80C14
Optical Sampling Module

User Manual

071-2955-00

Tektronix

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www.tektronix.com
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Contacting Tektronix

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For product information, sales, service, and technical support:

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

Warranty

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of three (3) years from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Parts, modules and replacement products used by Tektronix for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Tektronix.

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

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

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[W4 – 15AUG04]

Table of Contents

List of Figures

List of Tables

General Safety Summary

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

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

Only qualified personnel should perform service procedures.

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

To Avoid Fire or Personal Injury

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

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

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

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

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

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

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

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

Do not operate in wet/damp conditions.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry.

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

Terms in This Manual

These terms may appear in this manual:

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

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

Symbols and Terms on the Product

These terms may appear on the product:

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

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

CAUTION
Refer to Manual

Protective Ground
(Earth) Terminal

Environmental Considerations

This section provides information about the environmental impact of the product.

Product End-of-Life Handling

Observe the following guidelines when recycling an instrument or component:

Equipment Recycling. Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. In order to avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.

This symbol indicates that this product complies with the applicable European Union requirements according to Directives 2002/96/EC and 2006/66/EC on waste electrical and electronic equipment (WEEE) and batteries. For information about recycling options, check the Support/Service section of the Tektronix Web site (www.tektronix.com).

Restriction of Hazardous Substances

This product has been classified as Monitoring and Control equipment, and is outside the scope of the 2002/95/EC RoHS Directive.

Preface

This manual for the 80C14 Optical Sampling Module includes the following information:

- Key features
- How to install the module
- How to control signal acquisition, processing, and input/output of information

Go to the Tektronix manuals Web site (www.tek.com/manuals) to locate the latest version of this document.

Specifications

Specifications are located in the specifications and performance verification document for your main instrument. You can download these manuals from the Tektronix Web site (www.tek.com/manuals).

To meet measurement specifications:

- The instrument was calibrated/adjusted at an ambient temperature between +20 °C and +30 °C.
- The instrument has been operating continuously for 20 minutes within the operating temperature range specified.
- Vertical compensation has 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 the specifications.

Manual Structure

This manual contains 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.

Related Documentation

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

Getting Started

The 80C14 Series Optical Sampling Module is a high-performance optical module that supports high bandwidth telecom and datacom standards including 16 GFC Fibre Channel and 14.063 Gb/s Infiniband. The 80C14 Series module is compatible with the following instruments (mainframes):

- DSA8300 Digital Serial Analyzer
- DSA8200 Digital Signal Analyzer
- CSA8000, CSA8000B, and CSA8200 Communications Signal Analyzers
- TDS8000, TDS8000B, and TDS8200 Digital Sampling Oscilloscopes

Instrument Requirements

- TekScope application software version 5.1 or greater. Select **Help > About** from the TekScope application Help menu to show your current version.
- Microsoft Windows XP operating system.

Contact Tektronix Customer Support for information on how to upgrade your instrument to meet these requirements.

Module Features

Table 1 lists the 80C14 optical module features. (See Table 1 on page 2.)

A figure in the *Operating Basics* section shows the module controls, connectors, and indicators. (See Figure 3 on page 9.)

Table 1: 80C14 module features

Feature	Description [1]
Number of input channels	1
Effective wavelength range	700 nm to 1650 nm
Supported standards or data filtering rates	8GFC (8.500 Gb/s) OC-192/STM-64 (9.953 Gb/s) 10GBase-W (9.953 Gb/s) 10GBase-R (10.31 Gb/s) 40GBase-R4 (10.31 Gb/s) 100GBase-SR10 (10.31 Gb/s) 10GFC (10.52 Gb/s) ITU-T G.975 FEC (10.664 Gb/s) ITU-T G.709 (10.709 Gb/s) 10 GbE FEC (11.1 Gb/s) 10GFC FEC (11.3 Gb/s) Super FEC (12.5 Gb/s) 16GFC (14.025 Gb/s) 14G Infiniband FDR (14.0625 Gb/s)
Typical optical bandwidth at optical connector	> 14 GHz
Clock recovery support	Clock recovery supported with the use of the CR175A or CR286A Clock Recovery instrument (purchased separately)
Absolute maximum nondestructive optical input [2]	4 mW average power (850 nm) 2 mW average power (1350 nm, 1550 nm) 10 mW peak power for 60 ms.
Internal fiber diameter	62.5 mm/125 µm multimode mode [3]
Optical return loss	> 14 dB for multimode fiber > 24 dB for single-mode fiber
Output zero	< 1 µW 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 nondestructive levels may exceed saturation and compression limits of the module.

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

Options and Accessories

This section lists the standard and optional accessories available for the sampling modules.

Standard Accessories

The following accessories are shipped with the module:

Table 2: Standard accessories

Item	Part number
Certificate of Traceable Calibration for product at first shipment	Not orderable
SMA male 50 Ω termination (installed, one for each buffered electrical output connector)	015-1022-XX
Fiber cleaning kit	020-2494-XX

Options

The following table lists available sampling module options:

Table 3: Available 80C14 options

Option	Description
Option C3	Three years of calibration service
Option C5	Five years of calibration service
Option D1	Calibration data report
Option D3	Three years of calibration data reports (requires Opt. C3)
Option D5	Five years of calibration data reports (requires Opt. C5)
Option R3	Extended repair warranty to three years
Option R5	Extended repair warranty to five years

Optional Accessories

You can order the following accessories for use with the sampling modules:

Table 4: 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, APC-108	119-5115-XX
SMA 2.5 UCI adapter	119-4517-XX
SC/PC UCI adapter	119-5116-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

Table 4: Optional accessories (cont.)

Item	Part number
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
CSA8000 & TDS8000 Series Service Manual	071-0438-XX
DSA8200 Service Manual	071-2049-XX
80C14 Series Optical Sampling Module User Manual (this document)	071-2955-XX

See the Tektronix Web site for the current list of optional accessories.

Installation

Electrostatic Discharge

CAUTION. *The electrical data outputs on the optical module are subject to damage from electrostatic discharge (ESD). To prevent damage from electrostatic discharge, observe the followig guidelines:*

Store the module, with the supplied SMA terminations installed, 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.

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).

Always use a grounded wrist strap (provided with your instrument) when installing, removing, or 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.

Circuitry in the optical module is very susceptible to damage from overdriven signals. Verify that the optical signal is within acceptable power levels for the module before connecting the signal to the module.

Correct Module Handling Guidelines

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

Never install or remove a module when the instrument is powered on (front-panel On/Standby power switch is ON).

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

Place the protective cap(s) on the optical and electrical input connectors 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.

Check that all connectors, jumpers, and protective caps are clean before connecting them to the module. (See page 16, Cleaning the Optical Connectors.)

Module Locations

The optical modules fit in the large upper module slots in supported instruments, such as the DSA8300. The large compartments support single channel modules, while the small compartments support single or dual channel modules. Eight of the 10 inputs are usable at one time. (See Figure 1.)

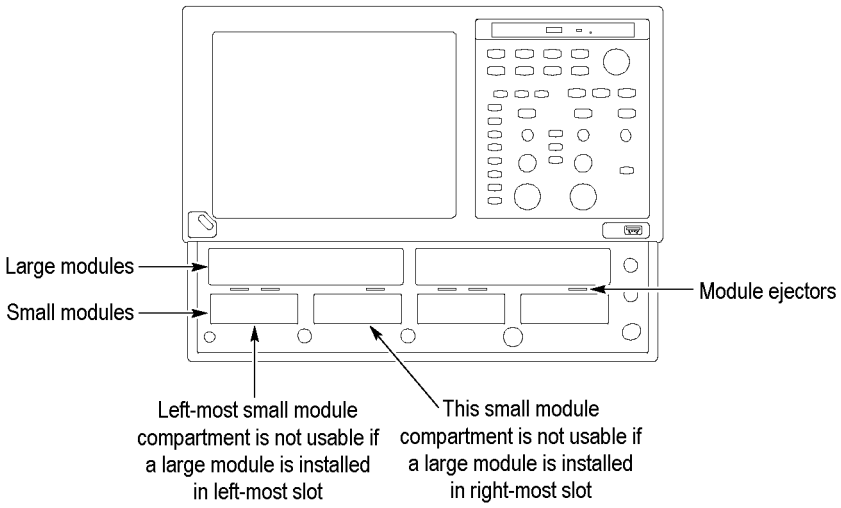


Figure 1: Module compartments

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

NOTE. *Installing a large module in either large compartment disables some of the small compartment channels. Refer to the instrument Online Help about compartment interaction.*

Installing a Module

1. Power off the instrument using the front-panel On/Standby power switch.
2. Plug the grounding strap into the instrument ground connector, and place the ground strap on your wrist, with contact to skin.
3. Turn the hold-down screws all the way counterclockwise so that they are completely out and the module retaining tab is flush with the edge of the module.
4. Insert the module into a compartment and slowly push it in with firm pressure until it is seated.
5. Turn the hold-down screws clockwise to lock the module in place.
6. Once you have installed the module, power on the instrument. Verify that the module passes power-on tests.

NOTE. *After first installing a sampling module(s) or after moving a sampling module from one compartment to another, and after the 20-minute instrument warm-up period, select* ***Utilities > Compensation*** *to run the compensation tool to ensure optimum measurement accuracy. You must also run a compensation if an extender is installed, changed, or removed from a module. (See page 12, Optimizing Measurement Accuracy.)*

After running Compensation, save the new values to retain them; otherwise they are lost when powering off the instrument.

Removing a Module

1. Power off the instrument using the front-panel On/Standby power switch.
2. Plug the grounding strap into the instrument ground connector, and place the ground strap on your wrist, with contact to skin.
3. Turn the hold-down screws all the way counterclockwise so that they are completely out and the module retaining tab is flush with the edge of the module.
4. Slide the appropriate large module ejector lever sideways to unseat the module from the mainframe connector.
5. Pull on the hold-down screws to remove the module from the slot.
6. Handle the module appropriately (move to another slot in the instrument or place in a static-protected environment to transport or store the module).

Operating Basics

This section contains optical module signal connection and operation information.

Usage

Handle your optical module carefully at all times.

Connecting Optical Signals

Take care to preserve the integrity of the connectors by keeping them free of contamination. (See page 16, *Cleaning the Optical Connectors*.)

The input of the 80C14 module can couple to any single-mode dimension or multimode dimension not exceeding a core diameter/cladding diameter of 62.5/125 mm. Use UCI (universal connector interface) series adapters to couple alternate cable types to the optical module. Refer to the Tektronix Web site for details.

Attach the fiber optic cable to the optical input receptacle as follows:

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 can damage the UCI adapter.*

1. Line up the key with the slot in the UCI adapter before inserting.

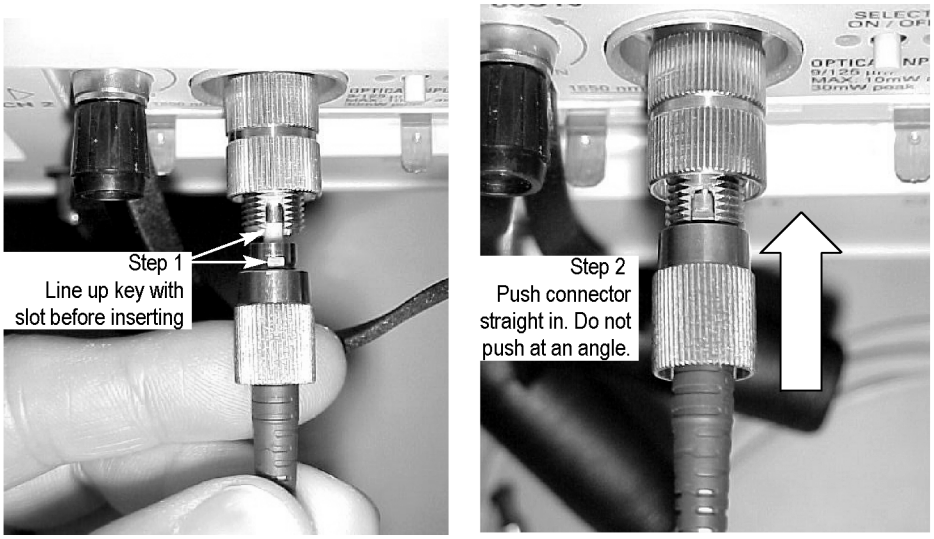


Figure 2: Connecting optical cables correctly

2. Firmly push the cable connector or adapter into the interface ferrule until it reaches the stop. Do not twist the cable while inserting.

3. Firmly tighten the cable connector or the adapter shell. Tighten with finger pressure only.
4. To remove, loosen the cable connector or adapter shell.

Attenuating Optical Signals

You may need to attenuate the optical input power to an appropriate level for the module. The 80C14 absolute maximum optical signal levels are:

- 4 mW average optical power at 850 nm
- 2 mW average optical power at 1350 nm and 1350 nm
- 10 mW peak at wavelength of highest responsivity

CAUTION. *To avoid damaging the optical input of the module, attenuate the input optical signal to the absolute maximum optical signal levels listed above.*

NOTE. *The 80C14 module can have a somewhat deteriorated response for signals greater than 800 $\mu W_{p\text{-}p}$ (1310 nm and 1550 nm) and 1300 $\mu W_{p\text{-}p}$ (850 nm).*

NOTE. *Optical sampling modules may have dynamic ranges exceeded without obvious visual indication on the waveform because the overloaded signal output of the photodetector may still be within the dynamic range of the internal electrical sampler. To ensure accurate measurements, make sure that input signal levels are within valid ranges for the module.*

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 following figure shows the 80C14 front panel. (See Figure 3.)

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 push the channel button and the channel is not being acquired (for any channel or math waveform), then the instrument activates (turns on) the channel.
- If you push the button and the channel is active as a channel waveform, then the instrument selects the channel waveform.
- If the channel waveform is already selected when you push the channel button, the instrument turns the channel off.

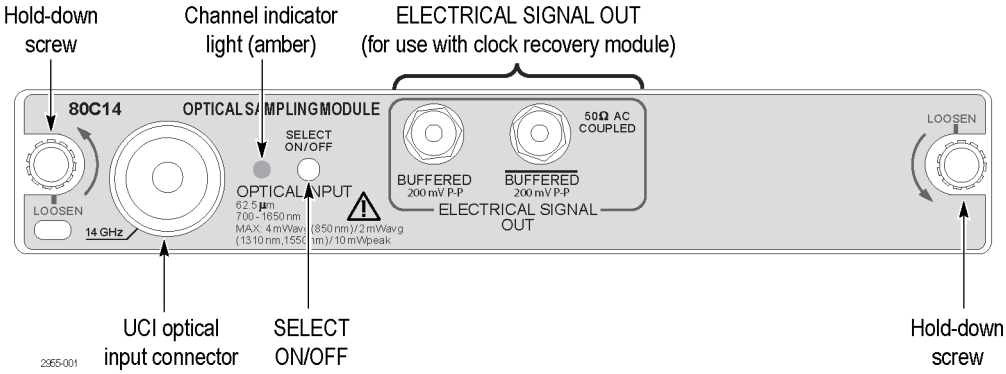


Figure 3: 80C14 optical module front panel

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. Go to www.tek.com to download the latest catalog.)

Outputs

The 80C14 module provides buffered electrical signal outputs. For clock recovery purposes, route this signal to the input of an CR175A or CR286A Electrical Clock Recovery instrument.

CAUTION. *Electrostatic discharge (ESD) will cause permanent damage to electrical outputs. Adhere to standard ESD handling precautions when using the outputs. In particular, make sure to discharge to ground any cables or connectors before attaching them to the BUFFERED outputs. To discharge a cable, touch the center pin of the coaxial cable to a grounded conductor (such as the outside ground conductor of the coaxial data output connector) just before connecting the cable to the module.*

NOTE. *Use 50 Ω terminations, provided with your optical module, on all unused electrical outputs.*

Hold-Down Screws

Hold-down screws attach the module to the main instrument. Once the hold-down screws are loosened, use the module slot 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.

NOTE. *Do not pull on module connectors to remove a module; always use the hold-down screws to pull the module out far enough for you to hold the module and remove it from the instrument.*

Commands from the Main Instrument Front Panel

The Vertical Setup dialog box lets you toggle between the basic and optical module controls. (See Figure 4.) The DSA8300 controls are similar.

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 is found in the Online Help of your instrument.

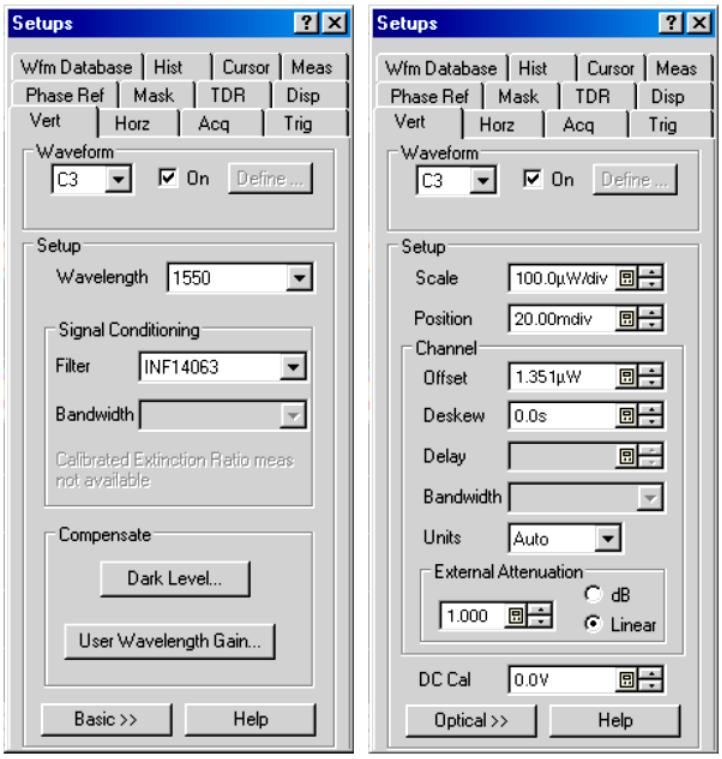


Figure 4: Vertical Setup dialog boxes (DSA8200)

Programmer Interface Commands

The remote programming commands for all sampling modules are documented in the *Programmer Guide* accessible 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 *Online Help* for your main instrument.

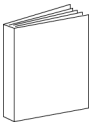
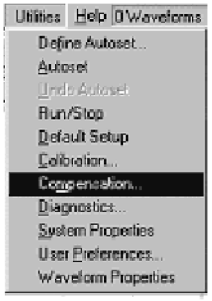
Optimizing Measurement Accuracy

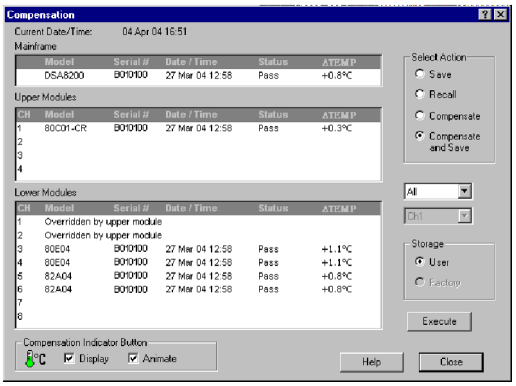
Performing the following procedures to increase (or maintain) the measurement accuracy of the optical module:

- Run Vertical Compensation
- Clean the Optical Connectors
- Run Dark-Level and User Wavelength Gain Compensations

Perform Vertical Compensation

Performing a vertical compensation optimizes the accuracy of automatic measurements. This procedure uses internal routines to optimize the signal vertical offset, gain, and linearity.

Overview	Step	Control elements and resources
Prerequisites	**1.** The instrument must have the sampling module(s) to be compensated installed. 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) unless directed otherwise by on-screen instructions. **3.** Power on the instrument and allow a 20-minute warm-up before doing this procedure.	 See the instrument user documentation and online help for details on operating the instrument controls.
Access the compensation routines	**4.** Select **Utilities > Compensation** from the application menu bar.	

Overview	Step	Control elements and resources
Select what to compensate	**5.** The Compensation dialog box lists the main instrument (mainframe) and installed sampling modules. The temperature change from the last compensation is also listed. **6.** Wait until the Status for all items changes from **Warm Up** to **Pass**, **Fail**, or **Comp Req'd**.	
Save compensation values	**7.** Under Select Action, click **Compensate and Save**.	
Select what to compensate	**8.** Select what to compensate: ■ **DSA8200**: From the top pulldown list, choose **All** (default selection) to compensate the main instrument and all installed modules . ■ **DSA8300**: You will need to run two compensations to compensate the mainframe and all modules. Select **Mainframe** and run the compensation, then select **All Modules** and run the compensation.	
Run compensation	**9.** Click **Execute** to begin the compensation. **10.** Follow any on-screen instructions to disconnect inputs and install terminations; 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.	
Compensation fail actions	**12.** If **Fail** appears as the**Status**, rerun the compensation. If **Fail** status continues after rerunning compensation, and the instrument has passed the 20-minute warm-up period, the module or main instrument may need service. Contact Tektronix Customer Service.	
Save compensation values	**13.** Click the **Save** option button under Select Action. Click the **Execute** button to save the compensation values. ■ Make sure to save the compensation values. In-memory compensation values are lost when you power off the instrument.	

Perform Dark-Level and User Wavelength Gain Compensations

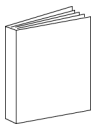
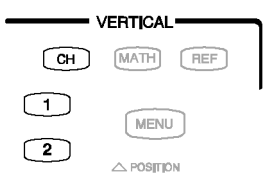
Perform a dark-level compensation to maximize the accuracy of the extinction ratio and other optical automatic measurements. Perform a User Wavelength Gain compensation to optimize an optical channel to your custom input signal.

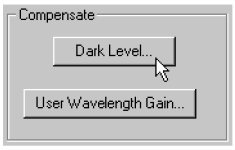
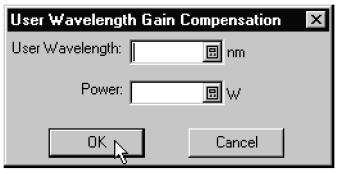
Use the following procedure to perform either compensation.

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

This procedure applies only to optical modules.

NOTE. *This procedure shows images from the DSA8200 instrument user interface. The DSA8300 UI, although different in appearance, has a similar UI layout as the DSA8200 for most functions.*

Overview	To perform optical compensations	Control elements and resources
Prerequisites	**1.** Install the optical sampling module in the instrument. Set the acquisition system to run continuously.	 See the instrument user documentation and online help for details on operating the instrument controls.
Select the waveform	**2.** Use the Vertical buttons to select the channel to compensate.	
Access the dark-level compensation	**3.** Click **Setup > Vertical**.	

Overview	To perform optical compensations	Control elements and resources
Run the dark-level compensation	**4.** Click the **Dark Level** button under Compensation. Follow the on-screen instructions. **5.** Repeat steps 2 through 4 for any additional optical channels that you want to compensate. If any of the following settings or conditions change after performing a dark level compensation, perform another compensation to maintain the specified accuracy. ■ Trigger rate setting ■ Vertical offset setting ■ Filter or bandwidth setting ■ Ambient temperature change of more than 1 °C	
Run the user wavelength gain compensation	You can optionally use a custom input signal to compensate an optical channel: **6.** In the Vert Setup dialog box, click the **User Wavelength Gain** button under Compensation. Follow the instructions on screen. ■ In the User Wavelength Gain Compensation dialog box, set the wavelength and power of the signal to be applied to the channel. **7.** You must connect an optical signal to the module input with a precisely known amount of optical power. Use an independently calibrated average optical power meter to precisely measure this power. Then connect the signal to the module using the same fiber cables. **8.** Click the **OK** button to execute the compensation. **9.** Repeat steps 2, 6, and 7 for any additional optical channels that you want to compensate.	 

Cleaning

Exterior

The case of the module keeps dust out and should not be opened. Confine cleaning to the front panel of the module. To clean the case, remove the module from the main instrument but first read the entire *Installation* procedure for proper handling of the module. (See page 4.)

WARNING. *To prevent injury, power off 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 in this instrument. Use a 75% isopropyl alcohol solution as a cleaner and rinse with deionized water. Use only deionized water when cleaning the menu buttons or front-panel buttons. Before using any other type of cleaner, consult your Tektronix Service Center or representative.*

Interior

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

Cleaning the 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.*

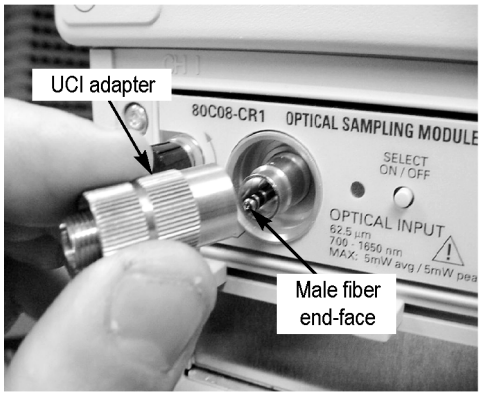
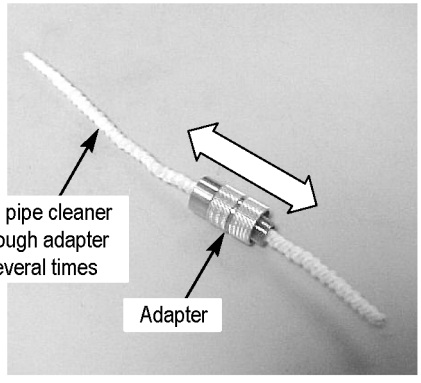
To reduce the need for cleaning, immediately replace protective caps on the optical connectors when not in use.

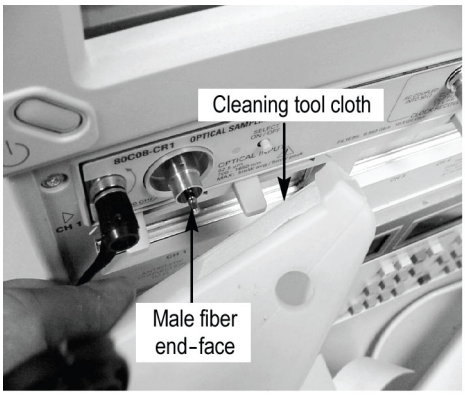
Use the following items to clean optical connectors:

- Dry, clean, and dust-free compressed air
- Fiber cleaning cassette and/or tape dispenser cleaner
- Pipe cleaner

CAUTION. *Clean both ferrule endfaces with a dry cloth tape cleaner (cassetted or in a dispenser).*

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 020-2494-XX) are available from several suppliers.
Remove UCI adapter	**2.** Loosen the UCI adapter and remove it. This exposes the male fiber end-face behind the UCI connector.	
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.*	

Overview	To clean the optical connectors	Related information
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.** Place the UCI adapter back on the cleaned fiber end-face.	
Dust cap	**7.** When the module does not have a fiber attached to its input(s), attach the black dust-cap to prevent airborne contaminates from lodging in the female optical input.	
Clean attaching devices	**8.** Clean any male fiber end-face input fiber or device that you attach to the UCI input.	Use a similar cleaning method to clean the fiber end-face input fiber or device.

Reference

This section describes available filter selections, how to enable clock recovery, and explains optical bandwidth.

Wavelength, Filter, and Bandwidth Selection

See Table 1 for available wavelength, filter, and bandwidth information. (See Table 1 on page 2.)

To select the optical wavelength, use the Vertical Setups menu. (See Figure 4 on page 11.)

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 *Online Help* for your main instrument.

Clock Recovery

The 80C14 module comes standard with a buffered electrical signal output that, when routed to a CR175A or CR286A Clock Recovery instrument, provides a recovered clock signal. Refer to the CR175A or CR286A instrument user documentation for triggering information.

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. The frequency dependent response of a system is typically described using a logarithmic decibel scale. 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:

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

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

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

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 V(DC).

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

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

For the Tektronix 8000 series sampling oscilloscopes, 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:

$$dB = 10\ log\left(\frac{.05}{response\ at\ DC}\right) = -3\,dB$$

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, 65 GHz, and 80 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).

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 page 19, *Optical Bandwidth*.)

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:

$$dB = 20\ log\left(\frac{V_i}{V_l}\right) \quad for\ optical,\ db = \left(\frac{P_o}{P_i}\right)$$

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, and P_i is the power in. (See page 19, *Optical Bandwidth*.)

dBm

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

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 nonFEC data stream 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. Impedance is very much like resistance to a DC signal in a DC circuit. Impedance is made up of resistance, 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.

Index

T

U

V

W