10.51875 Gb/s (10GFC) (CR-2 only), Continuous-rate from 9.8 Gb/s to 12.6 Gb/s (CR-4)[2]
Absolute maximum nondestructive optical input[3]	1 mW average power; 10 mW peak power for 60 ms.		
Internal fiber diameter[4]	62.5 μm/125 μm multimode		
Optical return loss	> 14 dB for multimode fiber > 24 dB for single-mode fiber		> 14 dB
Minimum optical bandwidth at optical connector	> 10 GHz		> 9.5 GHz
Output zero	< 1 uW immediately after dark calibration ± 2% (vertical offset)		
Independent channel deskew	Standard		
Offset capability at front of module	Standard		
Power meter	Standard		

[1]   **Some values in the table are typical.**

[2]   **Continuous-rate clock recovery supporting any standard or user-definable rate in the range from 9.8 Gb/s to 12.6 Gb/s.**

[3]   **The optical input powers below non-destructive levels may exceed saturation and compression limits of the module.**

[4]   **Compatible with single-mode fiber of equal or smaller diameter.**

Table 6: Optical module features (80C09, 80C10, and 80C11)

Feature	80C09[1]	80C10[1]	80C11[1]
Number of input channels	1	1[2]	1
Effective wavelength range	1100 nm to 1650 nm	1310 nm ± 30 nm 1550 nm ± 30 nm	1100 nm to 1650 nm
Supported standards or data filtering rates	OC-192/STM-64, FEC10.70922Gb/s	OC-768/STM256, 43.018 Gb/s G.709 FEC	OC-192/STM-64 (9.953 Gb/s), 10GBASE-W (9.953 Gb/s), 10GBASE-R (10.31 Gb/s), 10GFC (10.518 Gb/s), G.975 FEC (10.66 Gb/s, G.709 FEC (10.71 Gb/s), 10GbE FEC (11.10 Gb/s)

Table 6: Optical module features (80C09, 80C10, and 80C11) (cont.)

Feature	80C09[1]	80C10[1]	80C11[1]
Clock recovery option	OC-192/STM-64, FEC10.709225Gb/s	None	9.95328 Gb/s (10GBASE-W/ OC-192/STM-64) (CR-1, CR2, & CR-3), 10.66423 Gb/s (CR-2), 10.70922 Gb/s (CR-3), Continuous-rate from 9.8 Gb/s to 12.6 Gb/s (CR-4)[3]
Absolute maximum nondestructive optical input[4]	5 mW average power; 10 mW peak power at wavelength with highest relative responsivity.	20 mW average power; 60 mW peak power at wavelength with highest relative responsivity.	5 mW average power; 10 mW peak power at wavelength with highest relative responsivity
Internal fiber diameter	9 μm/125 μm single mode[5]		
Optical return loss	$>$ 30 dB		
Minimum optical bandwidth	$>$ 30 GHz	$>$ 60 GHz, minimum $>$ 65 GHz, typical	$>$ 20 GHz
Output zero	$<$ 10 μW immediately after dark calibration	1550 nm: $\pm$ [25 μW +0.04 $\times$ |Vertical Offset|] 1310 nm: $\pm$ [35 μW +0.04 $\times$ |Vertical Offset|]	10.71 Gb/s settings: $<$ 10 μW $\pm$ 2% (vertical offset) 20 GHz, 30 GHz settings: $<$ 10 μW $\pm$ 4% (vertical offset)
Independent channel deskew	Standard		
Offset capability at front of module	Standard		
Power meter	Standard		

[1] **Some values in the table are typical.**

[2] **The 80C10 has two separate optical inputs, one for 1310 nm and one for 1550 nm.**

[3] **Continuous-rate clock recovery supporting any standard or user-definable rate in the range from 9.8 Gb/s to 12.6 Gb/s.**

[4] **The optical input powers below non-destructive levels may exceed saturation and compression limits of the module.**

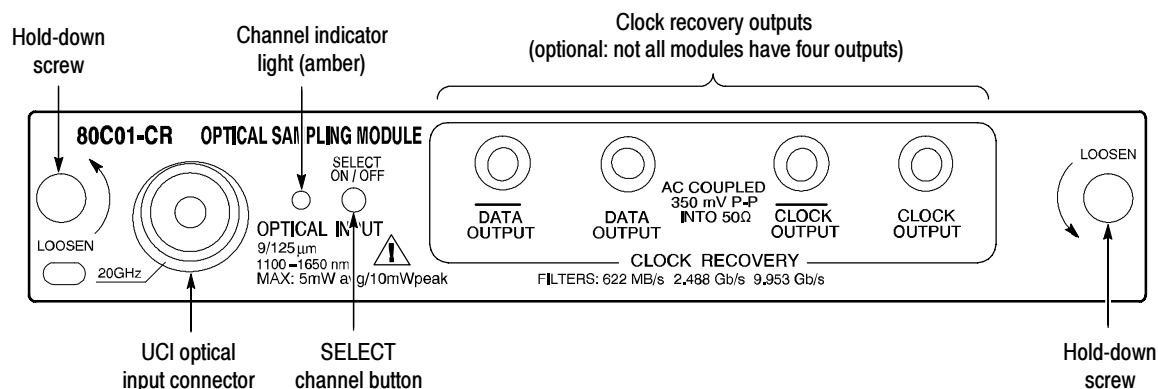[5] **Compatible with single-mode fiber of equal or smaller diameter.**

Figure 1: Optical module, 80C01-CR shown

Options and Accessories

This section lists the standard and optional accessories available for the sampling modules, as well as the product options.

Options   The following options can be ordered for the sampling modules:

Table 7: Available options

Option	Module	Description
Option CR	80C01-CR	Adds 622.08 Mb/s and 2.48832 Gb/s clock recovery
	80C02-CR	Adds 9.95328 Gb/s clock recovery
	80C03-CR	Adds 1.0625 Gb/s, 1.2500 Gb/s, 2.48832 Gb/s, and 2.500 Gb/s clock recovery
Option CR1	80C04-CR1	Adds 9.95328 Gb/s clock recovery
	80C07-CR1	Adds 155/622/2488 Mb/s clock recovery
	80C07B-CR1	Adds 155/622/1063/1250/2125/2488/2500/2666 Mb/s clock recovery
	80C08-CR1	Adds 9.95328 Gb/s and 10.3125 Gb/s clock recovery
	80C08B-CR1	Adds 9.95328 Gb/s and 10.3125 Gb/s clock recovery
	80C08C-CR1	Adds 9.95328 Gb/s and 10.3125 Gb/s clock recovery
	80C09-CR1	Adds 9.95328 Gb/s and 10.709225 Gb/s clock recovery
	80C11-CR1	Adds 9.95328 Gb/s clock recovery

Table 7: Available options (cont.)

Option	Module	Description
Option CR2	80C04-CR2	Adds 9.95328 Gb/s and 10.66423 Gb/s clock recovery
	80C08B-CR2	Adds 10.3125 Gb/s and 10.51875 Gb/s clock recovery
	80C08C-CR2	Adds 10.3125 Gb/s and 10.51875 Gb/s clock recovery
	80C11-CR2	Adds 9.95328 Gb/s and 10.66423 Gb/s clock recovery
Option CR3	80C11-CR3	Adds 9.95328 Gb/s and 10.70922 Gb/s clock recovery
Option CR4	80C08C-CR4	Adds continuous clock recovery from 9.8 Gb/s to 12.6 Gb/s
	80C11-CR4	Adds continuous clock recovery from 9.8 Gb/s to 12.6 Gb/s
Option F1	80C07B	Adds reference receiver filters OC-3 (155 Mb/s) and OC-12 (622 Mb/s)
Option F2		Adds reference receiver filters OC-3 (155 Mb/s) and FibreChannel (1063 Mb/s)
Option F3		Adds reference receiver filters OC-3 (155 Mb/s) and Gigabit Ethernet (1250 Mb/s)
Option F4		Adds reference receiver filters OC-3 (155 Mb/s) and 2G FibreChannel (2125 Mb/s)
Option F5		Adds reference receiver filters OC-12 (622 Mb/s) and FibreChannel (1063 Mb/s)
Option F6		Adds reference receiver filters OC-12 (622 Mb/s) and Gigabit Ethernet (1250 Mb/s)
Option F7		Adds reference receiver filters OC-12 (622 Mb/s) and 2G FibreChannel (2125 Mb/s)
Option F8		Adds reference receiver filters FibreChannel (1063 Mb/s) and Gigabit Ethernet (1250 Mb/s)
Option F9		Adds reference receiver filters FibreChannel (1063 Mb/s) and 2G FibreChannel (2125 Mb/s)
Option F10		Adds reference receiver filters Gigabit Ethernet (1250 Mb/s) and 2G FibreChannel (2125 Mb/s)
Option C3	All modules	Three years of calibration service
Option C5	All modules	Five years of calibration service
Option D1	All modules	Calibration data report
Option D3	All modules	Three years of calibration data reports (requires Opt. C3)
Option D5	All modules	Five years of calibration data reports (requires Opt. C5)
Option R3	All modules	Extended repair warranty to three years
Option R5	All modules	Extended repair warranty to five years.

Standard Accessories The following accessories are shipped with the module:

Table 8: Standard accessories

Item	Part number
Certificate of Traceable Calibration for product at initial shipment	Not orderable
Frequency response data[1]	Not orderable
FC/PC UCI adapter, installed	119-5115-xx
Fiber cleaning kit	020-2494-xx
SMA male 50 Ω termination (installed, one per clock recovery output connector)	015-1022-xx

1   Frequency response data is provided for each module's filtered modes.

Optional Accessories The following accessories are orderable for use with the sampling module at the time this manual originally published. Consult a current Tektronix catalog for additions, changes, and details:

Table 9: Optional accessories

Item	Part number
D4/PC Universal Optical Input (UCI) adapter	119-4514-xx
Biconic UCI adapter	119-4515-xx
FC/PC UCI adapter	119-4516-xx
SMA 2.5 UCI adapter	119-4517-xx
SC/PC UCI adapter	119-4518-xx
DIN/PC UCI adapter	119-4546-xx
DIAMOND 2.5 UCI adapter	119-4556-xx
SMA UCI adapter	119-4557-xx
DIAMOND 3.5 UCI adapter	119-4558-xx
ST/PC UCI adapter	119-4513-xx
3.5 male to 3.5 female SMA	015-0552-xx
Slip-on SMA connector	015-0553-xx
CSA8000B & TDS8000B Service Manual	071-0438-xx
80C00 Series Optical Sampling Modules User Manual (printed)	071-0435-xx

Installation

The optical modules fit in the large slot in the front panel of a compatible instrument, such as a CSA8000B or TDS8000B. Figure 2 shows the front panel of a CSA8000B and the locations of the module compartments.
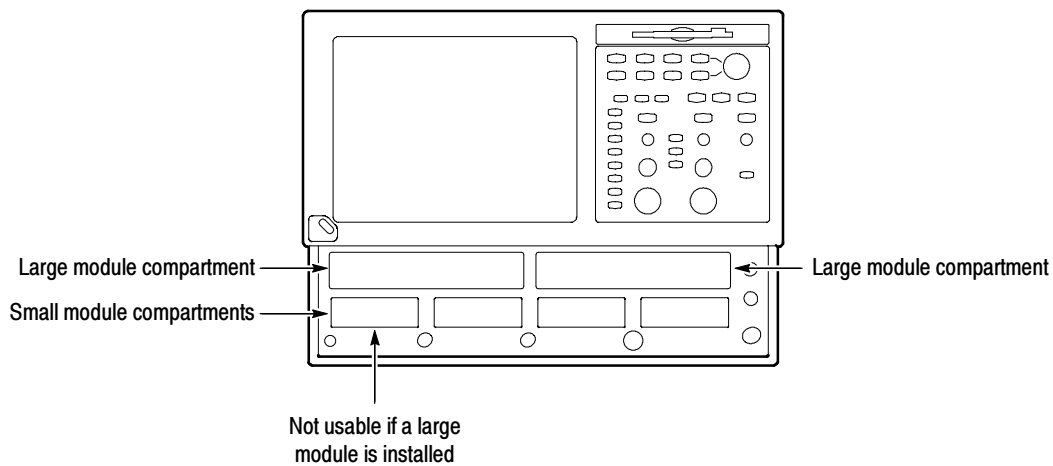
Figure 2: Module compartments

At least one module must be installed in the main instrument to acquire signals.

NOTE. Installing a large module, in either large compartment, disables the left-most small compartment (CH 1 and CH 2 for small modules).

The large compartments support single channel sampling modules, while the small compartments support single or dual channel sampling modules. Eight of the 10 inputs are usable at one time.

Electrostatic Discharge

To prevent electrostatic damage to the main instrument and optical modules, follow the precautions described in this manual and the manuals accompanying your main instrument.

Circuitry in the optical module is very susceptible to damage from electrostatic discharge and from over drive signals. Be sure to only operate the optical module in a static-controlled environment (grounded conductive table top, wrist strap, floor mat, and ionized air blower). Be sure to discharge to ground any electrostatic charge that may be present on electrical cables before attaching the cable to the optical module recovered clock and data outputs.

⚠️ *CAUTION. The recovered clock and data outputs of the optical module are subject to damage from electrostatic discharge (ESD). To prevent damage from electrostatic discharge, store the optical module with the supplied SMA terminations installed. Store the module in a static-free container, such as the shipping container. Whenever you move the optical module from one instrument to another, use a static-free container to carry the optical module.*

Always use a wrist strap (provided with your instrument) when handling an optical module or making connections. Discharge to ground any electrostatic charge that may be present on cables before attaching the cable to the optical-module.

Module Installation

To install a large module, first power off the instrument using the front-panel On/Standby power switch. Then place the module into a compartment and slowly push it in with firm pressure. Once the module is seated, turn the hold-down screws clockwise to lock the module into place. See Figure 3.

NOTE. To facilitate installation, turn the hold-down screws so that they are completely out (all the way counterclockwise), and then be sure to seat the module completely into its compartment. Doing so will help ensure the retaining ear on each screw rotates into position as you tighten the screws.

⚠️ *CAUTION. To prevent damage to the optical module or instrument, never install or remove a module when the front-panel On/Standby power switch is ON (powered-on).*

Once you have secured the module, you can turn on the instrument. See the main instrument user manual for information on powering on your instrument and checking its function.

NOTE. When removing a module, after turning the hold-down screws counter-clockwise, use the module ejectors on the main instrument to eject the module.

Large module ejectors

Hold-down screw   Hold-down screw
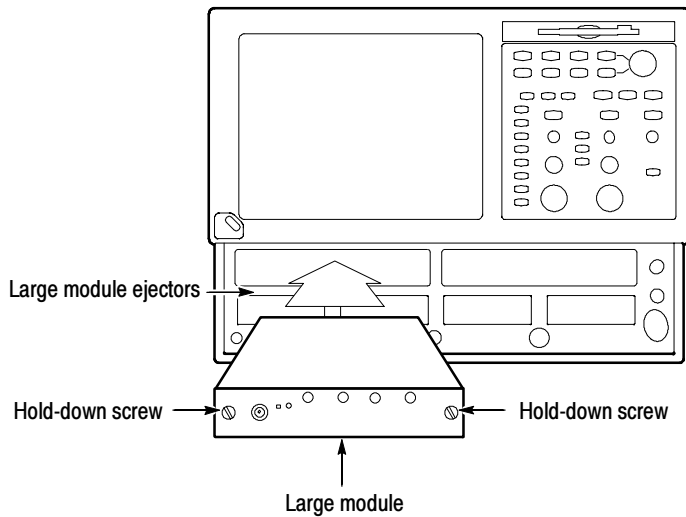
Large module

Figure 3: Installing a large module

NOTE. After first installing a sampling module(s) or after moving a sampling module from one compartment to another, you should run Compensation from the Utilities menu to ensure the instrument meets it specifications. You must run a compensation if an extender is installed, changed, or removed from a module. For instructions on running a compensation, see Optimizing Measurement Accuracy *on page 20.*

After running Compensation, you must save the new values to retain them, otherwise they will be lost when turning the instrument power off.

Operating Basics

This section describes the front panel, connecting to the circuit under test, system interaction with the main instrument, and the programmer interface.

Usage

Handle your optical module carefully at all times.

⚠ **CAUTION.** *To avoid damaging your optical module, take the following precautions:*

Do not drop your module since damage and misalignment of the photodiode optical assembly can result. Store the module in a secure location when not in use.

Replace the protective cap on the input connector when the module is not in use.

To prevent loss of optical power or damage to the optical connectors, keep the connectors clean at all times. Also insure that all connectors and jumpers attached to the inputs are clean prior to insertion. See Cleaning Optical Connectors *on page 22.*

Connecting Optical Signals

Take care to preserve the integrity of the connectors by keeping them free of contamination. For cleaning information, see *Cleaning Optical Connectors* on page 22.

The input of the 80C01, 80C02, 80C04, 80C05, 80C06, 80C09, 80C10, and 80C11 modules (see note) can couple to single-mode optical fibers with a core diameter/cladding diameter of 9/125 μm. The 80C03, 80C07, 80C07B, 80C08, 80C08B, and 80C08C modules can couple to any single-mode dimension or multimode dimension not exceeding a core diameter/cladding diameter of 62.5/125 μm. Alternate types can be coupled by use of UCI (universal connector interface) series adapters. Refer to a current Tektronix catalog for details.

NOTE. *The 80C10 has two separate optical inputs. The user must choose the correct one to use depending on 1310 nm or 1550 nm operation.*

Attach the fiber optic cable with a suitable connector or a UCI Interface adapter to the optical input receptacle as follows. Figure 4 illustrates the proper use of a UCI adapter.

1. Firmly press the cable connector or adapter into the interface ferrule until it reaches the stop.

2. Line up the key with the slot in the UCI adapter before inserting.
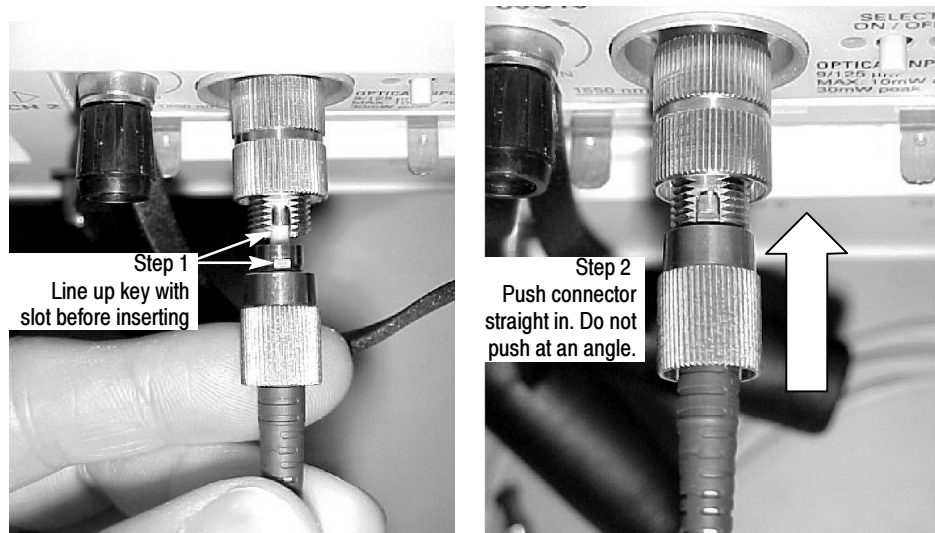
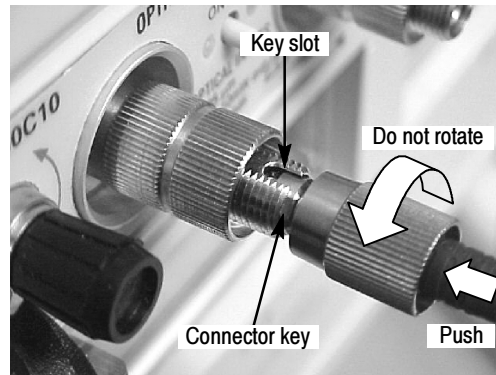**Figure 4: Connecting optical cables — correct method**

CAUTION. *Do not insert the connector into the UCI adapter at an angle. Do not insert the connector and then rotate to line up the key with the slot. Either action may damage the UCI adapter.*

Figure 5: Connecting optical cables — wrong method

3. Firmly tighten the cable connector or the adapter shell. Tighten with finger pressure only.

4. To remove, unscrew the cable connector or adapter shell.

Attenuating Optical Signals

To keep the optical input power to an appropriate level, it may be necessary to attenuate the optical signal.

CAUTION. To avoid damaging the optical input of the module, attenuate to the Absolute Maximum Nondestructive Optical Input specifications. To maintain the levels within performance range and to avoid clipping, attenuate optical signals as indicated in the table below:

Module	Average	Peak
80C01	5 mW	10 mW
80C02	5 mW	10 mW
80C03	5 mW	10 mW
80C04	5 mW	10 mW
80C05	20 mW	60 mW
80C06	20 mW	60 mW
80C07	5 mW	10 mW
80C07B	5 mW	10 mW
80C08	1 mW	10 mW
80C08B	1 mW	10 mW
80C08C	1 mW	10 mW
80C09	5 mW	10 mW
80C10	20 mW	60 mW
80C11	5 mW	10 mW

NOTE. The 80C03, 80C07, and 80C07B modules can have a somewhat deteriorated response for signals larger than 200 μW_{p-p}. The 80C08, 80C08B, and 80C08C modules also can have a somewhat deteriorated response for signals larger than 500 μW_{p-p}, and the vertical response will eventually saturate for levels approaching 1 mW_{p-p}.

NOTE. Optical sampling modules may have dynamic ranges exceeded without obvious visual indication onscreen because the photodetector and/or filters used may not necessarily pass through overloaded signals to the samplers at the front end.

System Interaction

Your optical module is a part of a larger instrument system. Most optical module functions are controlled automatically by the main instrument. These include such things as vertical scaling and horizontal sampling rate. You do not directly control these parameters; they are controlled for you as you perform tasks on the main instrument. The parameters that you control from the optical module front panel are explained in the *Front Panel Controls* section.

An additional optical module function that you control from the main instrument is external channel attenuation. External Attenuation lets you enter a number representing any external attenuation you have added to a channel.

Front Panel Controls

The optical module front panel is shown in Figure 6.

Channel Selection   Each channel has a SELECT channel button and an amber channel light. The button operates as follows:

- If the amber channel light is on, the channel is acquiring a waveform.

- If you press the button and the channel is not currently being acquired (for any channel or math waveform), then the instrument activates (turns on) the channel.

- If you press the button and the channel is currently active as a channel waveform, then the instrument selects the channel waveform.

- If the channel waveform is already selected when you press the channel button, the instrument turns the channel off.
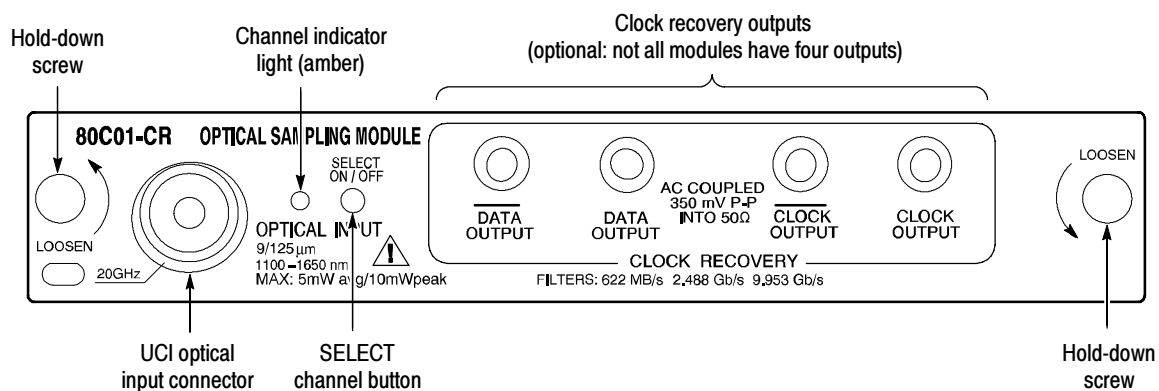

Figure 6: Optical module, 80C01-CR shown

Optical Input Connector   The optical input connector uses a universal connector interface (UCI) that allows use of many standard fiber-optic female connector styles. Some of the standard UCI interfaces supported are FC, ST, SC, and DIN. (Refer to a current Tektronix catalog for details.)

Clock Recovery Outputs   Optional clock and data-recovery circuitry provides clock and data outputs; the recovered clock is internally routed to the main-instrument trigger circuit. The circuitry also provides front-panel outputs: normal and complemented clock, and on some modules, normal and complemented data. Refer to Table 10. Use 50 Ω terminations, provided with your optical module, on unused outputs.

Table 10: Clock recovery outputs

Modules	Front panel outputs
80C01-CR	DATA, $\overline{\text{DATA}}$, CLOCK, $\overline{\text{CLOCK}}$
80C02-CR	DATA, CLOCK, 1/16 CLOCK
80C03-CR	CLOCK, $\overline{\text{CLOCK}}$, DATA, $\overline{\text{DATA}}$
80C04-CR1 80C04-CR2	DATA, CLOCK, 1/16 CLOCK CLOCK, 1/16 CLOCK
80C07-CR1	DATA, $\overline{\text{DATA}}$, CLOCK, $\overline{\text{CLOCK}}$
80C07B-CR1	DATA, $\overline{\text{DATA}}$, CLOCK, $\overline{\text{CLOCK}}$
80C08-CR1	CLOCK, 1/16 CLOCK
80C08B-CR1 80C08B-CR2	CLOCK, 1/16 CLOCK CLOCK, 1/16 CLOCK
80C08C-CR1 80C08C-CR2 80C08C-CR4	CLOCK, 1/16 CLOCK CLOCK, 1/16 CLOCK CLOCK, 1/16 CLOCK
80C09-CR1	CLOCK, 1/16 CLOCK
80C11-CR1 80C11-CR2 80C11-CR3 80C11-CR4	DATA, CLOCK, 1/16 CLOCK CLOCK, 1/16 CLOCK CLOCK, 1/16 CLOCK CLOCK, 1/16 CLOCK

You can disable the internal recovered clock from being used as the main instrument trigger by selecting external or internal triggering; select the recovered clock rate without actually selecting recovered clock as the trigger condition in order to activate the front-panel clock recovery signals.

Hold-Down Screws   Hold-down screws secure the module to the main instrument. Once the hold-down screws are loosened, use the eject levers to remove the module from a powered-down main instrument. Indicators on the hold-down screws point in the direction that the latch is pointing.

Commands From the Main-Instrument Front Panel

The Vertical Setup dialog box lets you toggle between the basic and optical module controls. The basic and optical controls are shown in Figure 7.

You first select the channel you want to set in the Waveform section of the dialog box. Then you select the Setup Wavelength, Filter, Bandwidth, or Compensate controls in the dialog box to change those settings or to initiate a compensation. Optical modules with the clock recovery option also have source and rate controls in the Trigger dialog box.

Detailed information on these dialog boxes can be found in the *CSA8000B & TDS8000B User Manual* and the *CSA8000 and TDS8000 Online Help*.
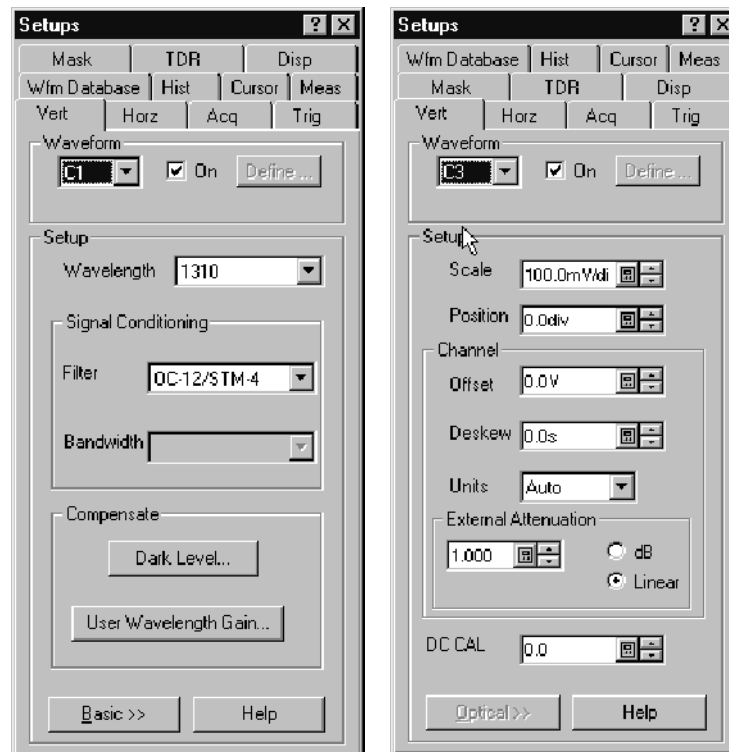
Figure 7: System Vertical menu

Programmer Interface Commands

The remote programming commands for all sampling modules are documented in the *CSA8000 & TDS8000 Programmer Guide* accessed from the instrument Help menu.

User Adjustments

All optical module setups, parameters, and adjustments are controlled by the main instrument. To save, recall, or change any module settings, use the main-instrument menus or front-panel controls. Consult the *CSA8000B & TDS8000B User Manual* or the *CSA8000 and TDS8000 Online Help*.
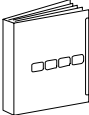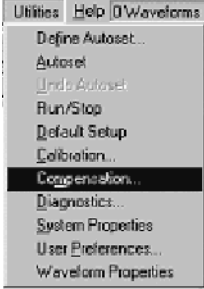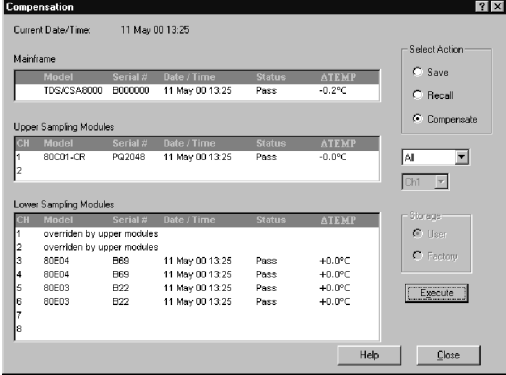
Optimizing Measurement Accuracy

Measurement accuracy of optical modules is increased (or maintained) by performing the following procedures:

- Vertical Compensation

- Cleaning the Optical Connectors

- Dark-Level and User Wavelength Gain Compensations

Perform Vertical Compensation   Performing a vertical compensation will maximize the accuracy of the automatic measurements you take. This procedure uses internal routines to optimize the vertical offset, gain, and linearity.

Overview	To perform optical compensations	Control elements and resources
Prerequisites	1. The instrument must have the optical sampling module(s) to be compensated in place. The acquisition system should be set to run continuously. 2. Dust covers must be in place on all optical module channels (or otherwise eliminate the optical input). 3. Power on the instrument and allow a 20 minute warm-up before doing this procedure	See the instrument User Manual for details on operating the instrument controls.
Access the compensation routines	4. From the application menu bar, click **Utilities**, and then click **Compensation**.	Utilities Help 0 Waveforms Define Autoset... Autoset Undo Autoset Run/Stop Default Setup Calibration... Compensation... Diagnostics... System Properties User Preferences... Waveform Properties

Overview	To perform optical compensations (cont.)	Control elements and resources
	5. In the Compensation dialog box, the main instrument (mainframe) and sampling modules are listed. The temperature change from the last compensation is also listed.	
	6. Wait until the Status for all items you wish to compensate changes from **Warm Up** to **Pass**, **Fail**, or **Comp Req'd**.	
	7. Under Select Action, click the **Compensate** option button.	
	8. From the top pulldown list, choose **All** (default selection) to select the main instrument and all its modules as targets to compensate.	
	9. Click the **Execute** button to begin the compensation.	
	10. Follow the instructions to disconnect inputs and install terminations that will appear on screen; be sure to follow static precautions when following these instructions.	
Verify that the compensation routines pass	11. The compensation may take several minutes to complete. Verify that **Pass** appears as **Status** for the main instrument and for all sampling modules listed in the Compensation dialog box when compensation completes.	
	12. If instead **Fail** appears as **Status**, rerun the compensation. If **Fail** status continues after rerunning compensation and you have allowed warm up to occur, the module or main instrument may need service.	
	13. Click the **Save** option button under Select Action. Click the **Execute** button to save the compensation.	
	■ If you don't save the new compensation values, they will be lost when the instrument is powered off.	

End of Procedure

Cleaning Optical Connectors

Small dust particles and oils can easily contaminate optical connectors and reduce or block the signal. Take care to preserve the integrity of the connectors by keeping them free of contamination.

⚠ **CAUTION.** *To prevent loss of optical power or damage to the optical connectors, keep the connectors clean at all times.*

To reduce the need for cleaning, immediately replace protective caps on the optical connectors when not in use.
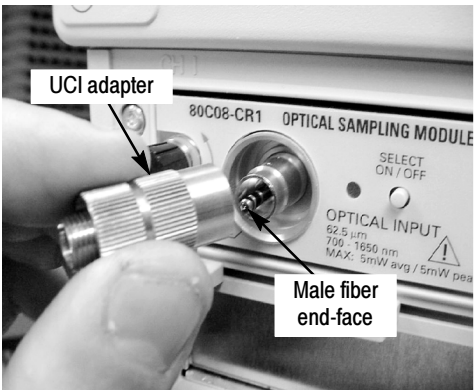
Use the following items to clean optical connectors:

- dry, clean, and dust-free compressed air

- fiber cleaning cassette and/or tape dispenser cleaner

- pipe cleaner
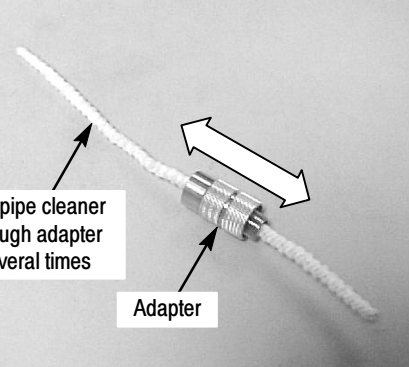
⚠ **CAUTION.** *Clean your connecting fiber (ferrule endface) with a dry cloth tape (cassetted or in a dispenser) cleaner. Both ferrule endfaces can be cleaned in this way.*

For safe and effective cleaning of the optical male fiber end-face exposed after removing the UCI adapter, Tektronix recommends the following method and tools.

Overview	To clean the optical connectors	Related information
Supplies required	1. One compressed air can, such as Tektronix part number 118-1068-01. One FIS cassette cleaner, (such as FI-6270) or one FIS tape dispenser cleaner (such as FI-7111).	Cleaning kits for optical connectors (such as the Tektronix Optical Connector Cleaner part number 006-8134-00) are available from a number of suppliers.
Remove UCI adapter	2. Unscrew the UCI adapter and remove it. This exposes the male fiber end-face behind the UCI connector.	
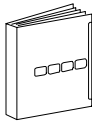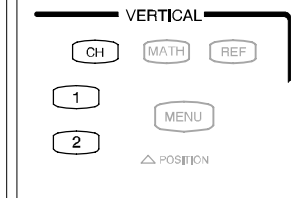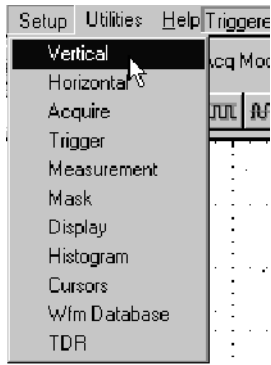
Overview	To clean the optical connectors (cont.)	Related information
Clean UCI adapter	3. Clean contaminates from the inside wall of the hollow female-to-female ferrule alignment tube inside the UCI adapter. ■ Use the compressed air can to clean the female input of the UCI adapter end-to-end. ■ Pull the pipe cleaner through the UCI adapter. ⚠ *CAUTION. Do not blow compressed air into the female input of the UCI adapter when it is installed on the module.*	Pull pipe cleaner through adapter several times Adapter
Clean fiber input	4. Advance the fiber cleaning cassette or tape-dispenser cleaner to expose an unused clean section of the lint-free, dry, cleaning surface. 5. Lightly drag the clean, dry, surface of the cleaning tool cloth against the male end-face of the fiber input for a short distance (a centimeter or two). 6. Replace the UCI adapter back onto the cleaned fiber end-face.	Cleaning tool cloth Male fiber end-face
Dust cap	7. When the module does not have a fiber attached to its input(s) ensure the black dust-cap is in place to prevent airborne contaminates from lodging in the female optical input.	Dust cap
Clean attaching devices	8. Clean any male fiber end-face input fiber or device that will be attached to the UCI input.	Use a similar cleaning method to clean the fiber end-face input fiber or device that will be attached.
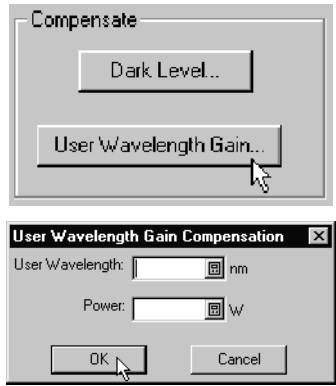
End of Procedure

**Perform Dark-Level and
User Wavelength Gain
Compensations**

Performing a dark-level calibration will maximize the accuracy of the extinction ratio and other optical automatic measurements you take. Performing a User Wavelength Gain compensation will optimize an optical channel for your custom input signal. Use the following procedure to perform either compensation; this procedure applies only to optical modules.

NOTE. *These procedures compensate the selected module and the its current bandwidth and filter selection. The compensation values are not saved when powering off the instrument.*

Overview	To perform optical compensations	Control elements and resources
Prerequisites	1. The instrument must have the optical sampling module(s) to be dark-level calibrated in place. The acquisition system should be set to run continuously.	See the instrument User Manual for details on operating the instrument controls.
Select the waveform	2. Use the Vertical buttons to select the channel to be compensated.	
Access the dark-level compensation	3. From the application menu bar, click **Setup**, and then click **Vertical**.	
Run the dark-level compensation	4. In Vert Setup dialog box, click the **Dark Level** button under Compensation. Follow the instructions on screen. 5. Repeat steps 2 and 4 for any additional optical channels that you want to compensate.	

Overview	To perform optical compensations (cont.)	Control elements and resources
Run the user wavelength gain compensation	If you want, you can can compensate an optical channel for a custom input signal: 6. In Vert Setup dialog box, click the **User Wavelength Gain** button under Compensation. Follow the instructions on screen. 7. In the User Wavelength Gain Compensation dialog box, set the wavelength and power of the signal to be applied to the channel. ■ You must connect an optical signal to the module input with a precisely known amount of optical power. An independently-calibrated average optical power meter is used to measure this power precisely. Then signal is connected to the 80C00 with the same fiber cables. 8. Press the **OK** button to execute the compensation. 9. Repeat steps 2, 6, and 7 for any additional optical channels that you want to compensate.	 Compensate Dark Level... User Wavelength Gain... User Wavelength Gain Compensation ✕ User Wavelength: [ ] nm Power: [ ] W OK Cancel

Note. The 80C10 has two separate optical inputs each optimized for different wavelength regions (1310 nm or 1550 nm). Therefore, it supports two different user wavelength gain compensation calibrations, one for each input.

End of Procedure

Cleaning

The case of the module keeps dust out and should not be opened. Cleaning the exterior of the module is usually confined to the front panel. If you desire to clean the case, remove the module from the main instrument but first read the entire *Installation* procedure starting on page 10 for proper handling of the module.

⚠️ **WARNING.** *To prevent injury, power down the instrument and disconnect it from line voltage before performing any cleaning.*

Clean the exterior surfaces of the module with a dry lint-free cloth or a soft-bristle brush. If any dirt remains, use a damp cloth or swab dipped in a 75% isopropyl alcohol solution. Use a swab to clean narrow spaces around controls and connectors. Do not allow moisture inside the module. Do not use abrasive compounds on any part of the chassis that may damage the chassis.

⚠ **CAUTION.** *To prevent damage, avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. Use only deionized water when cleaning the menu buttons or front-panel buttons. Use a 75% isopropyl alcohol solution as a cleaner, and rinse with deionized water. Before using any other type of cleaner, consult your Tektronix Service Center or representative.*

Do not open the case of the module. There are no user serviceable components and cleaning the interior is not required.

Reference

This section describes how to select the optical module wavelength, how to enable clock recovery, and explains optical bandwidth.

Wavelength, Filter, and Bandwidth Selection

To select the optical wavelength, use the Vertical Setups menu. This menu is shown in Figure 7 on page 19.

First select the channel in the Waveform section of the menu. Then select the Wavelength that matches your system from the Setup Wavelength drop down box.

Use the Signal Conditioning boxes to select the filter and bandwidth appropriate for your optical standard.

For more information, consult the *CSA8000 and TDS8000 Online Help*.

Table 11: Wavelength, Filter, and Bandwidth selections

Module	Wavelength selections	Filter	Bandwidth
80C01	1310 nm 1550 nm User	None (select a bandwidth) OC-12/STM-4 (622.08 Mb/s) OC-192/STM-64 (9.953 Gb/s) OC-48/STM-16 (2.48832 Gb/s)	20 GHz 12.5 GHz
80C02	1310 nm 1550 nm User	None (select a bandwidth) OC-192/STM-64 (9.953 Gb/s)	30 GHz 20 GHz 12.5 GHz
80C03	780 nm 850 nm 1310 nm 1550 nm User	None 2.50 Gb/s OC-48/STM-16 (2.488 Gb/s) FC1063 (1.0625 Gb/s) GbE (1.25 Gb/s)	2 GHz
80C04	1310 nm 1550 nm User	None (select a bandwidth) OC-192/STM-64 (9.953 Gb/s) FEC10.66 Gb/s	30 GHz 20 GHz
80C05	1550 nm User	None (select a bandwidth) OC-192/STM-64 (9.953 Gb/s)	40 GHz 30 GHz 20 GHz
80C06	1550 nm User	None	50 GHz

Table 11: Wavelength, Filter, and Bandwidth selections (cont.)

Module	Wavelength selections	Filter	Bandwidth
80C07	780 nm 850 nm 1310 nm 1550 nm User	None OC-3/STM-1 (155 Mb/s) OC-12/STM-4 (622.08 Mb/s) OC-48/STM-16 (2.48832 Gb/s)	2 GHz

80C07B	780 nm
	850 nm
	1310 nm
	1550 nm
	User
		None
		
		Standard:
		  OC-48 / STM-16
		  2 Gigabit Ethernet (ENET2500 / 2GBE)
		  Infiniband
		
		Optional:
		  OC-3 / STM-1
		  OC-12 / STM-4
		  FibreChannel (FC1063 / FC)
		  Gigabit Ethernet (ENET1250 / GBE)
		  2G FibreChannel (FC2125 / 2FC)
			2.5 GHz

80C08	780 nm 850 nm 1310 nm 1550 nm User	None 10GBASE-W (9.953 Gb/s) 10GBASE-R (10.31 Gb/s)	10 GHz
80C08B	780 nm 850 nm 1310 nm 1550 nm User	None 10GBASE-W (9.953 Gb/s) 10GBASE-R (10.31 Gb/s) OC-192/STM-64 (9.953 Gb/s) 10GFC (10.518 Gb/s)	10 GHz
80C08C	780 nm 850 nm 1310 nm 1550 nm User	None OC-192/STM-64 (9.953 Gb/s) 10GBASE-W (9.953 Gb/s) 10GBASE-R (10.31 Gb/s) 10GFC (10.518 Gb/s) G.975 FEC (10.66 Gb/s) G.709 FEC (10.709 Gb/s) 10GbE FEC (11.10 Gb/s)	10 GHz
80C09	1310 nm 1550 nm User	None (select a bandwidth) OC-192/STM-64 (9.953 Gb/s) FEC10.71 Gb/s	30 GHz 20 GHz

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Table 11: Wavelength, Filter, and Bandwidth selections (cont.)

Module	Wavelength selections	Filter	Bandwidth
80C10	1310 nm 1550 nm User	None (select a bandwidth) OC-768/STM-256 (39.813 Gb/s) G.709 FEC (43.018 Gb/s)	30 GHz 65 GHz
80C11	1310 nm 1550 nm User	None (select a bandwidth) OC-192/STM-64 (9.953 Gb/s) 10GBASE-W (9.953 Gb/s) 10GBASE-R (10.31 Gb/s) 10GFC (10.518 Gb/s) G.975 FEC (10.66 Gb/s G.709 FEC (10.709 Gb/s) 10GbE FEC (11.10 Gb/s)	28 GHz

Clock Recovery

This section describes the clock recovery option. Clock recovery is only available on modules with Option CR, CR1, CR2, CR3, or CR4. Table 10 on page 18 provides a list of all available optical modules and the clock recovery options available for each module.

- **DATA and $\overline{\text{DATA}}$ (recovered data).** These outputs provide a 50 Ω, AC-coupled, ~ECL/2 level signal from the optical module data signal. These signals are digitally buffered and retimed to be synchronous with the serial recovered clock.

- **CLOCK and $\overline{\text{CLOCK}}$ (recovered clock).** These outputs are clock signals synchronous with the incoming data signal.

- **1/16 CLOCK (recovered clock).** This output provides the clock signal at $1/16^{\text{th}}$ the rate.

Clock recovery options CR, CR1, CR2, and CR3 provide various predefined output rates (depending on the optical module model and the CR option). Clock recovery option CR4 provides both predefined selections and a continuous-rate selection. The continuous rate is depends on the user entering the bit rate into the Trigger Setup dialog box of the main instrument with an accuracy better than 1000 ppm. Table 15 on page 60 summarizes the clock recovery options for all modules.

NOTE. If clock and data recovery are enabled and no signal (or not the appropriate signal) is applied to the front panel, the recovered clock and data may free run.

Optical Bandwidth

Traditionally bandwidth is defined as the frequency at which the power out is one half the power out at a frequency near DC. In the voltage domain the power dissipated into a resistive load (such as a 50 Ω termination of a sampler) is the V_{RMS}^2/R where V_{RMS} is the RMS of the voltage swing seen at the resistive load, and R is the resistance value. A logarithmic scale using decibels is typically used to describe a system's frequency dependent response. A value expressed in terms of a decibel relative to a reference is defined as:

$$dB = 10\log\left(\frac{value}{reference}\right)$$

For electrical bandwidths the reference of a system is commonly the response of the system to a sinusoidal frequency at or near DC. The point at which the system response (power is the common parameter that is referred to in many systems) is one half would therefore be:

$$dB = 10\log\left(\frac{0.5}{response\ at\ DC}\right) = -3dB$$

In terms of frequency, voltage, and resistance the bandwidth is expressed as:

$$-3dB = 10\log\left(\frac{V(f)^2}{R} \div \frac{V(DC)^2}{R}\right)$$

where V(f) is the RMS of the voltage swing response at the bandwidth frequency and V(DC) is the RMS voltage swing response at a frequency approaching DC. Further math yields $V(f) = 0.707 \times V(DC)$.

The expression is simplified by cancelling the R and moving the squared term inside the log expression to a multiple outside the log expression:

$$10\log\left(\frac{V(f)^2}{R} \div \frac{V(DC)^2}{R}\right) = 2 \times 10\log\left(\frac{V(f)}{V(DC)}\right) = 20\log\left(\frac{V(f)}{V(DC)}\right)$$

In the CSA8000B and TDS8000B instruments, the vertical units displayed for an optical module are not in volts, but in watts, which are units of power. The optical-to-electrical converter inside the module outputs a voltage whose amplitude is linearly dependent on the incoming optical power; in this condition the voltage applied at the electrical sampler already represents optical power in its linear form (as opposed to having to square the voltage and divide by R). For the optical sampling modules then, the bandwidth where the displayed optical power is one half that approaching DC is:

$$dB = 10 \log\left(\frac{0.5}{response\ at\ DC}\right) = -3dB$$

The V(f) is the frequency at which the vertical swing is one half (0.5) the V(DC) not 0.707. The optical bandwidth therefore corresponds to the traditional electrical bandwidth of –6 dB. During testing of optical modules by impulse testing, the resulting impulse waveform is converted to frequency by Fourier transform and the bandwidth is defined as –3 dB = 10 log(vertical swing at frequency / vertical swing at DC). During reference receiver curve calculation, however, the definition is changed to match the industry standard definition which assumes electrical bandwidths are –3 dB = 20 × log(vertical swing at frequency / vertical swing at DC).

Bandwidth for Unfiltered Frequency Settings

The curve calculation of frequency response for the unfiltered frequency settings (2 GHz, 2.5 GHz, 12.5 GHz, 20 GHz, 30 GHz, 40 GHz, 50 GHz, and 65 GHz) uses the definition for dB and bandwidth where –3 dB = 10 log(vertical swing at frequency / vertical swing at DC); that is, the optical bandwidth.

Bandwidth for Reference Receiver Settings

The curve calculation of frequency response for reference receiver settings (FC, GbE, and OC/STM standards) uses the definition of dB and bandwidth that matches the industry standard which assumes electrical bandwidths where –3 dB = 20 log(vertical swing at frequency / vertical swing at DC).

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 ν 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

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

Table 12: 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, and
	    OC-192/STM-64 for 9.953 Gb/s SONET/SDH standards.

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 and
	    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 12: 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 five 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 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 12: 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
80C11	Long wavelength 1100 nm - 1650 nm. Unamplified O/E converter with two user-selectable optical bandwidths: 　　20 GHz, 　　30 GHz, or with five 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 for 10G Fibre Channel 10.51875 or two data filters: 　　G.975 FEC 10.66423 Gb/s 　　G.709 FEC 10.709225 Gb/s

Table 13: Optical modules - Acquisition

Name	Characteristics
Number of input channels	1 optical
Internal fiber diameter[1]	
80C01, 80C02, 80C04, 80C05, 80C06, 80C09, 80C10, 80C11	9 μm/125 μm single mode
80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C	62.5 μm (Corning 62.5/125 CPC6 specs) multimode (compatible with single-mode fiber) cladding: 125 μm, buffer: 900 μm
Fiber connector	Rifocs UCI (universal connector interface) male connector

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics
Optical return loss	
80C01, 80C02, 80C04, 80C05, 80C06, 80C09, 80C10, 80C11	$>$ 30 dB for single-mode fiber
80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C	$>$ 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	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	1 mW average power; 10 mW peak power at wavelength with highest relative responsivity.
Maximum operating ranges[11]	
80C01, 80C02, 80C04, 80C09	0 to 10 mW displayed limits, not including offset.
80C03, 80C07, 80C07B	0 to 1 mW displayed limits, not including offset.
80C05	0 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 to 60 mW displayed limits, including offset, which may be coerced to above 4 mW/div to ensure 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	0 to 2 mW displayed limits, not including offset.
80C10	0 to 30 mW displayed limits, not including offset.
80C11	5 mW average power; 10mW 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.

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics
Effective wavelength range[3], typical	
80C01, 80C02, 80C04, 80C09, 80C11	1100 nm to 1650 nm
80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C	700 nm to 1650 nm
80C05, 80C06	1520 nm to 1580 nm
80C10	1550 nm: 1520 nm to 1580 nm 1310 nm: 1290 nm to 1330 nm
Calibrated wavelengths	
80C01, 80C02, 80C04, 80C09, 80C10, 80C11	1550 nm and 1310 nm $\pm$ 20 nm
80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C	1550 nm, 1310 nm, 850 nm, and 780 nm (all $\pm$ 20 nm)
80C05, 80C06	1550 nm $\pm$ 20 nm

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics	
✓ Dark level	To achieve these levels, perform a dark level compensation, keep the trigger rate and vertical offset at the same settings as they were during the compensation, and if the ambient temperature changes more than 1 °C, perform another dark level compensation.	
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	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	65 GHz 1550 nm	± [25 μW + 0.04 × |vertical offset|]
	65 GHz 1310 nm	± [35 μW + 0.04 × |vertical offset|]
80C11	OC-192, 10.71 Gb/s, 10.71 Gb/s, 10GBASE-W, 10GBASE-R, 10GBE FEC, 10GFC	$<$ 10 μW ±2% (vertical offset)
	20 GHz, 30 GHz	$<$ 10 μW ±4% (vertical offset)

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics	
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
80C08, 80C08B, 80C08C	200 μW per division	2 μW per division
80C10	3 mW per division	30 μW per division
	Full scale vertical on the display of the main instrument is 10 divisions. Maximum full scale and minimum full scale are therefore 10 times the values listed above. Vertical scale is adjustable in a 1-2-5 sequence. Between those settings, the scale can be adjusted in smaller increments.	
Vertical offset range		
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	± 15 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) (typical)	
80C07, 80C07B	± 1 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)	
80C08, 80C08B, 80C08C	± 4 mW offset relative to center of waveform display (5 divisions from either top or bottom of waveform display)	

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics	
DC vertical accuracy[4], typical	*Setting*	*Accuracy*
80C01, 80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C	All settings	$\pm 25\ \mu W\ \pm 2\%$ of [(vertical value) - (vertical offset)]
80C02	12.5 GHz, OC-192/STM-64	$\pm 25\ \mu W\ \pm 2\%$ of [(vertical value) - (vertical offset)]
	20 GHz	$\pm 25\ \mu W\ \pm 4\%$ of [(vertical value) - (vertical offset)]
	30 GHz	$\pm 25\ \mu W\ \pm 6\%$ of [(vertical value) - (vertical offset)]
80C04	10.66 Gb/s, OC-192/STM-64	$\pm 25\ \mu W\ \pm 2\%$ of [(vertical value) - (vertical offset)]
	20 GHz	$\pm 25\ \mu W\ \pm 4\%$ of [(vertical value) - (vertical offset)]
	30 GHz	$\pm 25\ \mu W\ \pm 6\%$ of [(vertical value) - (vertical offset)]
80C05	OC-192/STM-64	$\pm 25\ \mu W\ \pm 2\%$ of [(vertical value) - (vertical offset)]
	20 GHz	$\pm 25\ \mu W\ \pm 4\%$ of [(vertical value) - (vertical offset)]
	30 GHz	$\pm 25\ \mu W\ \pm 6\%$ of [(vertical value) - (vertical offset)]
	40 GHz	$\pm 25\ \mu W\ \pm 8\%$ of [(vertical value) - (vertical offset)]
80C06	50 GHz	$\pm 120\ \mu W\ \pm 6\%$ of [(vertical value) - (vertical offset)]
80C09	10.71 Gb/s, OC-192/STM-64	$\pm 25\ \mu W\ \pm 2\%$ of [(vertical value) - (vertical offset)]
	20 GHz	$\pm 25\ \mu W\ \pm 4\%$ of [(vertical value) - (vertical offset)]
	30 GHz	$\pm 25\ \mu W\ \pm 6\%$ of [(vertical value) - (vertical offset)]
80C10	30 GHz	$\pm 25\ \mu W\ \pm 4\%$ of [(vertical value) - (vertical offset)]
	39 Gb/s, OC-768/STM-256, 43 Gb/s (G.709), FEC43.02 Gb/s	$\pm 25\ \mu W\ \pm 6\%$ of [(vertical value) - (vertical offset)]
	65 GHz setting	$\pm 25\ \mu W\ \pm 8\%$ of [(vertical value) - (vertical offset)]

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics	
80C11	OC-192, 10.66Gb/s, 10.71Gb/s, 10Gbase-W, 10Gbase-R, 10GBE FEC, 10GFC	± 25 uW ± 2% of [(vertical reading) − (vertical offset)]
	20 GHz	± 25 uW ± 4% of [(vertical reading) − (vertical offset)]
	30 GHz	± 25 uW ± 6% of [(vertical reading) − (vertical offset)]
DC vertical difference accuracy[4], typical	The accuracy of the difference between two cursors in the vertical scale of the same channel.	
	Setting	*Accuracy*
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	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 13: Optical modules - Acquisition (cont.)

Name	Characteristics	
80C11	OC-192, 10.66 Gb/s, 10.71 Gb/s, 10Gbase-W, 10Gbase-R, 10GBE FEC, 10GFC	$\pm$ 2% of [difference reading]
	20 GHz	$\pm$ 4% of [difference reading]
	30 GHz	$\pm$ 6% of [difference reading]
Offset capabilities	Open loop. User assigned, fixed offset value is applied to channel.	
✓ Minimum optical bandwidth[5]	*Setting*	*Bandwidth*
80C01	20 GHz	> 20 GHz
	12.5 GHz	> 12.5 GHz
80C02	30 GHz	> 28 GHz > 30 GHz, typical[7]
	20 GHz	> 20 GHz
	12.5 GHz	> 12.5 GHz
80C02-CR	30 GHz	> 28 GHz > 29 GHz, typical[7]
80C03	2.5 GHz	> 2.3 GHz, typical
80C04	30 GHz	> 28 GHz > 30 GHz, typical[7]
	20 GHz	> 20 GHz
80C04-CR1, 80C04-CR2	30 GHz	> 28 GHz[7] > 29 GHz, typical[7]
80C05	20 GHz	> 20 GHz
	30 GHz	> 30 GHz
	40 GHz	> 40 GHz, typical
80C06	55 GHz[6]	> 55 GHz, typical
80C07, 80C07B	2.5 GHz	> 2.3 GHz, typical
80C08, 80C08B, 80C08C	10 GHz	> 9 GHz > 10 GHz, typical
80C09	30 GHz	> 30 GHz, typical[7]
	20 GHz	> 20 GHz
80C09-CR1	30 GHz	> 29 GHz, typical[7]
80C09, 80C09-CR1	30 GHz	> 28 GHz[7]
80C10	30 GHz	> 30 GHz
	65 GHz	> 65 GHz

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics	
80C11, 80C11-CR	20 GHz	$>$ 20 GHz
	30 GHz	$>$ 28 GHz $>$ 30 GHz (typical)
Rise time, typical For peak optical signal input which creates $<$ 2 mW$_{pp}$ modulation depth.		
80C01	OC-12/STM-4	750 ps $\pm$ 50 ps
	OC-48/STM-16	187 ps $\pm$ 15 ps
	OC-192/STM-64	47 ps $\pm$ 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 $\pm$ 10 ps
80C04	30 GHz	$<$ 16 ps
	20 GHz	$<$ 25 ps
	10.66 Gb/s	44 ps $\pm$ 10 ps
	OC-192/STM-64	47 ps $\pm$ 10 ps
80C05	40 GHz	$<$ 12 ps
	30 GHz	$<$ 16 ps
	20 GHz	$<$ 25 ps
	OC-192/STM-64	47 ps $\pm$ 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 $\pm$ 10 ps
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 13: Optical modules - Acquisition (cont.)

Name	Characteristics	
80C11	30 GHz	$<$ 16 ps
	20 GHz	$<$ 25 ps
	OC-192, 10Gbase-W, 10Gbase-R, 10GBE FEC, 10GFC	47 ps $\pm$ 10 ps
	10.66 Gb/s, 10.71 Gb/s	44 ps $\pm$ 10 ps
Rise time, typical For peak optical signal input which creates $<$ 200 μW_{pp} modulation depth.	*Setting*	*Rise Time*
80C03	FC1063	440 ps $\pm$ 35 ps
	GBE	373 ps $\pm$ 30 ps
	OC-48/STM-16	187 ps $\pm$ 15 ps
80C07	OC-3	3.0 ns $\pm$ 170 ps
	OC-12	750 ps $\pm$ 50 ps
	OC-48	187 ps $\pm$ 15 ps
80C07B	OC-3	3.0 ns $\pm$ 170 ps
	OC-12	750 ps $\pm$ 50 ps
	ENET1250	373 ps $\pm$ 30 ps
	FC1063	440 ps $\pm$ 35 ps
	FC2125	220 ps $\pm$ 18 ps
	OC-48, ENET2500, INFINIBAND, 2.5 GHz	187 ps $\pm$ 15 ps

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics	
Rise time, typical For peak optical signal input which creates < 500 μW_{pp} modulation depth.	*Setting*	*Rise Time*
80C08	10 GHz	$<$ 50 ps
	10GBASE-W, 10GBASE-R	47 ps $\pm$ 10 ps
80C08B	10 GHz	$<$ 50 ps
	10GBASE-W, 10GBASE-R, OC-192/STM-64, 10GFC	47 ps $\pm$ 10 ps
80C08C	10 GHz	$<$ 50 ps
	10GBASE-W, 10GBASE-R, OC-192/STM-64, 10GFC, 10GBE FEC	47 ps $\pm$ 10 ps
Time domain vertical response aberrations, typical For peak optical signal input < 5 mW$_{p-p}$ except for 80C03 and 80C07 which creates 200 μW_{pp} modulation depth.	*Setting*	*Aberrations*
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% $_{p-p}$

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics	
80C04	OC-192/STM-64, 10.66 Gb/s	$<$ 10%
	20 GHz	$<$ 20%
	30 GHz	$<$ 30%
80C07, 80C07B	All settings	$<$ 5% (typical)
80C09	OC-192/STM-64, 10.71 Gb/s	$<$ 10%
	20 GHz	$<$ 20%
	30 GHz	$<$ 30%
80C11	OC-192, 10.66Gb/s, 10.71Gb/s, 10Gbase-W, 10Gbase-R, 10GBE FEC, 10GFC	$<$ 10%
	20 GHz	$<$ 20%
	30 GHz	$<$ 30%
Time domain vertical response aberrations, typical For peak optical signal input $<$ 10 mW$_{p-p}$.	*Setting*	*Aberrations*
80C05	OC-192/STM-64	$<$ 5%
	20 GHz, 30 GHz	$<$ 10%
	40 GHz	$<$ 15%
80C06	50 GHz	$<$ 5% (typical) $<$ 10% (maximum)
Time domain vertical response aberrations, typical For peak optical signal input $<$ 2 mW$_{p-p}$.	*Setting*	*Aberrations*
80C08, 80C08B, 80C08C	All settings	$<$ 10% (typical)

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics	
✓ Time domain vertical response aberrations, typical For peak optical signal input < 20 mW$_{p-p}$.	*Setting*	*Aberrations*
80C10	OC-768/STM-256, FEC43.02 Gb/s, 30 GHz	$<5\%$ (maximum) $<3\%$ (typical)
	65 GHz	$<10\%$ (maximum) $<5\%$ (typical)
✓ Vertical equivalent optical noise (maximum and typical)[8]	*Setting*	*Noise*
80C01	OC-12/STM-4, OC-48/STM-16 OC-192/STM-64, 12.5 GHz	<12 μW$_{rms}$ (maximum) <8 μW$_{rms}$ (typical)
	20 GHz	<25 μW$_{rms}$ (maximum) <15 μW$_{rms}$ (typical)
80C01-CR	OC-12/STM-4, OC-48/STM-16 OC-192/STM-64, 12.5 GHz	<15 μW$_{rms}$ (maximum) <10 μW$_{rms}$ (typical)
	20 GHz	<25 μW$_{rms}$ (maximum) <15 μW$_{rms}$ (typical)
80C02	OC-192/STM-64, 12.5 GHz	<10 μW$_{rms}$ (maximum) <6 μW$_{rms}$ (typical)
	20 GHz	<15 μW$_{rms}$ (maximum) <10 μW$_{rms}$ (typical)
	30 GHz	<30 μW$_{rms}$[7] (maximum) <20 μW$_{rms}$ (typical)
80C02-CR	OC-192/STM-64, 12.5 GHz	<12 μW$_{rms}$ (maximum) <7 μW$_{rms}$ (typical)
	20 GHz	<20 μW$_{rms}$ (maximum) <15 μW$_{rms}$ (typical)
	30 GHz	<40 μW$_{rms}$[7] (maximum) <30 μW$_{rms}$ (typical)
80C03, 80C03-CR	FC1063, GBE	<1 μW$_{rms}$ (maximum) <0.75 μW$_{rms}$ (typical)
	OC-48/STM-16	<1.5 μW$_{rms}$ (maximum) <1 μW$_{rms}$ (typical)

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics	
80C04	OC-192/STM-64, FEC 10.66 Gb/s	$< 10~\mu W_{rms}$ (maximum) $< 6~\mu W_{rms}$ (typical)
	20 GHz	$< 15~\mu W_{rms}$ (maximum) $< 10~\mu W_{rms}$ (typical)
	30 GHz	$< 30~\mu W_{rms}$[7] (maximum) $< 20~\mu W_{rms}$ (typical)
80C04-CR1, 80C04-CR2	OC-192/STM-64	$< 12~\mu W_{rms}$ (maximum) $< 7~\mu W_{rms}$ (typical)
	20 GHz	$< 20~\mu W_{rms}$ (maximum) $< 15~\mu W_{rms}$ (typical)
	30 GHz	$< 40~\mu W_{rms}$[7] (maximum) $< 30~\mu W_{rms}$ (typical)
80C05	OC-192/STM-64	$< 15~\mu W_{rms}$ (maximum) $< 10~\mu W_{rms}$ (typical)
	20 GHz	$< 25~\mu W_{rms}$ (maximum) $< 15~\mu W_{rms}$ (typical)
	30 GHz	$< 35~\mu W_{rms}$ (maximum) $< 25~\mu W_{rms}$ (typical)
	40 GHz	$< 70~\mu W_{rms}$[7] (maximum) $< 50~\mu W_{rms}$ (typical)
80C06	50 GHz	$< 192~\mu W_{rms}$ (maximum) $< 150~\mu W_{rms}$ (typical)
80C07	OC-3/STM-1, OC-12/STM-4	$< 1~\mu W_{rms}$ (maximum) $< 0.50~\mu W_{rms}$ (typical)
	OC-48/STM-16	$< 1.5~\mu W_{rms}$ (maximum) $< 0.70~\mu W_{rms}$ (typical)
80C07B[12]	OC-3/STM-1, OC-12/STM-4, ENET1250, FC1063	$< 1~\mu W_{rms}$ (maximum) $< 0.50~\mu W_{rms}$ (typical)
	FC2125	$< 1.5~\mu W_{rms}$ (maximum) $< 0.85~\mu W_{rms}$ (typical)
	OC-48/STM-4, ENET2500, INFINIBAND, 2.5 GHz	$< 1.5~\mu W_{rms}$ (maximum) $< 0.70~\mu W_{rms}$ (typical)
80C08, 80C08B (no clock recovery)	All settings	$< 5~\mu W_{rms}$ (maximum) $< 2.5~\mu W_{rms}$ (typical)
80C08-CR1, 80C08B-CR1 80C08B-CR2	All settings	$< 5.5~\mu W_{rms}$ (maximum) $< 3.0~\mu W_{rms}$ (typical)

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics		
80C08C (no clock recovery)	All settings	1310 nm, 1550 nm	$< 3.0\ \mu W_{rms}$ (maximum) $< 1.7\ \mu W_{rms}$ (typical)
		850 mm	$< 5.0\ \mu W_{rms}$ (maximum) $< 3.0\ \mu W_{rms}$ (typical)
		780 nm	$< 6.0\ \mu W_{rms}$ (maximum) $< 3.5\ \mu W_{rms}$ (typical)
80C08C-CR1, 80C08C-CR2 80C08C-CR4	All settings	1310 nm, 1550 nm	$< 3.5\ \mu W_{rms}$ (maximum) $< 1.9\ \mu W_{rms}$ (typical)
		850 nm	$< 5.5\ \mu W_{rms}$ (maximum) $< 3.3\ \mu W_{rms}$ (typical)
		780 nm	$< 6.6\ \mu W_{rms}$ (maximum) $< 3.9\ \mu W_{rms}$ (typical)
80C09	OC-192/STM-64, FEC 10.71 Gb/s		$< 10\ \mu W_{rms}$ (maximum) $< 6\ \mu W_{rms}$ (typical)
	20 GHz		$< 20\ \mu W_{rms}$ (maximum) $< 15\ \mu W_{rms}$ (typical)
	30 GHz		$< 30\ \mu W_{rms}$[7] (maximum) $< 20\ \mu W_{rms}$ (typical)
80C09-CR1, 80C09-CR2	OC-192/STM-64, FEC 10.71 Gb/s		$< 10\ \mu W_{rms}$ (maximum) $< 7\ \mu W_{rms}$ (typical)
	20 GHz		$< 20\ \mu W_{rms}$ (maximum) $< 15\ \mu W_{rms}$ (typical)
	30 GHz		$< 30\ \mu W_{rms}$[7] (maximum) $< 30\ \mu W_{rms}$ (typical)
80C10	OC-768/ STM-256	1310 nm	$< 110\ \mu W_{rms}$ (maximum) $< 75\ \mu W_{rms}$ (typical)
	43.02 Gb/s FEC	1550 nm	$< 60\ \mu W_{rms}$ (maximum) $< 40\ \mu W_{rms}$ (typical)
	30 GHz	1310 nm	$< 90\ \mu W_{rms}$ (maximum) $< 55\ \mu W_{rms}$ (typical)
		1550 nm	$< 50\ \mu W_{rms}$ (maximum) $< 30\ \mu W_{rms}$ (typical)
	65 GHz	1310 nm	$< 220\ \mu W_{rms}$ (maximum) $< 150\ \mu W_{rms}$ (typical)
		1550 nm	$< 120\ \mu W_{rms}$ (maximum) $< 85\ \mu W_{rms}$ (typical)

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics	
80C11 (no clock recovery)	OC-192, 10.66Gb/s, 10.71Gb/s, 10Gbase-W, 10Gbase-R, 10GBE FEC, 10GFC	$<8~\mu W_{rms}$ (maximum) $<5.5~\mu W_{rms}$ (typical)
	20 GHz	$<14~\mu W_{rms}$ (maximum) $<10~\mu W_{rms}$ (typical)
	30 GHz (Warranted at ambient temperatures below 30 °C only)	$<30~\mu W_{rms}$ (maximum) $<20~\mu W_{rms}$ (typical)
80C11-CR1, 80C11-CR2, 80C11-CR3, 80C11-CR4	OC-192, 10.66Gb/s, 10.71Gb/s, 10Gbase-W, 10Gbase-R, 10GBE FEC, 10GFC	$<9~\mu W_{rms}$ (maximum) $<6~\mu W_{rms}$ (typical)
	20 GHz	$<15~\mu W_{rms}$ (maximum) $<11~\mu W_{rms}$ (typical)
	30 GHz (Warranted at ambient temperatures below 30 °C only)	$<35~\mu W_{rms}$ (maximum) $<25~\mu W_{rms}$ (typical)
✓ OC-3/STM-1 155 Mb/s Reference Receiver setting frequency response[7]	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:	

(MHz) Frequency	Lower	(dB) Nominal	Upper
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

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics
✓ OC-12/STM-4 622 Mb/s Reference Receiver setting frequency response[7]	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:

(MHz) Frequency	Lower	(dB) Nominal	Upper
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	-10.4

Name	Characteristics
✓ OC-48/STM-16 2.488 Gb/s Reference Receiver setting frequency response[7]	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:

(MHz) Frequency	Lower	(dB) Nominal	Upper
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

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics
✓ OC-192/STM-64 9.953 Gb/s Reference Receiver setting frequency response[7]	Scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits.

Tektronix manufactures and tests the 80C01, 80C02, 80C04, 80C05, 80C08[10], 80C09, and 80C11[10] optical modules using 10 Gb reference receivers to have a new superior and tighter tolerance OC-192/STM-64 Reference Receiver response. ITU experts recently agreed on the minimum performance specifications for 10 Gbit/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	Lower	(dB) Nominal	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 13: Optical modules - Acquisition (cont.)

Name	Characteristics
✓ OC-768/STM-256 39.813 Gb/s Reference Receiver setting frequency response[7]	Bessel–Thompson Scalar Frequency Response curve for margin testing and tolerance at various frequencies; based on ± 1.00 DC to 0.75x(data rate) and ± 5.0dB 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	Lower	(dB) Nominal	Upper
0	-1.00	0	0.50
5.97	-1.10	-0.10	0.40
11.94	-1.45	-0.45	0.05
17.92	-2.02	-1.02	-0.52
23.89	-2.86	-1.86	-1.36
29.86	-4.00	-3.00	-2.50
35.83	-5.96	-4.51	-3.33
39.81	-7.42	-5.71	-4.15
41.80	-8.20	-6.37	-4.62
44.79	-9.42	-7.42	-5.42
47.78	-11.22	-8.54	-5.87
53.75	-14.83	-10.93	-7.03
59.72	-18.41	-13.41	-8.41

Name	Characteristics
✓ 10GBASE-W Reference Receiver setting frequency response[7] ✓ 10GBASE-R Reference Receiver setting frequency response[7] ✓ 10GBE FEC Reference Receiver setting frequency response[7] ✓ 10GFC Reference Receiver setting frequency response[7] ✓ 10.66 Data Filter setting frequency response[7] ✓ 10.709 Data Filter setting frequency response[7]	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 10.00000 Gb/s reference receivers (as specified for the 9.95328 Gb/s rate of the 10GBASE-W) and listed below:

(MHz) Frequency	Lower	(dB) Nominal	Upper
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 13: Optical modules - Acquisition (cont.)

Name	Characteristics
✓ 10.66 Gb/s Reference Receiver setting frequency response[7]	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 (10.664 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 $(10.664/9.95328) \times 7.465$ 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:

(MHz) Frequency	Lower	(dB) Nominal	Upper
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 13: Optical modules - Acquisition (cont.)

Name	Characteristics
✓ 10.71 Gb/s Reference Receiver setting frequency response[7]	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 $(10.709/9.95328) \times 7.465$ 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:

(MHz) Frequency	Lower	(dB) Nominal	Upper
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

Name	Characteristics
✓ FEC 43.02 Gb/s Reference Receiver setting frequency response[7]	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	Lower	(dB) Nominal	Upper
0	-1.00	0	0.50
6.45	-1.10	-0.10	0.40
12.90	-1.45	-0.45	0.05
19.36	-2.02	-1.02	-0.52
25.81	-2.86	-1.86	-1.36
32.26	-4.00	-3.00	-2.50
38.71	-5.96	-4.51	-3.33
43.02	-7.42	-5.71	-4.15
45.17	-8.20	-6.37	-4.62
48.40	-9.42	-7.42	-5.42
51.63	-11.22	-8.54	-5.87
58.08	-14.83	-10.93	-7.03
64.53	-18.41	-13.41	-8.41

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics
✓ ENET2500 (2 GBE) 2.50 Gb/s Reference Receiver setting frequency response[7]	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:

(MHz) Frequency	Lower	(dB) Nominal	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

Name	Characteristics
✓ ENET1250 (GBE) 1.25 Gb/s Reference Receiver setting frequency response[7]	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:

(MHz) Frequency	Lower	(dB) Nominal	Upper
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

Table 13: Optical modules - Acquisition (cont.)

Name	Characteristics
✔ FC1063 (1.0625 Gb/s) Reference Receiver setting frequency response[7]	In FC1063 setting, scalar frequency response falls within industry standard, Bessel-Thompson reference receiver boundary limits. Fiber 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:

(MHz) Frequency	Lower	(dB) Nominal	Upper
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

Name	Characteristics
✔ FC2125 (2.125 Gb/s) Reference Receiver setting frequency response[7]	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:

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

1   **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   **The optical wavelengths that the product accepts and still provides a reasonable (25% of peak optimum) wavelength conversion gain.**

4   **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.**

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

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

7   **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 2mW$_{pp}$ (200 uW$_{pp}$ for 80C03 and 80C07; 500 uW$_{pp}$ for 80C08) or less signal is applied at the sampler input.**

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

9   **Clock recovery versions reduce the power reaching the vertical channel (splitter to clock recovery produces loss). Therefore, the non-clock recovery modules more closely exhibit the typical noise performance.**

10   **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.**

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

12   **The 80C07B optical noise specifications given are for the 1310 nm wavelength setting. The noise at wavelength setting 780 nm is typically increased by a factor of 2.0. The noise at 850 nm is typically increased by a factor of 1.6. The noise at 1550 nm is typically the same as at 1310 nm.**

Table 14: 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	+13 dBm to −21 dBm, typical
80C08, 80C08B, 80C08C	+0 dBm to −30 dBm, typical
Optical power meter accuracy, typical	5% of reading + connector uncertainty for either 780 nm (80C03 80C07, 80C07B, 80C08, 80C08B, 80C08C, 80C11), 850 nm (80C03, 80C07, 80C07B, 80C08, 80C08B, 80C08C, 80C11), 1310 nm, or 1550 nm ± 20 nm, typical

Table 15: 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	700 nm to 1650 nm
80C11	1270 nm to 1600 nm

Table 15: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (cont.)

Name	Characteristics
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 (2X GBE)
80C04-CR1	9.95328 Gb/s ± 1000 ppm (OC-192/STM-64)
80C04-CR2	9.95328 Gb/s ± 1000 ppm (OC-192/STM-64)
	10.664 Gb/s ± 1000 ppm (OC-192 FEC)
80C07-CR1	155.52 Mb/s ± 1000 ppm (OC-3/STM-1)
	622.08 Mb/s ± 1000 ppm (OC-12/STM-4)
	2488.32 Mb/s ± 1000 ppm (OC-48/STM-16)
80C07B-CR1	155.52 Mb/s ± 1000 ppm (OC-3/STM-1)
	622.08 Mb/s ± 1000 ppm (OC-12/STM-4)
	1062.5 Mb/s ± 1000 ppm (FC1063/FC)
	1250 Mb/s ± 1000 ppm (ENET1250/GBE)
	2125 Mb/s ± 1000 ppm (FC2125/2FC)
	2488.32 Mb/s ± 1000 ppm (OC-48/STM-16)
	2500 Mb/s ± 1000 ppm (ENET2500/2GBE)
	2500 Mb/s ± 1000 ppm (Infiniband)
	2666.06 Mb/s ± 1000 ppm (OC-48–FEC)
80C08-CR1	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)

Table 15: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (cont.)

Name	Characteristics
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)

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 function**s** 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

Table 15: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (cont.)

Name	Characteristics		
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 $\geq$ 8.2 dB[7]	*(OMA)*[8]
		-15 dBm typical -13 dBm warranted[6]	-12.3 dBm typical -11.3 dBm warranted[6]
		1550 nm, 1310 nm Bit Rate: 11.25 Gb/s to 12.6 Gb/s	
		(AOP @ ER $\geq$ 8.2 dB)[7]	*(OMA)*[8]
		-12.5 dBm typical -11.5 dBm warranted[6]	-10.8 dBm typical -9.8 dBm warranted[6]
		850 nm, 780 nm Bit Rate: 9.8 Gb/s to 11.25 Gb/s	
		AOP @ ER $\geq$ 8.2 dB[7]	*(OMA)*[8]
		-12 dBm typical -10 dBm warranted[6]	-9.3 dBm typical -8.3 dBm warranted[6]
		850 nm, 780 nm Bit Rate: 11.25 Gb/s to 12.6 Gb/s	
		(AOP @ ER $\geq$ 8.2 dB)[7]	*(OMA)*[8]
		-9.5 dBm typical -8.5 dBm warranted[6]	-7.8 dBm typical -6.8 dBm warranted[6]
80C09	+7 dBm (5.0 mW), typical	-10.0 dBm (100 μW), typical -7.5 dBm, warranted	

Table 15: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (cont.)

Name	Characteristics		
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 $\geq$ 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 $\geq$ 8.2 dB)[7]	*(OMA)*[8]
		-10.5 dBm typical -7.5 dBm warranted[6]	-8.8 dBm typical -5.8 dBm warranted[6]
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	

Table 15: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (cont.)

Name	Characteristics	
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
Clock and data rise time and fall times[2]		
80C01	Serial DATA output	$<$ 30 ps
	Serial CLOCK output	$<$ 30 ps
80C02	Serial DATA output	$<$ 30 ps
	Serial CLOCK output	$<$ 30 ps
	1/16th CLOCK output	$<$ 300 ps
80C03	Serial DATA output	$<$ 30 ps
	Serial CLOCK output	$<$ 30 ps
80C04	Serial DATA output	$<$ 30 ps
	Serial CLOCK output	$<$ 30 ps
	1/16th CLOCK output	$<$ 300 ps
80C04-CR2	Serial CLOCK output	$<$ 30 ps
	1/16th CLOCK output	$<$ 300 ps
80C07	Serial DATA output	$<$ 30 ps
	Serial CLOCK output	$<$ 30 ps
80C07B	Serial DATA output	$<$ 150 ps
	Serial CLOCK output	$<$ 150 ps
80C08 80C08B 80C08C	Serial CLOCK output	$<$ 30 ps
	1/16th CLOCK output	$<$ 300 ps

Table 15: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (cont.)

Name	Characteristics	
80C09	Serial CLOCK output	$<$ 30 ps
	1/16th CLOCK output	$<$ 300 ps
80C11	Serial CLOCK output	$<$ 30 ps
	1/16th CLOCK output	$<$ 300 ps
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 2 MHz minimum 1 MHz typical	
80C11-CR4	4 MHz Maximum 1 MHz Minimum 2 MHz Typical	
✓ 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]

Table 15: Optical modules - Clock recovery options (CR, CR1, CR2, CR3, and CR4) (cont.)

Name	Characteristics	
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 $\geq$ 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**

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

therefore, the displayed waveform may normally exhibit :

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

[6]   **Sensitivity is only warranted for operating ambient temperatures below +30 $^{\circ}$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 $\geq$ 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 $\times$ 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 16: 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	1.13 kg (2.50 lbs) 1.34 kg (2.95 lbs) (with clock recovery)
80C02	0.95 kg (2.10 lbs) 1.22 kg (2.70 lbs) (with clock recovery)
80C03	1.13 kg (2.50 lbs) 1.34 kg (2.95 lbs) (with clock recovery)
80C04	0.95 kg (2.10 lbs) 1.22 kg (2.70 lbs) (with clock recovery)
80C05	0.95 kg (2.10 lbs)
80C06	0.95 kg (2.10 lbs)
80C07	1.13 kg (2.50 lbs) 1.34 kg (2.95 lbs) (with clock recovery)
80C07B	0.95 kg (2.10 lbs) 1.36 kg (3.0 lbs) (with clock recovery)
80C08	0.95 kg (2.10 lbs)
80C08B	0.95 kg (2.10 lbs) 1.22 kg (2.70 lbs) (with clock recovery)
80C08C	0.95 kg (2.10 lbs) 1.22 kg (2.70 lbs) (with clock recovery)
80C09	0.95 kg (2.10 lbs) 1.22 kg (2.70 lbs) (with clock recovery)
80C10	0.95 kg (2.10 lbs)

Table 16: Optical modules - Mechanical (cont.)

Name	Characteristics
80C11	0.95 kg (2.1 lbs) 1.22 kg (2.70 lbs) (with clock recovery)
Overall dimensions	Height: 25.6 mm (1.0 in) Width: 166.7 mm (6.5 in) Depth: 307.7 mm (12.0 in)

Table 17: 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)

Glossary

Accuracy
The closeness of the indicated value to the true value.

Analog-to-Digital Converter
A device that converts an analog signal to a digital signal.

Attenuation
A decrease in magnitude (for optical systems this is usually optical power) of a signal.

Autoset
A means of letting the instrument set itself to provide a stable and meaningful display of a given waveform.

Average Optical Power (AOP)
The time averaged measurement of the optical power over a much longer time period than the bit rate of the signal.

Bandwidth
The difference between the limiting frequencies of a continuous frequency spectrum. Bandwidth is the frequency at which the power out is one half the power out at a frequency near DC. The range of frequencies handled by a device or system. Bandwidth is a measure of network capacity. Analog bandwidth is measured in cycles per second. Digital bandwidth is measured in bits of information per second. See *Optical Bandwidth* on page 30.

Channel
A place to connect a signal or attach a network or transmission line to sampling heads. Also, the smallest component of a math expression. A transmission path between two or more stations.

Channel Number
The number assigned to a specific signal input connector. The top channel of the left-most sampling head compartment of the main instrument is always channel 1, regardless of any repositioning or omission of sampling heads.

Clock
A signal that provides a timing reference.

Common Mode
A circumstance where a signal is induced in phase on both sides of a differential network.

dB

Decibel: a method of expressing power or voltage ratios. The decibel scale is logarithmic. It is often used to express the efficiency of power distribution systems when the ratio consists of the energy put into the system divided by the energy delivered (or in some cases, lost) by the system. One milliwatt of optical power is usually the optical reference for 0 dBm. The formula for decibels is:

$$dB = 20 \log\left(\frac{Vi}{Vl}\right) \quad \text{for optical,} \quad dB = 10 \log\left(\frac{Po}{Pi}\right)$$

where V_i is the voltage of the incident pulse, V_l is the voltage reflected back by the load, P_o is the power out, P_i is the power in, and log is the decimal-based logarithmic function. See *Optical Bandwidth* on page 30.

dBm

A logarithmic measure of power referenced to 1 milliwatt (1 mW optical power = 0.0 dBm):

$$dBm = 10 \log\left(\frac{optical\ power}{1\ mW}\right)$$

Degradation

A deterioration in a signal or system.

Differential Mode

A method of signal transmission where the true signal and its logical compliment are transmitted over a pair of conductors.

Digital signal

A signal made up of a series of on and off pulses.

Digital transmission system

A transmission system where information is transmitted in a series of on and off pulses.

Extinction Ratio

The ratio of two optical power levels of a digital signal generated by an optical source. P_1 is the optical power level generated when the light source is high, and P_2 is the power level generated when the light source is low.

$$r_e = \frac{P_1}{P_2}$$

FEC: Forward Error Correction

Additional bits and/or coding added to a data stream to allow for automatic error detection and correction at the receiving end. These extra bits and/or coding tend to increase a serial data rate above the original non-FEC data stream in order to accommodate the extra information added by the FEC.

Fiber Optics
A method of transmitting information in which light is modulated and transmitted over high-purity, filaments of glass. The bandwidth of fiber optic cable is much greater than that of copper wire.

Impedance
The opposition to an AC signal in the wire. It's very much like resistance to a DC signal in a DC circuit. Impedance is made up of resistance and inductive and capacitive reactance.

Initialize
Setting the instrument main instrument to a completely known, default condition.

Internal Clock
An internally generated trigger source that is synchronized with the Internal Clock Output signal.

Mode
A stable condition of oscillation in a laser. A laser can operate in one mode (single mode) or in many modes (multimode).

Modulation
A process whereby a signal is transformed from its original form into a signal that is more suitable for transmission over the medium between the transmitter and the receiver.

Multimode Cable
A thick cored optical fiber (compared to single mode cable) that can propagate light of multiple modes.

OMA (Optical Modulation Amplitude)
The difference between the average power levels of the logic 1 level, High, and the logic 0 level, Low, of the optical pulse signal. The levels are the Means of the logical levels sampled within an Aperture of the logical 1 and 0 regions of the pulse. The logical 1 and 0 time intervals are marked by the crossings of a reference level determined as the Average Optical Power (AOP) of the signal.

Protocol
Formal conventions that govern the format and control of signals in a communication process.

Recovered Clock
A clock signal derived from and synchronous with a received data sequence.

Setting
The state of the front panel and system at a given time.

Single-Mode Cable

An optical cable with a very small core diameter (usually in the range of 2-10 microns). Such cables are normally used only with laser sources due to their very small acceptance cone. Since the cone diameter approaches the wavelength of the source, only a single mode is propagated.

Trigger

An electrical event that initiates acquisition of a waveform as specified by the time base.

Waveform

The visible representation of an input signal or combination of signals.

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