Instruction Manual

Tektronix

OCP 5002 and OCP 5502
Optical Converters/Power Meters

070-7817-02

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

CE

Instrument Serial Numbers

Each instrument manufactured by Tektronix has a serial number on a panel insert or tag, or stamped on the chassis. The first letter in the serial number designates the country of manufacture. The last five digits of the serial number are assigned sequentially and are unique to each instrument. Those manufactured in the United States have six unique digits. The country of manufacture is identified as follows:

B010000	Tektronix, Inc., Beaverton, Oregon, USA
E200000	Tektronix United Kingdom, Ltd., London
J300000	Sony/Tektronix, Japan
H700000	Tektronix Holland, NV, Heerenveen, The Netherlands

Instruments manufactured for Tektronix by external vendors outside the United States are assigned a two digit alpha code to identify the country of manufacture (e.g., JP for Japan, HK for Hong Kong, IL for Israel, etc.).

Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077

Printed in U.S.A.

WARRANTY

Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

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; or c) 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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EC Declaration of Conformity

We

Tektronix Holland N.V.
Marktweg 73A
8444 AB Heerenveen
The Netherlands

declare under sole responsibility that the

OCP5002 and OCP5502 Optical Converters/Power Meters

meets the intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 55011 Class A Radiated and Conducted Emissions

EN 50082-1 Immunity:

- IEC 801-2 Electrostatic Discharge Immunity
- IEC 801-3 RF Electromagnetic Field Immunity
- IEC 801-4 Electrical Fast Transient/Burst Immunity

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About This Manual

This manual describes how to operate and maintain the OCP5002 and OCP5502 Optical Power Meters. The information is organized into eight chapters:

Chapter 1: General Information describes the features of the OCP5002 and OCP5502 and tells you how to prepare the instruments for operation. Chapter 1 also lists the standard accessories, optional accessories, and options available with the OCP5002 and OCP5502 and provides general safety information.

Chapter 2: Front Panel Operation explains how to operate the OCP5002 and OCP5502 using the front panel controls. An overview of front panel operation is followed by a reference section and a summary chart.

Chapter 3: Typical Applications provides examples of typical applications for the OCP. These examples include eye pattern analysis, FDDI mask tests, and system reflection measurements.

Chapter 4: Acceptance Tests provides tests that allow you to verify that the OCP is operating within the specifications listed in Chapter 7.

Chapter 5: Maintenance and Troubleshooting explains how to perform routine maintenance procedures such as cleaning the optical input connector or changing the connector to match your fiber connector type. Chapter 5 also describes how to determine if a problem you encounter is an instrument failure or an operation error.

Chapter 6: GPIB Commands describes the IEEE 488.2 Standard commands and OCP unique commands that control the instrument via the general-purpose interface bus (GPIB). The information in this chapter is primarily intended as a reference source; we assume you are familiar with GPIB controllers and software.

Chapter 7: Specifications lists the specifications of the OCP5002 and OCP5502.

Chapter 8: Replaceable Parts lists the OCP's replaceable parts. Use this information to order parts from your local Tektronix sales engineer.

Appendix A: GPIB Error Codes lists the error codes that can result when using the GPIB. Use these codes to debug GPIB software.

Appendix B: Diagnostic Error Codes lists the error codes encountered when running diagnostics on the OCP. Use these codes to determine if you have an instrument failure or an operation error.

If you want to

Make simple, manually-controlled power readings, read Chapters 1 and 2.

Make automated power readings, read Chapter 6.

Perform a more complete analysis of an optical system, read Chapter 3.

Verify that your instrument is operating within specifications, read Chapter 4.

Determine if you have problems with your instrument, read Chapter 5.

Conventions Used in This Manual

This manual represents literal characters such as button names and readout values in bold capital letters. For example, a key with the name AUTO above it would be referred to as **AUTO**.

OCP refers to both the OCP5002 and the OCP5502.

O/E Converter is the abbreviated form of Optical-to-Electrical Converter.

GPIB refers to the general-purpose interface bus.

IEEE 488.2 is the interface standard established by the Institute of Electrical and Electronic Engineers.

This manual includes the following three types of supplemental information.

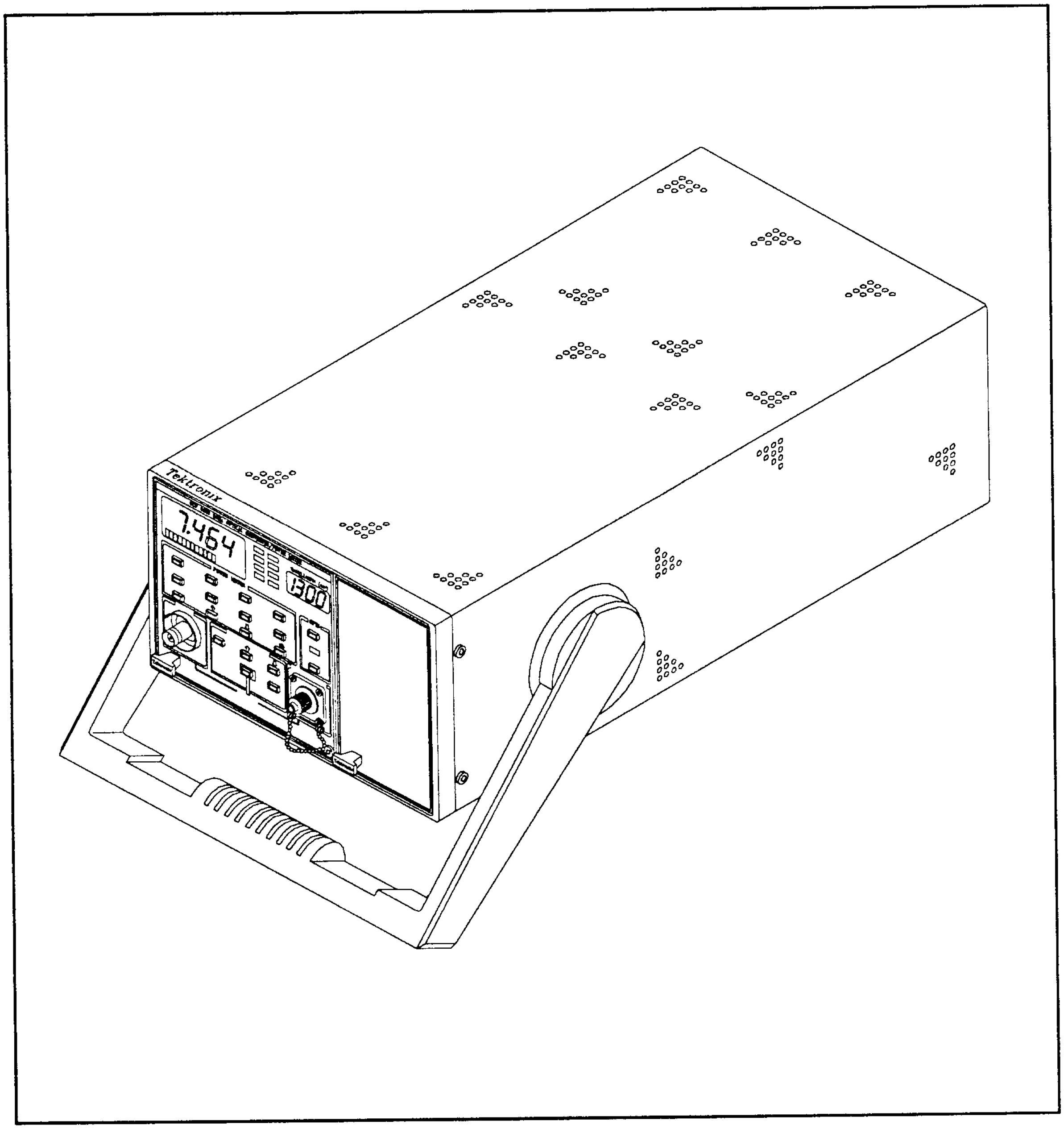
• ***Note*** *Notes include information that helps you use the OCP better.*

>>***Caution***

These statements call attention to practices that could cause damage to the instrument.

WARNING

These statements call attention to practices that could lead to personal injury or death.



The OCP5502 Optical Power Meter.

Chapter 1: General Information

Chapter 1 describes the OCP5002 and OCP5502 and explains how to prepare the OCP for operation. This chapter also lists the standard accessories, optional accessories, and options and provides general safety information.

PRODUCT DESCRIPTION

The OCP5002 and OCP5502 are functionally identical instruments and for simplicity will be referred to hereafter as the OCP except where differentiation is necessary. The OCP is a high-performance optical power meter that features a built-in O/E converter. The OCP5002 operates in a Tektronix TM5000 Series Power Module while the OCP5502 has a stand-alone power supply. (The frontispiece shows an OCP5502.)

The OCP5502 Power Module has an additional slot for adding other test equipment, such as the Tektronix OIG502 Optical Impulse Generator. This slot is covered with a blank plate. The "Getting Started" section of this chapter describes how to remove the blank plate and install an additional instrument.

The OCP includes features that let you

- Measure average optical power from +7 dBm to -80 dBm with a resolution of .01 dB. You can make these power measurements in Watts, dBm (1 mW reference), or dBref (user-defined reference). The OCP automatically matches the measurement range to the optical power applied at the input.
- Measure optical power of sources that generate wavelengths from 1100 to 1650 nm. The power meter displays the average power automatically. The O/E converter displays a conversion factor for converting the output voltage into a corresponding power level.
- Measure up to 2 GHz bandwidth using the O/E converter output. The DC offset feature extends the usable dynamic range of the O/E converter.
- Nullify drift of the O/E converter using the DC Stable feature. This feature minimizes the need to zero the O/E converter.
- Configure the OCP to accept FC/PC, ST/PC, or DIN 47256 optical connectors. Chapter 5 describes how to change the optical connectors. Options are also available for Biconic and SMA906 connectors.
- Use the GPIB feature to make remotely-controlled optical measurements in hazardous environments or write GPIB programs that allow non-technical personnel to test optical instruments. The OCP conforms to the IEEE 488.2 standard. Chapter 6 provides information about the GPIB commands.
- Control the O/E converter offset with a Tektronix oscilloscope that supports the TEKPROBE® Interface. The offset value is displayed on the oscilloscope screen.

ACCESSORIES AND OPTIONS

The following section describes the accessories and options available for the OCP. To order accessories from your local Tektronix sales representative, use the parts list in Chapter 8.

Standard Accessories

The OCP comes with two standard accessories:

- One Instruction Manual
- One package containing field-installable bulkhead adapters for FC, DIN, and ST optical connector types with dust covers for each

• *Note* *The OCP comes with the FC/PC adapter installed. Chapter 5 describes how to change bulkhead adapters.*

Optional Accessories

Four optional accessories are available for the OCP:

- Multimode optical fiber, two-meter, 62.5 μm, with FC/PC-to-SMA906 connectors
- Multimode optical fiber, two-meter, 62.5 μm, with FC/PC-to-Biconic connectors
- Multimode optical fiber, two-meter, 62.5 μm, with FC/PC-to-FC/PC connectors
- TEKPROBE® Interface Cable

•*Note:* *To extend the life of the OCP Power Meter* ***OPTICAL INPUT*** *connector, use one of the preceding optical fiber jumpers. These jumpers reduce the possibility of scratching the surface of the internal OCP fiber when making connections to the instrument.*

Options

The OCP5502 may be ordered as the following options:

• *Note* *When one of these options is ordered, the OCP5502 voltage selector is factory-set to the correct line voltage and the appropriate power cord is included.*

Option A1	220 VAC operation with European line plug
Option A2	240 VAC operation with UK line plug
Option A3	220 VAC operation with Australian line plug
Option A4	240 VAC operation with North American line plug
Option A5	220 VAC operation with Swiss line plug

SAFETY SUMMARY

The general safety information in this summary is for operating and service personnel. Specific warnings and cautions may be found throughout the manual where they apply and do not appear in this summary.

Terms Used in This Manual

>>***Caution***

These statements call attention to practices that could cause damage to the instrument.

WARNING

These statements call attention to practices that could lead to personal injury or death.

Terms Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible or a hazard to property including the instrument itself.

DANGER indicates a personal injury hazard immediately accessible.

GENERAL SAFETY INFORMATION

To avoid injury or equipment damage, observe the following safety practices.

Optical Input

To avoid eye injury, do not look directly into the end of an optical fiber when connecting it to the OCP **OPTICAL INPUT**. The output of the optical source may not be in the visible light spectrum.

Power Source

The OCP5002 operates in a Tektronix TM5000 Series Power Module. To avoid personal injury or damage to the instrument, do not operate the OCP5002 with any other power source.

The OCP5502 operates on 110, 120, 220, or 240 VAC line voltage and 50 or 60 Hz line frequency. To change operating voltage, see the "Getting Started" section in this chapter.

Grounding

To maintain proper grounding of the OCP5002, operate the power module according to the instructions provided in the Power Module instruction manual.

To maintain proper grounding of the OCP5502, use the power cord supplied with the instrument and use a properly grounded AC outlet.

Danger from Loss of Ground

All accessible conductive parts (including controls that appear to be insulated) can cause electric shock upon loss of ground connection.

Explosive Atmospheres

To avoid explosion, do not operate this instrument in an explosive atmosphere unless it has been specifically certified for such operation.

Operating Environment

For safe operation, operate this instrument in an environment compatible with the instrument and power module environmental specifications. To prevent instrument damage or fire, do not spill any liquids into the instrument.

Covers and Panels

To avoid personal injury or damage to the instrument, do not remove the instrument's covers or panels or operate the instrument without covers and panels in place.

GETTING STARTED

This section tells you how to prepare the OCP5002 and OCP5502 for operation.

OCP5002

The OCP5002 is designed to operate in two plug-in slots of a Tektronix TM5000 Series Power Module.

Caution

To prevent possible instrument damage, turn the Power Module off before intserting the OCP5002.

Install the OCP5002 only in the first two (leftmost facing the mainframe) slots of the Power Module. Installing the OCP5002 in any other slots will damage the OCP5002.

Figure 1-1 shows how to install the OCP5002 into the Power Module. Align the top and bottom grooves of the OCP5002 with the rails of the Power Module and slide the OCP5002 in until the instrument's front panel is flush with the Power Module cabinet.

To remove the OCP5002, grasp the release lever and pull the instrument out.

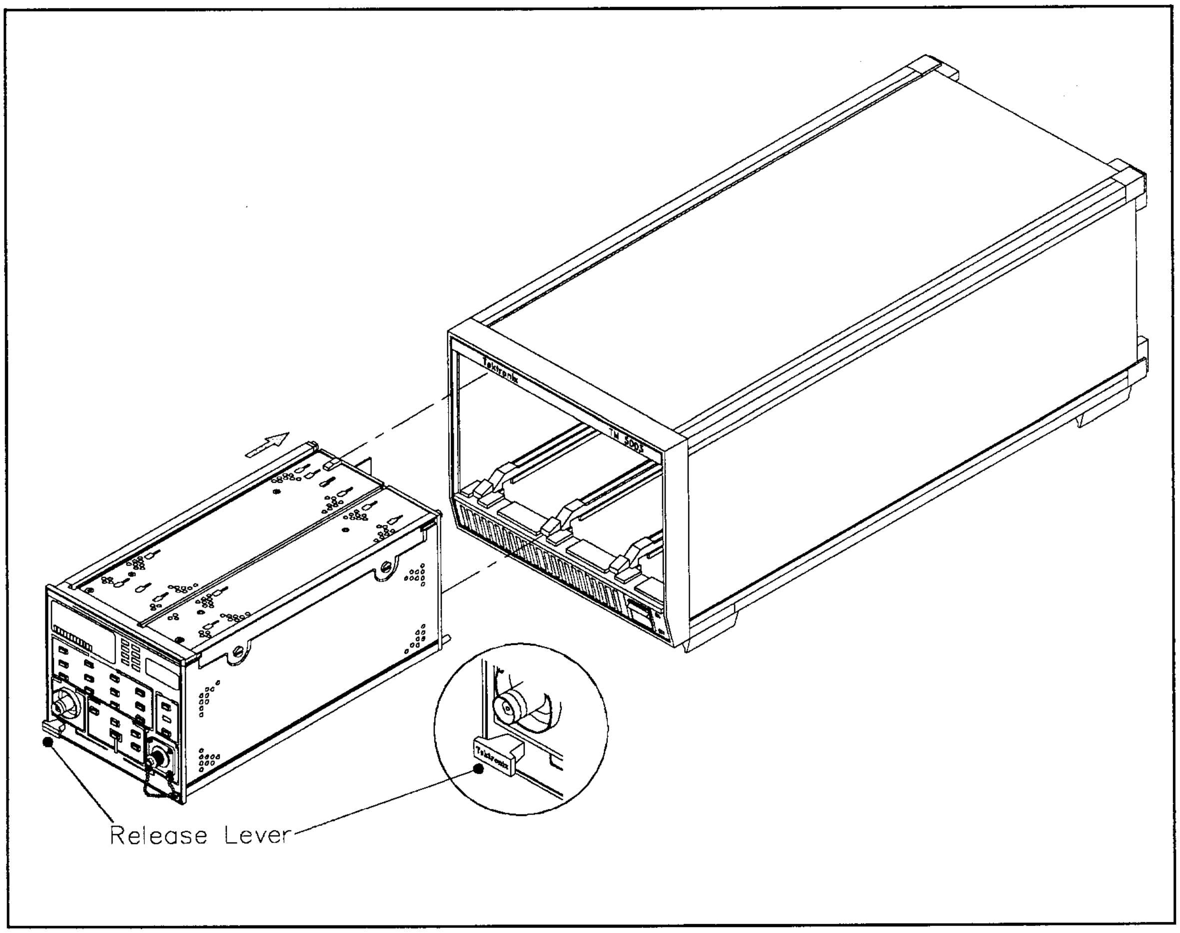


Figure 1-1. Installing the OCP5002 into the Power Module.

OCP5502

The OCP5502 uses a stand-alone power supply and requires no installation. Chapter 5 describes how to remove the OCP from the power supply.

Voltage Selector

The OCP5502 can be operated at 110 VAC, 120 VAC, 220 VAC, or 240 VAC by setting the voltage selector to the correct line voltage. Figure 1-2 shows the location of the voltage selector. To change the operating voltage, perform these steps.

1. Disconnect the power cord from the power source.
2. Push the latch/release bar up and pull the voltage selector assembly out.
3. Pull the fuse block from the voltage selector assembly and check the fuse value. Use a 1 amp fuse for 110 or 120 volt operation and a 0.5 amp fuse for 220 or 240 volt operation.
3. Rotate the fuse block so that the correct line voltage will appear in the selection window.
4. Reinstall the fuse block into the selection window and push the voltage selector back into the instrument until it snaps into place.
5. Verify that the voltage shown in the selection window is correct for the line voltage available. If it is not correct, repeat steps 3 and 4.
6. Connect the instrument line cord to the power source and turn the instrument on. If you need to use a different power cord, see "Options" in this chapter.

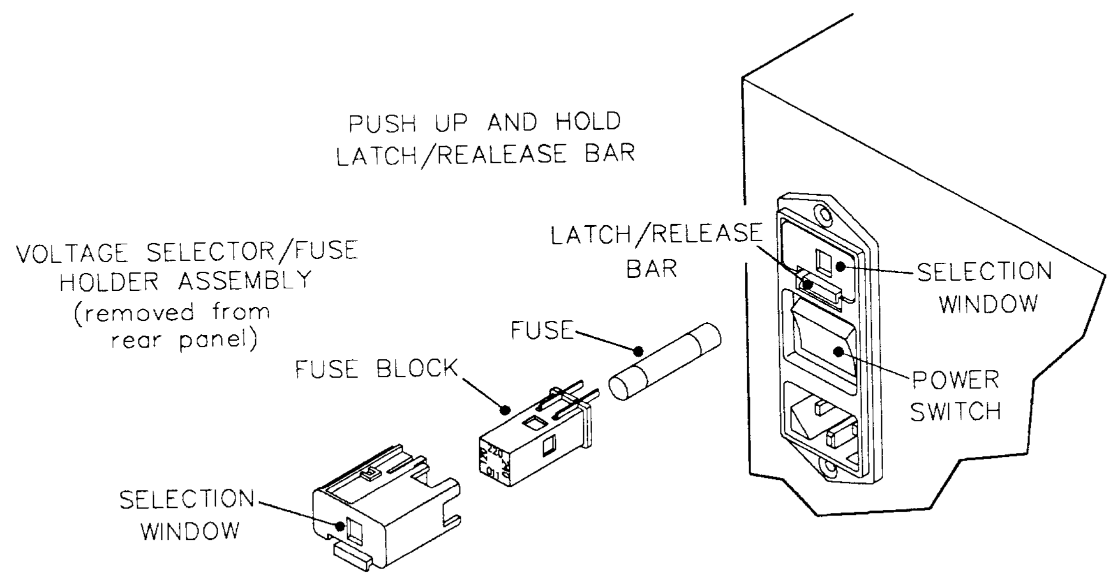


Figure 1-2. Voltage Selector Assembly.

Removing the Blank Plate

The OCP5502 has a blank plate inserted in the unused plug-in slot (see the frontispiece at the beginning of this manual). You can remove this plate and install another single-wide Tektronix plug-in instrument, such as the OIG502 Optical Impulse Generator. To remove the plate, grasp the release lever and pull the plate out. Slide the plug-in instrument into the vacant plug-in slot.

Leave the blank plate installed unless an instrument is to be inserted. To reinstall the plate, push the plate in until it snaps into place.

Connecting the OCP to Other Equipment

Figure 1-3 shows how to connect the OCP to an optical source and an oscilloscope. Connect the output of the optical source to the OCP **OPTICAL INPUT** with an optical fiber. Connect the OCP **OUTPUT** to the input of an oscilloscope.

WARNING

To prevent eye injury, do not look directly into a laser output or the end of an active optical fiber.

The OCP monitors the average power of the optical source and the oscilloscope displays the O/E converter output waveform. Chapter 3 provides OCP application examples.

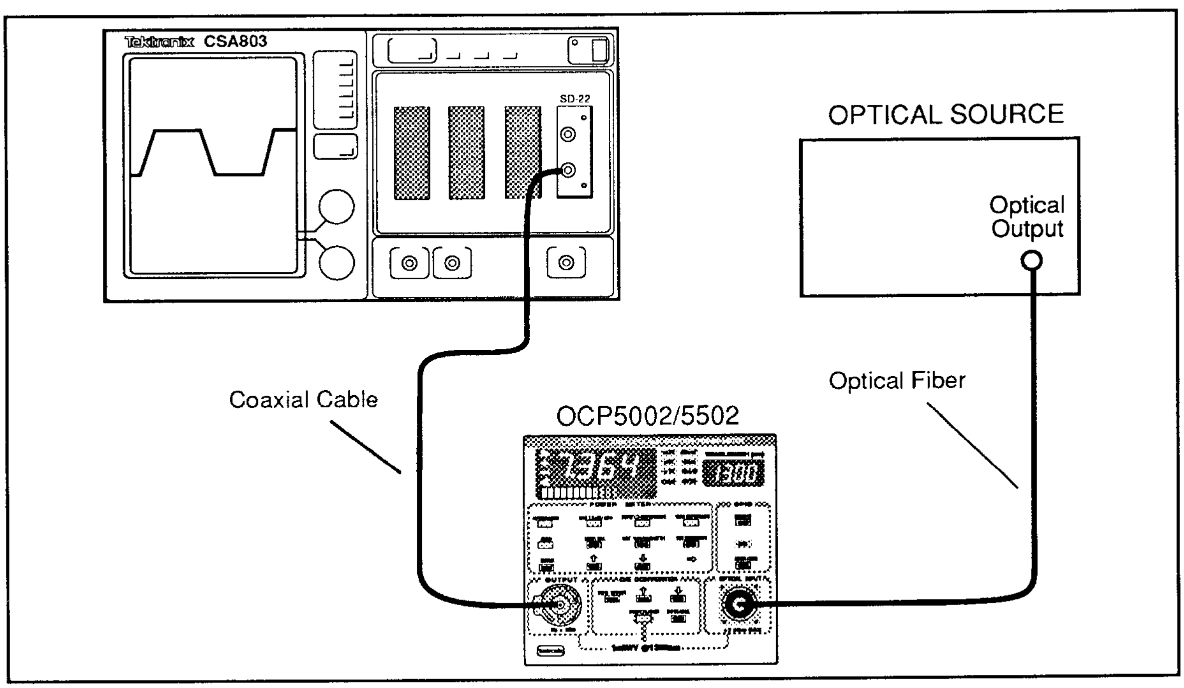


Figure 1-3. Connecting the OCP to Other Equipment.

Chapter 2: Front Panel Operation

Chapter 2 explains how to use the OCP front panel. A brief overview precedes the functional reference section and summary section.

OVERVIEW

The OCP front panel has five major sections: the digital displays, the power meter, the O/E Converter, the general-purpose interface bus (GPIB), and the input/output connectors.

Figure 2-1 shows the location of the front panel controls and connectors. All buttons that have an LED indicator are active only when the LED is lit or flashing. All instrument settings are saved when the instrument is powered down.

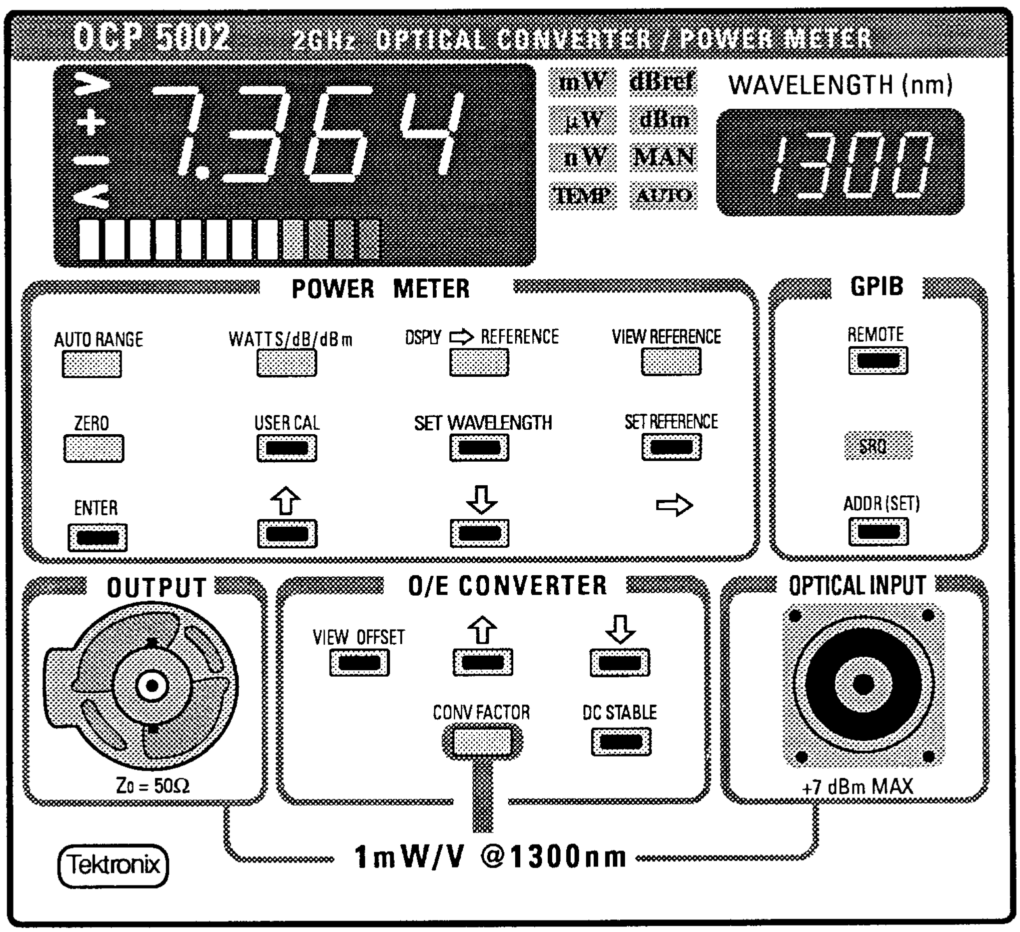


Figure 2-1. The OCP Front Panel.

Digital Displays

The digital displays are primarily associated with the power meter. The larger display indicates measured power and the smaller display indicates the selected wavelength of measurement. Other indicators show the units of measurement. All of the displays and indicators are described in detail in the reference section.

The power display can also display the conversion factor and offset value of the O/E converter. These parameters are described under the O/E converter heading of this section.

Power Meter

The power meter section of the OCP measures absolute optical power in watts (**nW**, **μW**, and **mW** modes), power relative to a 1 mW reference (**dBm** mode), or power relative to a user-defined reference (**dBref** mode). The power meter automatically matches the sensitivity range to the power of the optical signal applied at the input (this feature is called auto-ranging). When measuring power in the watts mode, you can manually select the sensitivity range (this is manual-ranging). The power meter measures average power.

The OCP measures optical power of sources that have wavelengths from 1100 to 1650 nm. The power meter sensitivity depends on wavelength, so you must specify the wavelength of the optical source to be measured. When you select a wavelength other than 1300 nm, the OCP automatically incorporates a calibration factor into the power reading.

O/E Converter

The O/E converter of the OCP changes the optical input signal into a corresponding electrical output signal. Use the O/E converter to observe the optical signal on an oscilloscope or voltmeter. The O/E converter has a bandwidth of 2 GHz.

The responsivity of the O/E converter is 1 V/mW at 1300 nm wavelength. When measuring an optical source with a wavelength other than 1300 nm, the O/E converter can display a conversion factor. Multiply the O/E converter output by this conversion factor to obtain the correct optical power.

You can superimpose a positive or negative DC offset on the O/E converter to extend the usable dynamic range of the converter. For example, an optical signal with a DC bias of +0.5 mW and an AC component of 1 mWp-p will saturate the O/E converter because the total peak power exceeds the maximum input limit of 1 mW. Use the offset to remove the DC component and observe the modulated signal. The offset range is ±1 mW. You can also change the offset with a Tektronix oscilloscope that supports the TEKPROBE® Interface. The offset value is displayed on the oscilloscope screen. The TEKPROBE® connector is described later in the input/output information.

Environmental changes can cause the O/E converter output to drift up or down over a period of time. The OCP features a DC Stable mode that uses the power meter to offset O/E converter drift. The DC Stable feature is useful when making long-term measurements.

GPIB

The GPIB feature lets you use a GPIB controller to operate the OCP. All front panel functions for the power meter and O/E converter are accessible through the GPIB. The GPIB feature is useful when making measurements in hazardous environments or when performing automated tests. Descriptions of the GPIB commands are provided in Section 6: GPIB Commands.

Input/Output Connectors

Connect the optical source being measured to the optical input of the OCP. The OCP accepts optical power levels up to 2 mW.

An FC/PC optical input connector is installed on the standard version of the OCP. You can change the connector to accept DIN 47256 or ST/PC fibers by using the universal adapter kit supplied with the OCP. Chapter 5 describes how to change the connector.

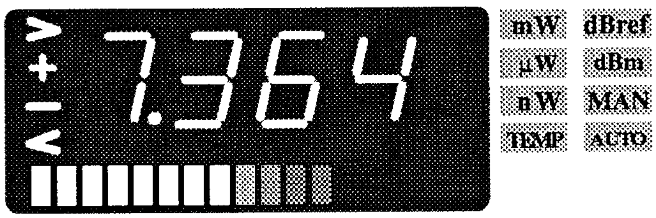
The output of the O/E converter appears at the OCP output connector. The maximum output voltage is 1 V at 50 Ω impedance. The output connector is a BNC type with a TEKPROBE® Interface. The TEKPROBE® Interface allows instruments such as the Tektronix 11200, 11300 or 11400 Series oscilloscopes or the DSA600 Series Digital Signal Analyzers to control the OCP offset. The OCP supplies offset gain, units, scale factor, and probe type information to the oscilloscope.

FRONT PANEL FUNCTIONAL REFERENCE

This section provides detailed descriptions of the front panel controls. Use this section as a reference for front panel operation.

Digital Displays and Indicators

There are two digital displays: one for power readings and one for wavelength selection. These displays and the other indicators associated with them are described below.



Power Display

The power display is the larger LED display located in the upper-left corner of the front panel. The four digit display shows the average power at the **OPTICAL INPUT** connector. The units of measurement are shown by the lighted indicator to the right of the display.

The decimal point and range indicators (nW, µW, and mW) show the current sensitivity range of the power meter. In manual-ranging mode, the decimal point moves as you change ranges (manual- and auto-ranging are discussed later in this section).

The > symbol indicates that the optical input power exceeds the maximum value for the current range selected. When the > symbol lights in **dBm** or **dBref** mode, the optical input power is above the maximum limit of the OCP. When the < symbol lights in **dBm** and **dBref** modes, the optical input is below the minimum detectable power of the OCP.

An LED bar display located below the digital readout indicates relative power within the current measurement range. Use the bar display when adjusting for peaks or nulls.

The power display shows the O/E converter offset value when the **VIEW OFFSET** button (described later) is pressed and the button's LED is lit. The + symbol indicates a positive offset value and the - symbol indicates a negative offset value.

mW, µW, nW, dBref, and dBm Indicators

These indicators, which are located to the right of the Power display, show the units of the power reading. **Watts** mode (**nW**, **µW**, and **mW**) measures optical power from 0 to 1 mW in six ranges. The **dBm** mode measures optical power from 0 to -80 dB using a 1 mW reference. The **dBref** mode shows the optical power in dB as measured against a user-defined reference.

TEMP Indicator

The OCP controls the temperature of the light-sensing photodiode by using a temperature controller. The **TEMP** indicator, which is located at the bottom-right side of the indicator column, shows the condition of the temperature controller. The **TEMP** indicator should be off during normal operation.

When the **TEMP** indicator flashes, the OCP photodiode temperature is not stabilized yet. The **TEMP** indicator may flash temporarily after powering-up the instrument but should go out after a short period of time.

If the **TEMP** indicator is on continuously, the OCP is unable to stabilize the photodiode temperature and measurement accuracy is degraded significantly. Verify that the operating environment is within the limits specified in Table 7-7 (0 to 50° C). If the operating environment is within specifications and the **TEMP** indicator stays on, an instrument malfunction has occurred. Contact your nearest Tektronix service representative for instrument repair or replacement.

AUTO and MAN Indicators

When auto-ranging is selected, the **AUTO** indicator will light up. When manual-ranging is selected, the **MAN** indicator will light up. Manual-ranging is available only in **Watts** mode.

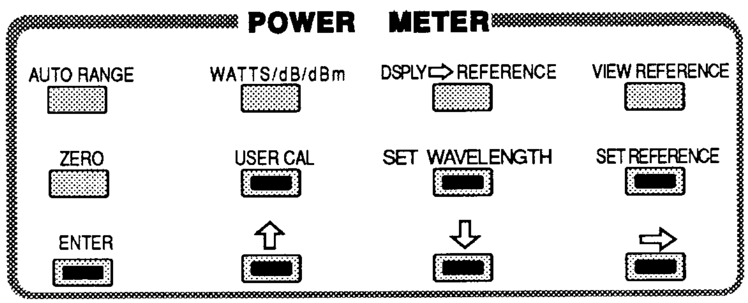
Wavelength Display

The wavelength display is the smaller LED display located at the upper-right corner of the front panel. This four-digit display shows the current OCP wavelength calibration setting. The factory-calibrated wavelength for the O/E converter is 1300 nm.

Set this display to the wavelength of the optical source you are measuring by using the **SET WAVELENGTH** button (described later). The display must match the wavelength of the optical source or the OCP measurements will not be accurate.

Power Meter Controls

The following describes the operation of front panel controls that relate to the power meter.



ZERO

The power meter offset may drift over a period of time, resulting in a non-zero reading when the optical input power is zero. To set the power display to zero, install the dust cover or turn off the optical source connected to the OCP and press the **ZERO** button. The power display will flash the word **bUSY** for a few seconds, then the meter will read zero.

If the power at the **OPTICAL INPUT** connector is above 1 nW when **ZERO** is pressed, the display will flash the word **bUSY** and then **FAIL** will appear in the power display. An error code will also appear in the wavelength display for two seconds and then the zeroing function will be aborted. To restore the zero condition, remove the input signal at the **OPTICAL INPUT** connector and press the **ZERO** button again.

WATTS/dB/dBm

Press the **W/dB/dBm** button to select one of the three display modes: **Watts**, **dBm**, **dBref**. The mode indicators are located on the right side of the power display. The highlighted indicator shows the selected mode.

Watts mode measures power in nW, μW, or mW. The **dBm** mode uses a 1 mW reference. The **dBref** mode measures dB compared to the user-defined reference. To find out how to change the dBref reference, see "Set Reference" and "Display Reference" in this section.

AUTO RANGE

The power meter automatically matches the sensitivity range to the power of the optical signal applied at the input (auto-ranging). When measuring power in the **Watts** mode, you can manually select the sensitivity range (manual-ranging). The power meter measures average power.

Press the **AUTO RANGE** button to select between manual and auto range power mode when measuring power in Watts. The **AUTO** indicator lights when auto-ranging is selected and the **MAN** indicator lights when manual-ranging is selected. When the instrument is displaying power in **dBm** or **dBref**, the OCP operates in auto-ranging only. Auto-ranging adjusts the ranges for power measurements up to 1 mW.

In manual ranging, the [↑] and [↓] buttons are lit. Press these buttons to select the desired range.

VIEW REFERENCE

Press and hold the **VIEW REFERENCE** button to view the current **dBref** reference power in the power display. The OCP displays the reference in **dBm** units when either **dBm** or **dBref** mode is selected. The OCP displays the **dBref** reference in watts when **Watts** mode is selected.

Example: If the OCP displays -34 dB in **dBref** mode and -10 dB when the **VIEW REFERENCE** button is pressed, then the measured power is -44 dBm.

DSPLY→ REFERENCE

To set the **dBref** reference to the currently measured power, press the button marked **DSPLAY→ REFERENCE**. If the OCP is currently in **dBref** mode, the power display will read 0.

Example: If the current **dBref** reference is 0 dBm (1 mW), and you want to calibrate the reference to an optical source that reads -10 dBm on the power meter, press the **DSPLAY→ REFERENCE** button. If the OCP is in **dBref** mode, the power meter will read 0 and all subsequent **dBref** measurements will be referenced to -10 dBm (100 μW).

SET REFERENCE

To manually set the reference power for **dBref** mode without using an optical reference source, press the **SET REFERENCE** button. The [↑], [↓], and [→] buttons light and the power display shows the current reference power in watts when **Watts** mode is selected or in dBm when either **dBm** or **dBref** mode is selected. Use the [→] button to select a digit and the [↑] or [↓] buttons to increment or decrement the digit (the digit flashes when selected). You may select between watts or dB by pressing the **WATTS/dB/dBm** button while in the set reference mode. Press **ENTER** when finished. Pressing any button other than **ENTER**, **WATTS/dB/dBm**, or the arrows aborts the function.

Example: To change the dBref reference value from 0 dB to -10.5 dB, perform the following steps.

1. Press the **SET REFERENCE** button.
2. Select the desired units by pressing the **WATTS/dB/dBm** button.
3. Press the [↑] or [↓] button until the most-significant power digit is 1.
4. Press the [→] button to select the next digit to the right. If necessary, use the [↑] or [↓] button to set the digit to 0.
5. Press the [→] button once more to select the next digit to the right and press the [↑] or [↓] button to set the digit to 5. If you need to go back to a previously edited digit, keep pressing the [→] button until the desired digit flashes and then use the [↑] or [↓] button to change the value.
6. Press **ENTER**. The reference will be updated to the newly edited value. If you wish to abort the function, press any button other than **ENTER**, **WATTS/dB/dBm**, or the arrow buttons.

SET WAVELENGTH

The OCP O/E converter is calibrated for 1300 nm wavelength sources; however, you can measure optical power of wavelengths from 1100 nm to 1650 nm by using the **SET WAVELENGTH** function. The OCP has seven possible selections: the standard wavelength of 1300 nm, the **USEr** wavelength, and five user-programmable wavelengths. See "User Cal" in this section for more information about the **USEr** wavelength.

To select a wavelength, press the **SET WAVELENGTH** button and then press the [↑] or [↓] button until the desired wavelength value appears in the wavelength display. Press the **ENTER** button to enter the value. Pressing any button other than **ENTER** or the arrows aborts the function.

The standard 1300 nm and **USEr** wavelengths are not changeable. Note that the [→] LED is off when these two wavelengths are selected.

If the desired wavelength does not appear in one of the seven current selections, change one of programmable wavelengths. When one of the five programmable wavelengths is selected, the [→] button lights. Press the [→] button to select the digit to be edited (the digit flashes when selected) and then use the [↑] or [↓] button to increment or decrement the number. The programmable wavelength range is from 1100 nm to 1650 nm. Press **ENTER** when finished. Pressing any button other than **ENTER** or the arrows aborts the function.

If you select a wavelength that is outside the 1100 to 1650 nm range and press **ENTER**, the word **FAIL** appears in the power display and an error code number appears in the wavelength display. After approximately 2 seconds, the function is aborted and the instrument returns to normal operation.

Example: To set the OCP wavelength to 1320 nm, perform the following steps.

1. Press the **SET WAVELENGTH** button. The wavelength display digits flash.
2. To select one of the programmable wavelengths, press the [↑] or [↓] button until the [→] button lights
3. If necessary, press the [→] button until the most-significant digit flashes. Set the digit to 1 using the [↑] or [↓] button.
4. Press the [→] button to select the second most-significant digit. Set the digit to 3 using the [↑] or [↓] button.
5. Press the [→] button to select the third most-significant digit. Set the digit to 2 using the [↑] or [↓] button.
6. Press the [→] button to select the least-significant digit. Set the digit to 0 using the [↑] or [↓] button.
7. Press **ENTER**. The wavelength value is updated to the new selection.

USER CAL

The **USER CAL** function lets you improve the accuracy of the OCP by calibrating the OCP to a precision optical source.

To select the **USER CAL** function, press the **USER CAL** button. The word **USEr** appears in the wavelength display and the [↑], [↓], and [→] buttons light. The power display shows the measured power with the most-significant digit flashing. You may press the **WATTS/dB/dBm** button to select watts or dB units and then use the three arrow buttons to edit the power reading to that of the precision optical source. The [→] button selects the digit to be edited (the selected digit flashes) while the [↑] or [↓] buttons increment or decrement the digit. When finished, press **ENTER**. Pressing any button other than **ENTER**, **WATTS/dB/dBm**, or the arrows aborts the operation.

The **USER CAL** function calculates a scaling constant for power measurements made in the **USEr** wavelength.

Example: To calibrate the OCP to an optical source with a known output of 500 µW, perform these steps.

1. Install the dust cap on the **OPTICAL INPUT** connector or turn off the connected optical source.
2. Press the **ZERO** button.
3. Connect the optical source to the **OPTICAL INPUT** connector.
4. Select **Watts** mode with the **WATTS/dB/dBm** button.
5. Press the **USER CAL** button. The word **USEr** appears in the wavelength display and the most-significant power digit flashes.
6. Edit the power display reading to 500 µW using the [→] button to select the digit to be edited and the [↑] and [↓] buttons to change the digit to the desired value.
7. Press **ENTER**. The OCP power meter is calibrated to the 500 µW source.

ENTER

Use the **ENTER** button to enter the current function and update the parameter changed by that function. The following functions are completed by the **ENTER** button: **USER CAL, SET REFERENCE, SET WAVELENGTH,** and **ADDR (SET)**.

To check the LEDs and indicator lights, press the **ENTER** button for two seconds or longer. All LEDs and indicators should light. If not, then the instrument is defective. Contact your Tektronix service representative for instrument repair.

[↑]

Operation of the [↑] button is mode dependent; see the preceding operation descriptions. When using this button to increment a selected digit, the digit will wrap around to zero. The [↑] button is operative only when lit.

[↓]

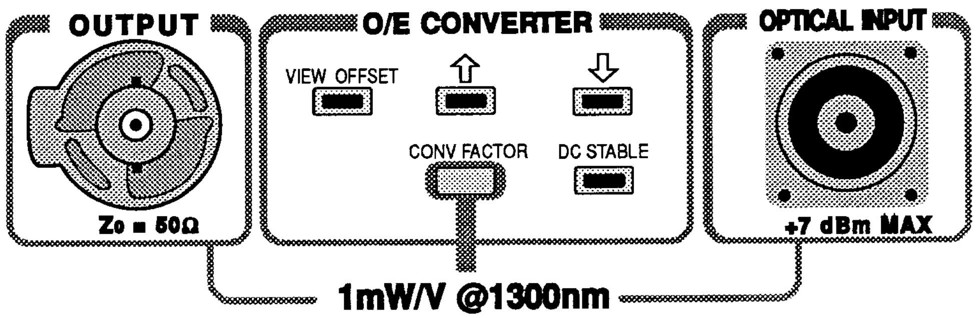
Operation of the [↓] button is mode dependent; see the preceding operation descriptions. When using this button to decrement a selected digit, the digit will wrap around to nine. The [↓] button is operative only when lit.

[→]

Operation of the [→] button is mode-dependent. When editing digits, the [→] button selects the digit to be changed (the selected digit flashes). When used with manual-ranging in the **Watts** mode, the [→] button moves the decimal point and changes the units (**mW**, **µW**, or **nW**). The [→] button is operative only when lit.

O/E Converter Controls

The O/E converter changes optical signals at the **OPTICAL INPUT** connector to corresponding electrical signals at the **OUTPUT** connector. This section describes the front panel controls that affect O/E converter operation.



VIEW OFFSET

To see the current DC offset value of the O/E converter, press the **VIEW OFFSET** button. The offset value in µW appears in the power display. The offset value is changed with the [↑] and [↓] buttons. The offset range is ±1 mW multiplied by the conversion factor. The [↑] and [↓] buttons and the conversion factor are described later in this section.

• *Note* *Due to differences in OCP amplifier characteristics, the OCP may not be able to adjust to the upper limit of the offset range.*

When the **VIEW OFFSET** LED is on, any offset changes made with the [↑] and [↓] buttons will be shown on the power display. When the **VIEW OFFSET** LED is off, the power display indicates measured power but the offset can still be changed with the arrow buttons.

The **VIEW OFFSET** button is inoperative when the TEKPROBE® interface is in use. The TEKPROBE® instrument displays the offset value.

[↑]

Press the [↑] button to increase the DC offset of the O/E converter in 0.1 µW increments. Holding the button in for 0.5 sec increases the step size. The [↑] button increments up to a maximum value of 1 mW multiplied by the conversion factor.

The [↑] button is active even when the **VIEW OFFSET** button is off. The TEKPROBE® interface disables the [↑] button (the [↑] LED will be off).

↓

Press the ↓ button to decrease the DC offset of the O/E converter in 0.1 μW increments. Holding the button in for 0.5 sec increases the step size. The ↓ button decrements down to a minimum value of -1 mW multiplied by the conversion factor.

The ↓ button is active even when the **VIEW OFFSET** button is off. The TEKPROBE® interface disables the ↓ button (the ↓ LED will be off).

CONV FACTOR

The O/E converter of the OCP is factory-calibrated for 1300 nm wavelength operation. When you measure other wavelengths with the OCP, press and hold the **CONV FACTOR** button to obtain the conversion gain of the O/E converter in mW/volt. The conversion factor appears on the power display. To calculate the optical power, multiply the **OUTPUT** voltage by the conversion factor.

Example: An 1550 nm optical source is connected to the OCP input and an oscilloscope is connected to the OCP output. The OCP wavelength is set to 1550 nm and power readout displays 1.137 when the CONV FACTOR button is pressed. The optical signal produces a pulse with a peak amplitude of 750 mV on the oscilloscope. The actual optical power is 0.750 V x 1.137 mW/V or 0.85275 mW.

• *Note* *The conversion factors will vary slightly between different OCP instruments because of differences in photodiode characteristics. Tektronix calibrates each OCP for the photodiode installed in it.*

When the **CONV FACTOR** button is released, the display reverts to the function prior to the button being pressed.

DC STABLE

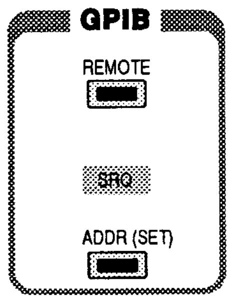
The **DC Stable** feature uses the power meter to nullify O/E converter drift. This features reduces the frequency at which you need to zero the O/E converter.

Press the **DC STABLE** button to alternately enable or disable this feature. The LED of the **DC STABLE** button lights when **DC Stable** mode is enabled and goes out when the **DC Stable** mode is disabled.

When the **DC Stable** mode is enabled, the power meter is restricted to full-scale ranges of 100 μW or greater.

GPIB Controls and Indicators

Use the General Purpose Interface Bus (GPIB) of the OCP to make computer-controlled measurements. Chapter 6 describes the IEEE 488.2 Standard and OCP-unique GPIB commands. This section describes front panel controls and indicators that relate to the GPIB interface.



REMOTE

When the LED of the **REMOTE** button is lit, the instrument has been addressed and placed into the remote state. Press the **REMOTE** button or any other button to exit the remote state.

When the **REMOTE** LED is flashing, the instrument has received a local lockout command from the controller. In local lockout, all front panel buttons are disabled. To disable the local lockout, turn the instrument power off and then on again.

Holding the **REMOTE** button down for two seconds or longer displays the word **CodE** in the power display and the software version number in the wavelength display.

ADDR (SET)

When the **ADDR (SET)** LED is lit, the instrument is being addressed on the GPIB.

Often, several instruments will operate on the same GPIB bus. Each instrument must have a unique address. You can program the GPIB address by pressing the **ADDR (SET)** button. After the button is pressed, the power display reads **Addr**, the GPIB address is displayed in the wavelength display and the [↑] and [↓] buttons are lit. The GPIB address can then be changed from 0 to 30 or set to OFF by using the [↑] and [↓] buttons. Setting the GPIB address to OFF disables the interface.

After selecting the desired address value, press the **ENTER** button. Pressing any button other than **ENTER** or the arrow buttons will abort the function.

SRQ

When this indicator is lit, the OCP is asserting the service request line. This indicator is primarily used for debugging GPIB application programs. The SRQ light will go off when the GPIB controller has polled the OCP.

Input and Output Connectors

This section describes the input and output connectors associated with the OCP.

OPTICAL INPUT

The **OPTICAL INPUT** uses a universal optical bulkhead connector. Use the universal connector kit to reconfigure the bulkhead to accept FC, ST, or DIN connectors. To change bulkhead connectors, see Chapter 5: Maintenance and Troubleshooting.

OUTPUT

The OCP **OUTPUT** produces 1 V per mW at 1300 nm optical wavelength. A conversion factor is provided for optical measurements at wavelengths other than 1300 nm (the conversion factor is described earlier in this chapter). The maximum output voltage range is -0.25 V to +1 V.

The **OUTPUT** connector is a BNC that includes a TEKPROBE® Interface.

TEKPROBE® Interface

The TEKPROBE® Interface allows you to control certain parameters of the OCP from another test instrument, such as a Tektronix 11200, 11300 or 11400 Series oscilloscopes or a DSA600 Series Digital Signal Analyzer. When a test instrument supporting the TEKPROBE® Interface is attached to the OCP **OUTPUT** connector, the OCP disables the **VIEW OFFSET** button and the [↑] and [↓] buttons of the O/E converter. The O/E converter offset is then controlled by the test instrument's position or offset control. The test instrument obtains offset gain, probe type, units, and scale factor from the OCP.

If the OCP wavelength is changed, recalibrate the test instrument probe because previous probe constants are reset. To calibrate the probe, set the vertical offset of the test instrument to 0 V and press the OCP **ZERO** button.

GPIB Interface Connector

The 24-pin GPIB Interface connector is located on the back of the OCP5502. The GPIB Interface connector for the OCP5002 is located on the back of the TM5000 Series Power Module. Command descriptions and examples are provided in Chapter 6: GPIB Commands.

FRONT PANEL SUMMARY

Figure 2-2 shows the operation sequence of each front panel function. The top line represents the initiation of a function. Follow the line down through each function to see it's valid sequence of operation. A completed sequence returns to the top line.

The O/E converter offset controls are disabled when the TEKPROBE® Interface is active.

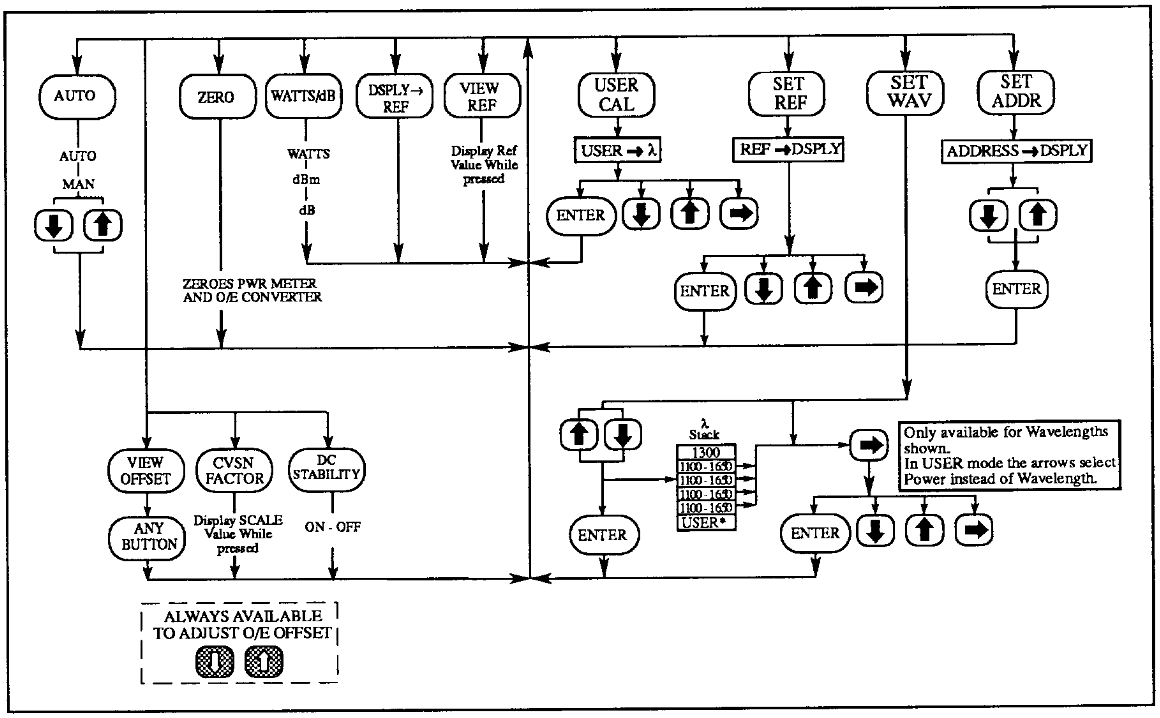


Figure 2-2. OCP Front Panel Flow Chart.

Chapter 3: Typical Applications

Chapter 3 provides examples of applications for the OCP. We assume that you are familiar with the operation of oscilloscopes and other test equipment mentioned in these application examples. If not, get help from the instrument's instruction manual.

The OCP can be used with a variety of measurement systems. The examples in this section use either a Tektronix 11800 Series Oscilloscope or a CSA803 Communication System Analyzer for signal acquisition. The 11400 Series oscilloscopes, the 11800 Series oscilloscopes, the CSA803 Communication System Analyzer, and the DSA600 Series Digital Signal Analyzer can digitally integrate the acquired signal.

The OCP, 11800 Series Oscilloscope, and CSA803 Analyzer all have GPIB control capability. All information may be accumulated under computer control, stored for future reference, and compared to data of other optical transmitters. For simplicity, these applications describe manual operation of the instruments.

This section includes the following applications for the OCP:

- Adjusting Eye Pattern While Monitoring Power
- Verifying Optical Standards
- Measuring Optical Reflections

WARNING

To prevent eye injury, do not look directly into a laser output or the end of an active fiber. The laser output may not be in the visible light spectrum.

ADJUSTING EYE PATTERN WHILE MONITORING POWER

A typical laser-based communication system will have transmitter requirements for the average power, maximum and minimum power levels, and rise time. Make these measurements by using an OCP to observe the eye pattern on an oscilloscope while monitoring the average optical power. An eye pattern results when an optical device is driven by a pattern generator or bit-error rate tester.

An optical transmitter might have two controls, one for the bias level and one for the modulation depth. The bias level should be adjusted to meet the system's minimum power level specification. The modulation depth should be adjusted for the maximum possible extinction ratio without inducing unwanted overshoot from relaxation oscillations. The extinction ratio is the average high (logic-one) power level divided by the average low (logic-zero) power level.

Figure 3-1 shows the drive current versus optical output curve of an optical transmitter.

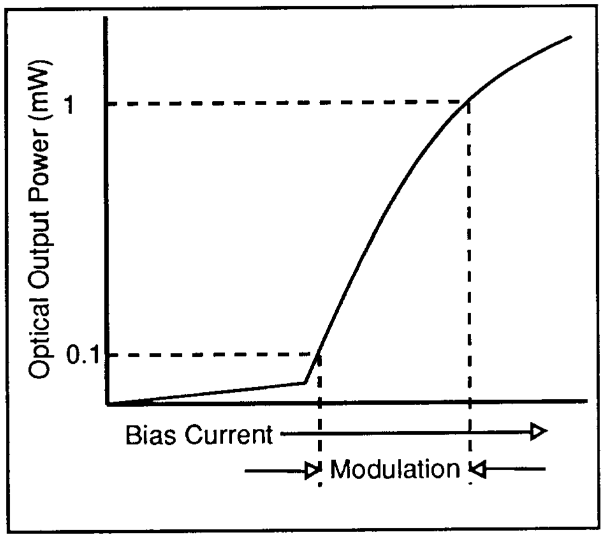


Figure 3-1. Optical Output vs. Current.

The following procedure explains how to run an eye pattern test on an optical transmitter. An analysis of three eye patterns follows the procedure.

Required Test Equipment

The following equipment is required for this application:

- OCP.
- Digital signal acquisition equipment with a rise time specification sufficient for the device under test. The OCP has a 260 ps rise time. This example uses a Tektronix CSA803 Communication System Analyzer with an SD22 sampling head. The CSA803-SD22 combination has a low noise figure and a rise time of less than 35 ps.
- Pseudo-Random Pattern Generator.
- Device Under Test (1300 nm or 1550 nm Laser Transmitter).
- Fiber jumpers and electrical cables.

Procedure

The following procedure describes how to acquire and adjust the eye pattern of the transmitter under test. Figure 3-2 shows the equipment connections.

1. Place the dust cap over the OCP **OPTICAL INPUT** and press the **ZERO** button. Be sure that the power readout displays **0.00** ±.1 nW.
2. Press the **DC STABLE** button so that its LED lights.
3. Set the OCP O/E converter offset to **0.00 µW**.
4. Connect the OCP **OUTPUT** to the input of the SD22 sampling head.
5. Press the enhanced accuracy menu button on the CSA803 and use manual calibration to offset null the CSA803 and OCP combination. The OCP has a 50 Ω load impedance and can be left connected for offset nulling. After offset nulling is completed, a signal of zero volts will correspond to zero microwatts. The OCP is specified to maintain this level of stability (±.5 µW over a ±5° C range).
6. Remove the dust cap and, using an optical fiber that has connectors compatible with your equipment, connect the optical transmitter under test to the OCP **OPTICAL INPUT**.
7. Be sure that the CSA803 is triggered by the signal from the psuedo-random pattern generator and set the CSA803 in dot response mode using the display mode menu. After the appropriate vertical and horizontal settings are selected, an eye pattern should be visible. Figures 3-3 through 3-5 show examples of eye patterns.
8. Press the **Watts/dB/dBm** button of the OCP until the **dBm** indicator lights. Note the average power reading.

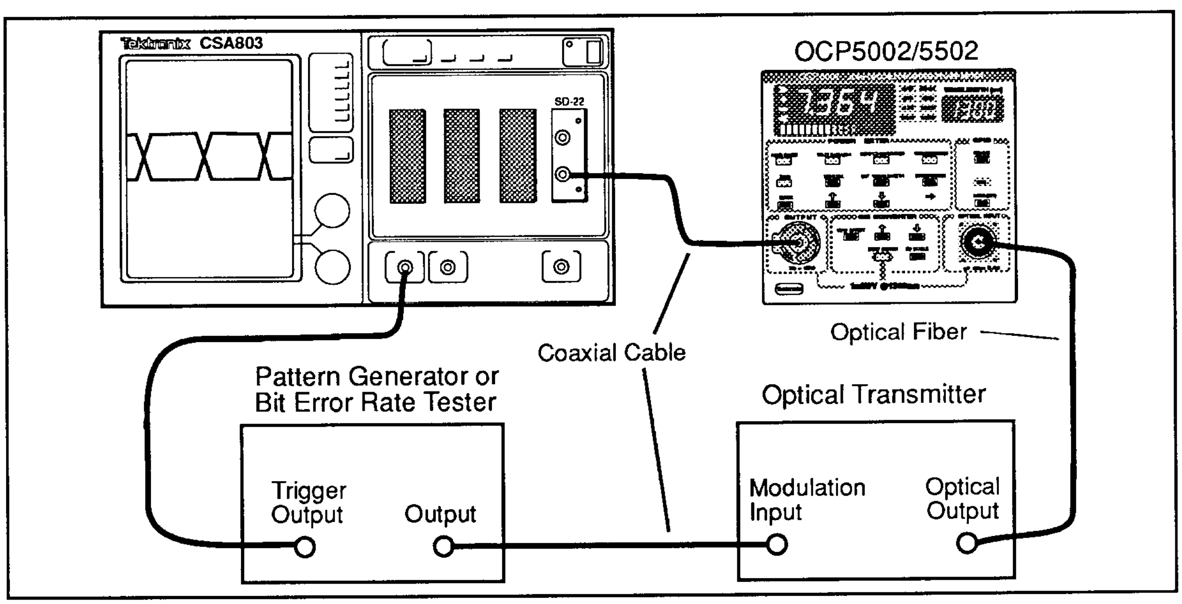


Figure 3-2. Equipment Connections for Eye Pattern Test.

10. Adjust the modulation depth of the optical transmitter while observing the eye pattern on the CSA803. Use the CSA803 to verify that the appropriate extinction ratio, duty cycle, rise time, and fall time are maintained. (When the optical transmitter is being tested with a random-pattern generator, the duty cycle of the modulated signal should be approximately 50%.) Use the CSA803's psuedo-random dot-response, color persistence, and statistical measurement modes for rise time measurements.

11. Verify that the correct average system power is maintained. Three things affect average power: the bias level, the modulation depth, and the duty cycle of the modulating signal. There may be some interaction between the bias level and the modulation level.

Figure 3-3 shows an eye pattern with a bias level that is too low. The crossover point of the eye pattern is below the 50% point, indicating that the transmitter is operating below the threshold point in the logic-zero state. Notice that the extinction ratio is very high because the logic-zero point is near the zero light level. (The ground symbol of the waveform represents the zero light level.) Also, the average power may be below the system specifications.

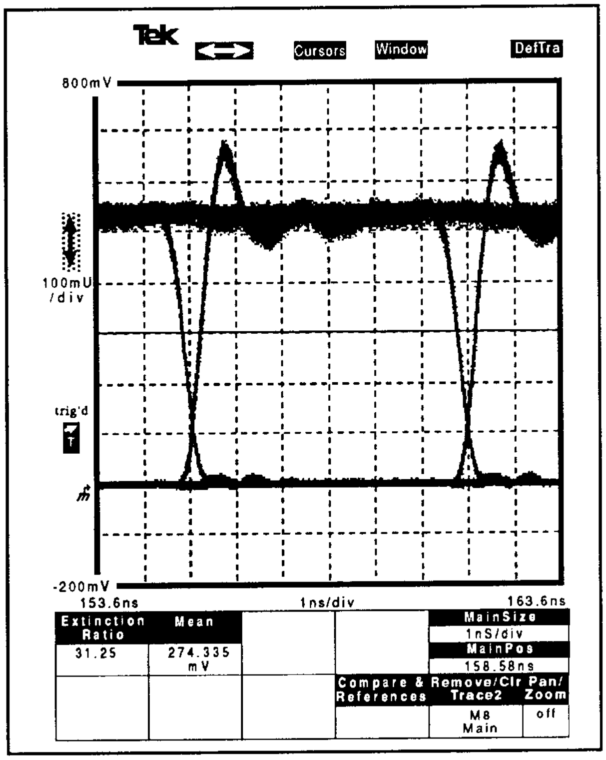


Figure 3-3. Underbiased Eye Pattern.

Figure 3-4 shows an eye pattern with the bias level set too high. Note the low extinction ratio because the logic-zero level is too high above the zero light level.

If the modulation depth is overdriven, the laser may exhibit large overshoots from relaxation oscillations. The eye pattern observed on an oscilloscope would close because of these oscillations and an increased delay to achieve a logic-one state.

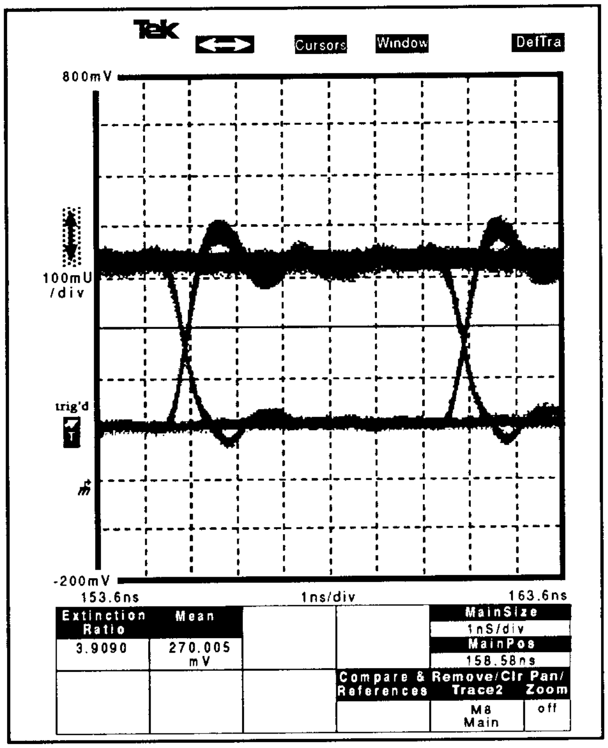


Figure 3-4. Overbiased Eye Pattern.

Figure 3-5 shows a properly adjusted eye pattern. The transmitter-under-test exhibited some overshoot but the extinction ratio is slightly above ten, which is an minimum value for many systems. The rise and fall lines cross near the center of the pattern. The average power is also within specifications.

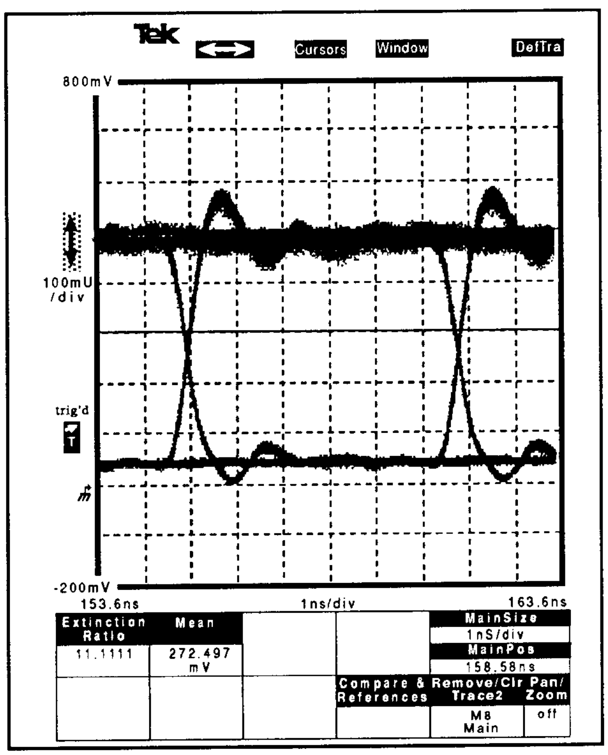


Figure 3-5. Properly Adjusted Eye Pattern.

VERIFYING OPTICAL STANDARDS

Optical standards are becoming better-defined and test procedures are being written to verify that optical components meet these standards. Fiber Distributed Data Interface (FDDI) and Synchronous Optical Network (SONET) are two examples of optical standards.

This application example tests the following characteristics of FDDI LED transmitters:

- Average Power
- Rise Time
- Fall Time
- Duty Cycle Distortion
- Random Jitter
- Extinction Ratio
- Pulse Envelope

Required Test Equipment

The following equipment is required for this application:

- OCP.
- Digital signal acquisition equipment with a rise time specification sufficient for the transmitter being tested. The OCP has a 260 ps rise time. This example uses a Tektronix CSA803 Communications System Analyzer with an SD22 sampling head. The CSA803-SD22 combination has a low noise figure and a rise time of less than 35 ps.
- Electrical pattern generator capable of generating FDDI test signals (i.e. Halt signal - 12.5 Mb/s NRZ format, Idle signal - 62.5 Mb/s NRZ format, FDDI test pattern).
- FDDI Transmitter being tested.
- Fiber jumpers and electrical cables.

Procedure

The following procedure describes a typical method for testing FDDI transmitters.

1. Place the dust cap over the OCP **OPTICAL INPUT** and press the **ZERO** button. Be sure that the power readout displays **0.00** ±.1 nW.
2. Press the **DC STABLE** button so that its LED lights.
3. Set the O/E converter offset of the OCP to 0.00 µW.
4. Using an optical fiber that has connectors compatible with your equipment, connect the OCP **OUTPUT** to the input of the SD22 sampling head. Figure 3-6 shows the equipment connections.
5. Press the enhanced accuracy menu button on the CSA803 and use manual calibration to offset null the CSA803 and OCP combination. The OCP has a 50 Ω-load impedance and can be left connected for offset nulling. After offset nulling is completed, a signal of zero volts will correspond to zero microwatts. The OCP is specified to maintain this level of stability (± .5 µW over a ±5° C range).

6. Using an optical fiber with connectors compatible with your equipment, connect the electrical pattern generator output to the FDDI transmitter input and apply a 12.5 Mb/s test pattern.
7. Connect the output fiber of the FDDI transmitter to the OCP **OPTICAL INPUT**.
8. Set the power mode to **dBm** and measure the optical power. To meet FDDI specifications the power must be between -20 dBm and -14 dBm.
9. Use the CSA803 measurement menu to check that the rise and fall times are between 0.6 and 3.5 ns. Use the extinction ratio measurement to verify that the extinction ratio (the ratio of the logic-one level to the logic-zero level) is greater than ten.
10. Apply the FDDI data-dependent test pattern as specified in the *FDDI Physical Layer Medium Dependent Specification* and use the CSA803 jitter analysis capabilities to insure that the peak-to-peak jitter is less than 0.6 ns.
11. Apply a 62.5 Mb/s test pattern to the FDDI transmitter. Use the CSA803 jitter analysis to insure that the peak-to-peak jitter is less than 0.76 ns.
12. Use the CSA803 mask capabilities to display the FDDI pulse envelope on the CSA803 screen. Apply a 12.5 Mb/s test pattern to the FDDI transmitter. Adjust the position and size of the FDDI transmitter signal to match the mask. Use the CSA803 to verify that the signal falls within the mask.

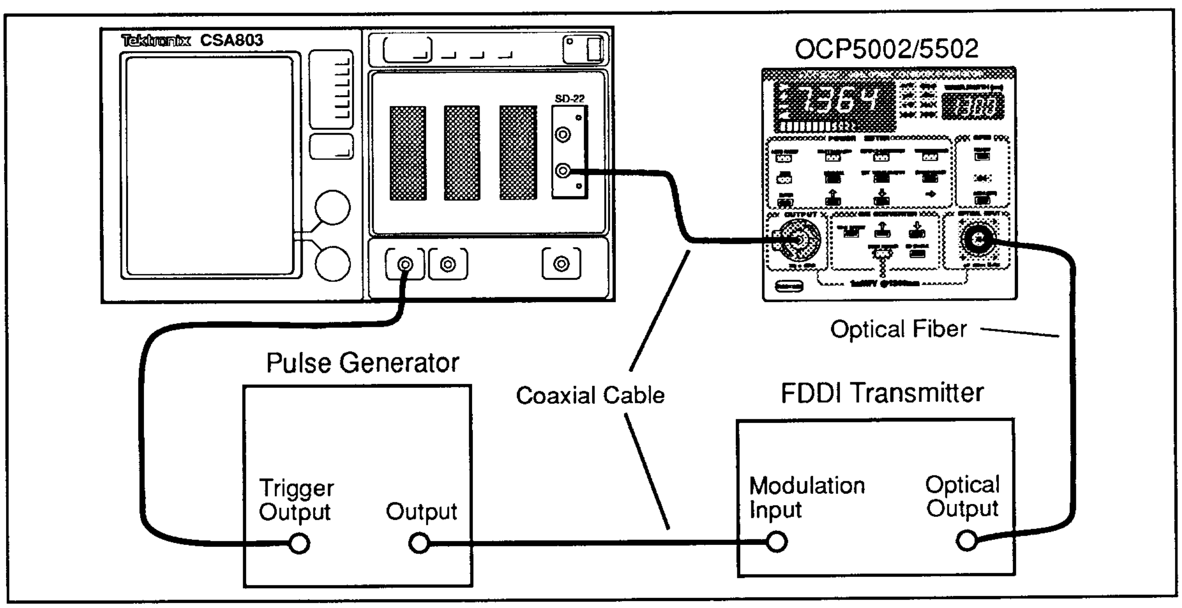


Figure 3-6. Equipment Connections for FDDI Test.

Figure 3-7 shows the waveform displayed from a 6.25 MHz psuedo-random test signal using a 12.5 Mb/s NRZ format. You can obtain the rise time, fall time, and extinction ratio using the OCP O/E converter and the CSA803. Use the OCP power meter to measure the average power of the transmitter.

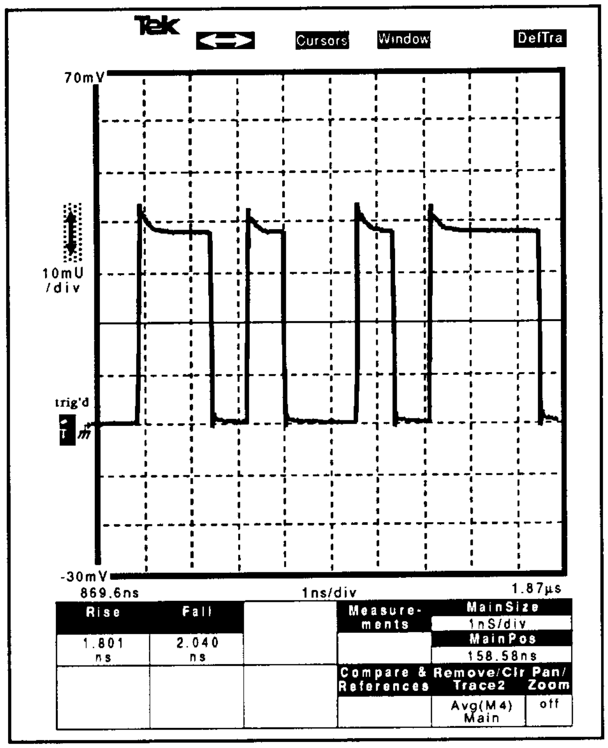


Figure 3-7. FDDI Waveform Display.

Figure 3-8 shows a histogram of the FDDI jitter tests. The CSA803 records the points of the signal that occur over a period of time. The jitter range is specified by the window shown. Both the RMS and peak-to-peak ranges can be displayed.

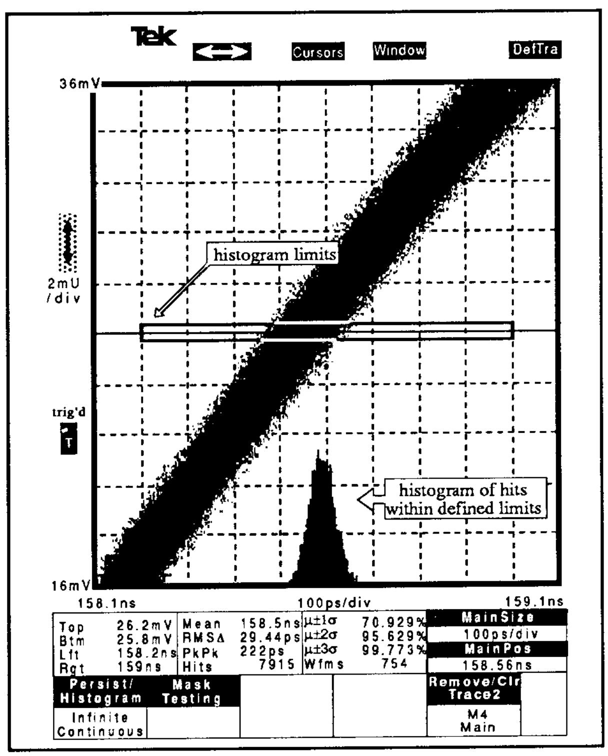


Figure 3-8. FDDI Jitter Test Waveform.

Figure 3-9 shows the comparison of the measured signal to the FDDI mask template. Use the CSA803 to create the mask limits. The number of points measured and the number of points that fell outside the mask are displayed. Use these figures to determine the error percentage.

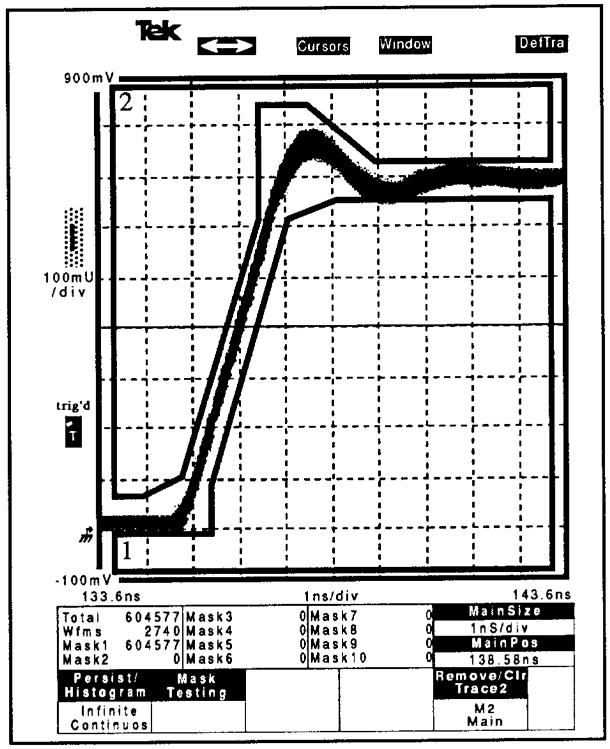


Figure 3-9. FDDI Mask Test.

MEASURING OPTICAL REFLECTIONS

Measurement of reflections from optical connectors and other components is important because reflections can cause unwanted fluctuations in laser transmitter output power. Poor connections introduce reflective losses that exceed optical link specifications.

Current methods of reflection measurement involve using stabilized sources and measuring the average power reflected by all components within the system. However, these methods lead to a fair amount of uncertainty regarding which components cause the reflections, especially in systems that have more than one optical connector.

The OCP, when combined with an OIG502 Optical Impulse Generator and 11800 Series Oscilloscope, helps you measure the total reflected power and the reflections caused by each individual component in an optical system. You need to make only one connection to the OCP for both individual and total reflection measurements.

Required Test Equipment

The following equipment is required for this application example:

- OCP.
- Digital signal acquisition equipment with a rise time specification sufficient for the transmitter being tested. The OCP has a 260 ps rise time. This example uses a Tektronix 11800 Series Oscilloscope with an SD22 sampling head. The 11800 Series-SD22 combination has a low noise figure and a rise time of less than 35 ps.
- OIG502 Optical Impulse Generator.
- Transmitter Under Test
- 3 dB optical splitter.
- Fiber jumpers and electrical cables.
- 2X electrical attenuator.

Procedure

1. Using an optical fiber that has connectors compatible with your equipment, connect the optical output of the OIG502 to one output of the the 3 dB optical splitter as shown in Figure 3-10.
2. Using an optical fiber that has connectors compatible with your equipment, connect the other output of the optical splitter to the OCP **OPTICAL INPUT**.
3. Connect a short fiber jumper to the splitter input (this is not necessary if the splitter has a pigtail). Clean the unconnected end of the jumper to provide a clean air-glass interface. This interface provides the -14 dB Fresnel reference reflection.
4. Connect the pretrigger output of the OIG502 to the 2X attenuator and connect the attenuator to the oscilloscope trigger input.
5. Set the OIG502 trigger rate to 1 MHz internal, select the high-energy impulse, and enable the laser.

6. Verify that the OCP has received an optical signal by monitoring the average power. Find the reference reflection by setting the 11800 Series in edge trigger mode and pressing the autoset button.
7. Verify that the displayed signal is the fiber end reflection by placing a drop of water on the end of the fiber. The water should drastically reduce the amplitude of the signal.

WARNING

To avoid eye injury, do not look directly into the fiber end.

8. Once you have found the correct reflection, clean the fiber end and average the display. Note the value of the -14 dB signal in mV and use it to calibrate other reflections.
9. Connect the device or connector under test to the jumper end and search for reflections. Compare this to the -14 dB reference reflection and calculate the device's return loss.

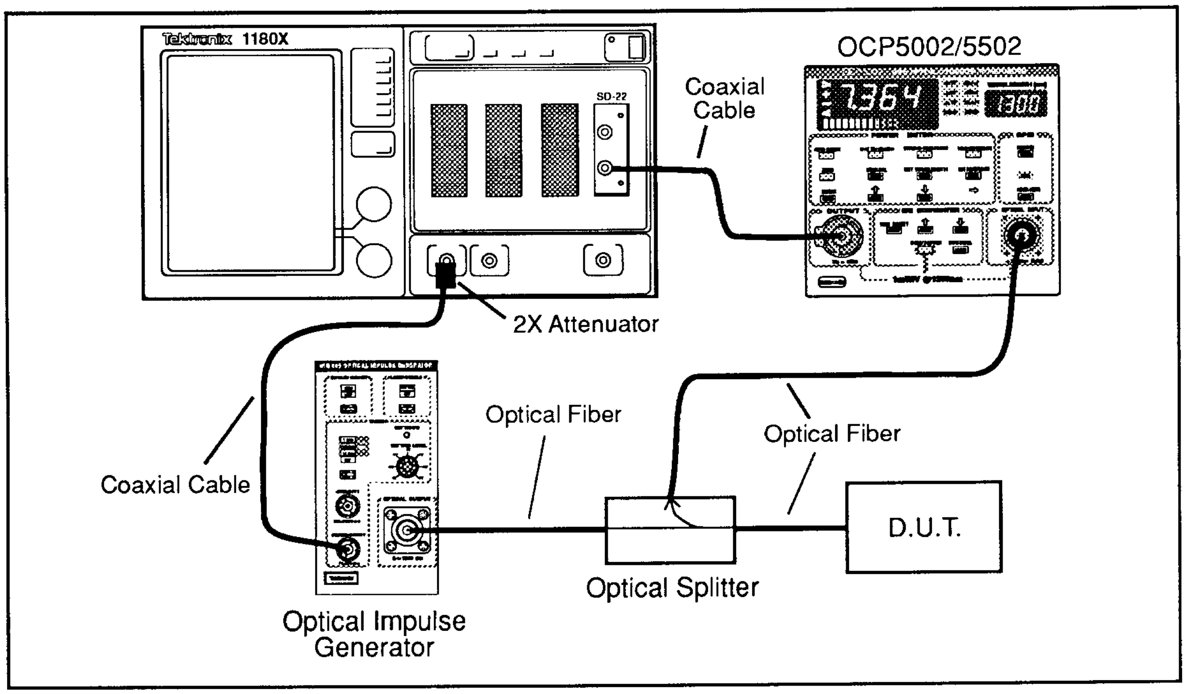


Figure 3-10. Equipment Connections for Reflection Test.

Figure 3-11 shows a waveform showing the Fresnel reference reflection on top and the actual reflections from the device under test on the bottom.

The OCP makes reflection measurements more conveniently. The O/E converter measures individual reflections from connectors and optical devices while the power meter measures total reflected optical power.

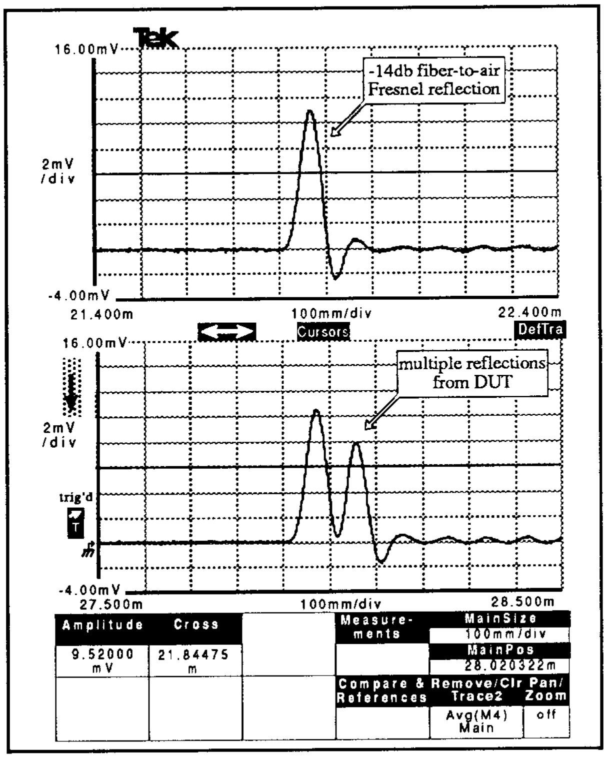


Figure 3-11. Reflection Measurement Display.

Chapter 4: Acceptance Tests

The test procedures in this chapter explain how to verify that the performance of the OCP meets the specifications that are listed in Chapter 7: Specifications. A procedure for calibrating the wavelength constants and O/E converter offset follows the test procedures.

Allow a 20-minute warm-up period for the instrument being tested and operate the instrument within the environmental specifications listed in Table 7-7 (the temperature range is 0° C to 50° C).

REQUIRED TEST EQUIPMENT

Table 4-1 lists the test equipment required to perform acceptance tests for the OCP. These procedures assume you are familiar with the operation of the equipment listed. For specific information regarding this equipment, consult the appropriate instruction manuals.

Table 4-1.
Required Acceptance Test Equipment.

Item	Description	Minimum Specification	Recommended Equipment
1	Digital Sampling Oscilloscope	4 GHz with the ability to perform digital integration on acquired waveform	Tektronix 11800 Series Oscilloscopes or CSA803 Analyzer
2	Sampling Head	4 GHz bandwidth	Tektronix SD-22, SD-24, SD-26, or SD-30
3	Optical Impulse Generator	<40 ps pulse width	Tektronix OIG502
4	Digital Voltmeter	4 1/2 digit, 1 mV resolution	Tektronix DM504, DM5520, DM5120, or DM5110/5111
5	Optical Power Meter for Reference Measurement	>2.5% accuracy, 5 pW resolution, and 5 mW maximum power	Hewlett-Packard HP8125A
6	Laser	1300 nm wavelength ±10 nm, 2 mW output	Tektronix LDM1301 with LDC600
7	RF Power Meter	<0.1 mV noise, >4 GHz bandwidth	Hewlett-Packard HP436A
8	Optical Attenuator	4 decades (40 dB)	JDS Model 5000L
9	Fiber Jumpers	62.5 µm multimode fiber	
10	Master Optical Fiber	Multimode (62.5 µm) fiber with single-mode connectors	Tektronix P/N 174-2322-00, 174-2323-00, or 174-2324-00
11	50 Ω Termination	±1 %, BNC male-to-BNC female	Tektronix P/N 011-0049-01
12	2X Electrical Attenuator (optional)	Connectors: BNC female-to-BNC male	Tektronix P/N 011-0069-02 (015-1018-00 adapter required with Tektronix 11800 Series Oscilloscope or CSA803 Analyzer)
13	Coaxial Cable	50 Ω impedance, BNC male connectors	Tektronix P/N 012-0076-00
14	Coaxial Cable	50 Ω impedance, 4 GHz bandwidth, SMA connectors	Tektronix P/N 174-1364-00
15	Adapter	SMA female-to-BNC male	Tektronix P/N 174-0572-00

ACCEPTANCE TESTS

The following acceptance tests are included in this section:

- Power Meter Zero
- Power Meter Stability
- Power Meter Absolute Accuracy
- O/E Converter Output Zero
- O/E Converter Gain
- O/E Converter Offset Range
- O/E Converter Noise
- O/E Converter Rise Time and Aberrations
- O/E Converter Output Impedance

Power Meter Zero Test

This procedure verifies that the power meter can properly zero the display.

1. Select **AUTO RANGE** mode and **Watts** units.
2. Install the dust cover on the **OPTICAL INPUT** port.
3. Press the **ZERO** key.
4. Verify that the display reads **<0.05 nW**.

Power Meter Stability

To check the power meter stability, turn the instrument on for 20 minutes. Leave the dust cover on. Verify that the displayed power does not change more than **±.05 nW** in a 30 second period.

Power Meter Absolute Accuracy

Perform the following steps to check the absolute accuracy of the OCP power meter. Figure 4-1 shows the equipment connections.

1. Install the dust cover on the OCP **OPTICAL INPUT**.
2. Press the **ZERO** key.
3. Connect the laser (item 6) to the input of the optical attenuator (item 8) using a fiber jumper (item 9).
4. To make a reference power measurement, connect the output of the optical attenuator to the input of the optical power meter (item 5) using the master optical fiber (item 10).
5. Adjust the attenuator so that the power meter reads **50 µW**.
6. Remove the dust cover from the OCP **OPTICAL INPUT**.
7. Disconnect the cable from the optical power meter and connect it to the OCP **OPTICAL INPUT**. Verify that the OCP power meter reading is within **±5%** of the optical power meter reading. If it is not, ensure that the fiber connectors are clean.

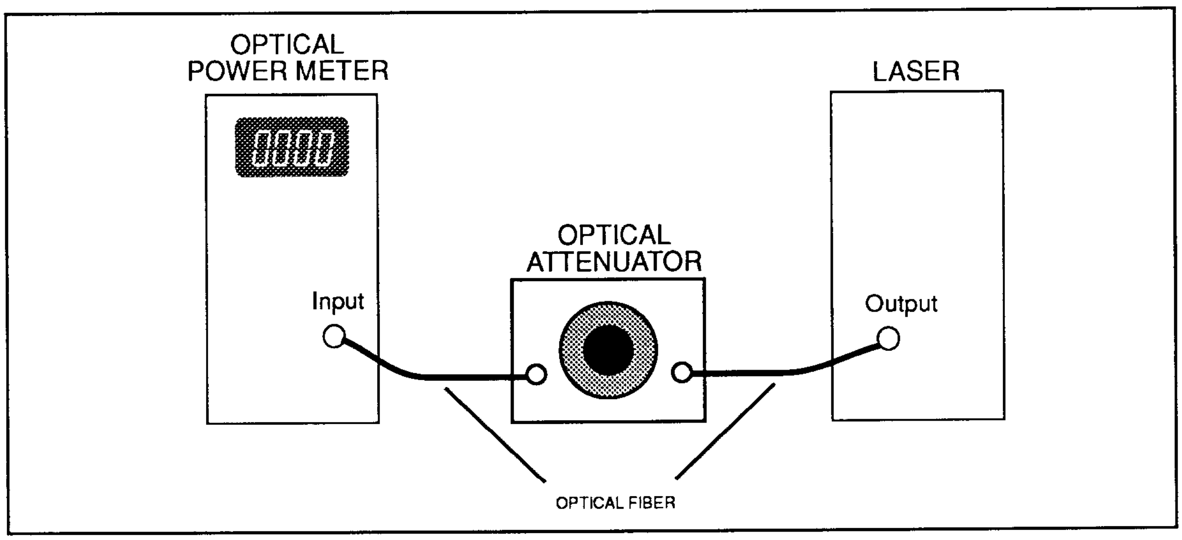


Figure 4-1. Equipment Connections for Absolute Accuracy Test.

O/E Converter Output Zero

This procedure verifies the zero capability of the O/E converter.

1. Using the coaxial cable (item 13) and a 50 Ω termination (item 11) connect the OCP **OUTPUT** to the digital voltmeter (item 4).
2. Install the dust cover on the OCP **OPTICAL INPUT**.
3. Press the **ZERO** key.
4. Set **DC STABLE** to **OFF** (the LED will be off).
5. Verify that the output voltage is **< ±5 mV**.

6. Set **DC STABLE** to **ON** (the LED will be on).
7. Verify that the output voltage is **< ±0.5 mV**.

O/E Converter Gain

Perform the following steps to check the gain of the O/E converter. This procedure is valid at the 1300 nm wavelength only.

1. Using a fiber jumper (item 9), connect the laser (item 6) to the input of the optical attenuator (item 8). Figure 4-1 shows the equipment connections.
2. To make a reference measurement, use the master optical fiber (item 10) to connect the optical attenuator output to the optical power meter (item 5) input.
3. Adjust the optical attenuator so that the reference power meter reads **100 µW**.
4. Set the OCP **DC STABLE** to **OFF** and **VIEW OFFSET** to **ZERO**.
5. Using a coaxial cable (item 13) and a 50 Ω termination (item 11), connect the digital voltmeter (item 4) to the OCP **OUTPUT**. Note the zero level.
6. Disconnect the optical attenuator output from the reference power meter and connect it to the OCP **OPTICAL INPUT**. Figure 4-2 shows the equipment connections.
7. Verify that the change in output voltage is **100 mV** ±8%.

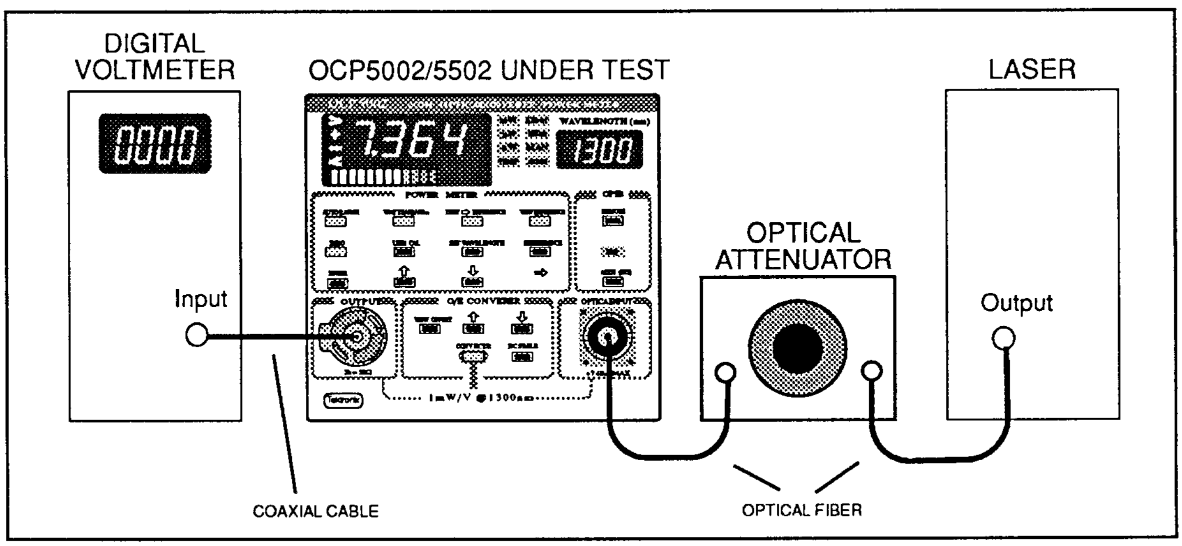


Figure 4-2. Equipment Connections for O/E Converter Gain Test.

O/E Converter Offset Range

This procedure checks the O/E converter offset range.

1. Using a coaxial cable (item 13) and a 50 Ω termination (item 11), connect the digital voltmeter (item 4) to the OCP **OUTPUT**.
2. Using a fiber jumper (item 9), connect the laser (item 6) to the input of the optical attenuator (item 8). Refer to Figure 4-1 for the equipment connections.
3. Using the master optical fiber (item 10), connect the optical attenuator output to the reference power meter (item 5) input.
4. Set laser source to **1 mW** and set the OCP **VIEW OFFSET** to **-1 mW**.
5. Connect the attenuator output to the OCP **OPTICAL INPUT**.
6. Check that the output is **0** ±50 mV with **DC STABLE ON** and **DC STABLE OFF**.
7. Set the OCP **VIEW OFFSET** back to **0**.

O/E Converter Noise

This procedure checks the noise level of the O/E converter.

1. Install the dust cover on the OCP **OPTICAL INPUT**.
2. Using the coaxial cable (item 14) and the BNC-to-SMA adapter (item 15), connect the RF power meter (item 7) to the OCP **OUTPUT**.
3. Verify that the power meter reading is less than **20 nW** for a 30-second interval.

Rise Time and Aberrations

Perform the following steps to measure the rise time and aberrations of the OCP. Figure 4-3 shows the equipment connections.

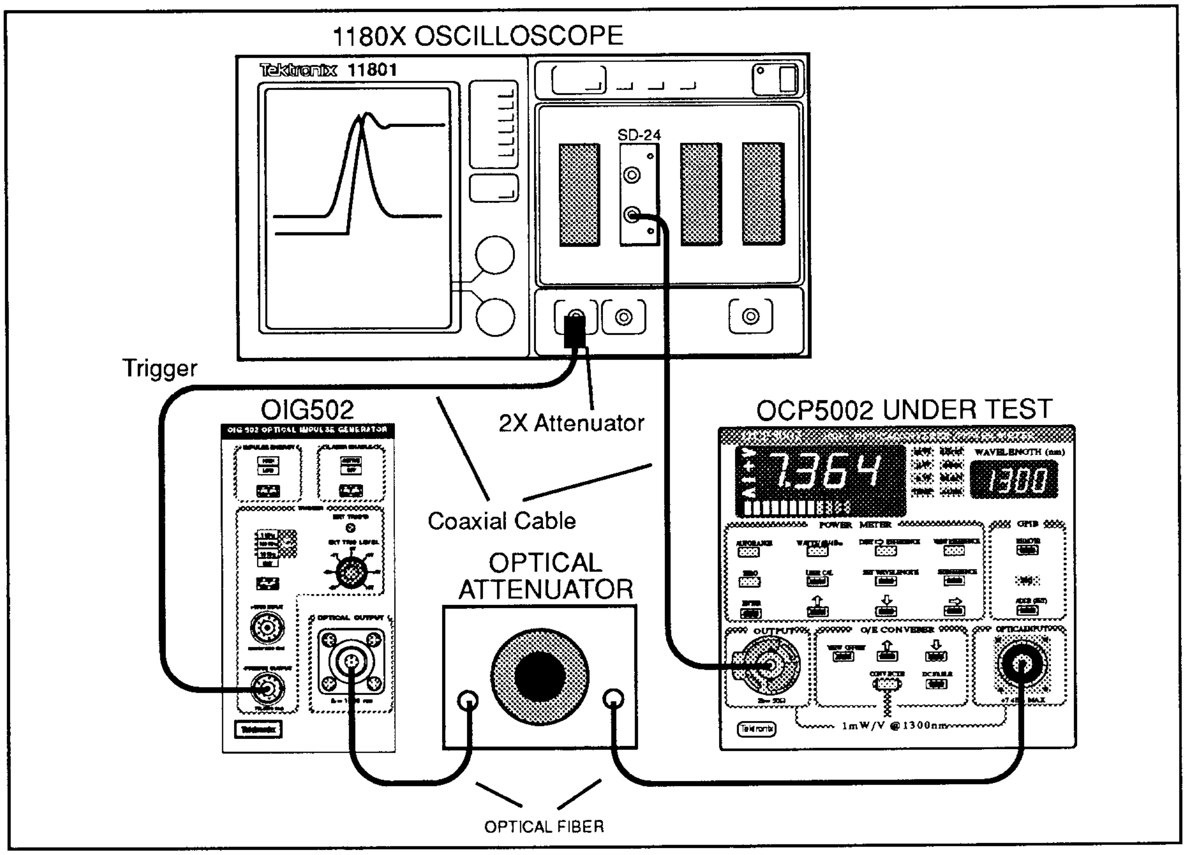


Figure 4-3. Equipment Connections for Rise Time Measurement

1. Using the fiber jumper (item 9), connect the output of the optical impulse generator (item 3) to the input of the optical attenuator (item 8).
2. Using the master optical fiber (item 10), connect the output of the optical attenuator to the OCP **OPTICAL INPUT**.
3. Set the OCP **VIEW OFFSET** to **0**.
4. Using a coaxial cable (item 13), connect the trigger output of the optical impulse generator (item 3) to the trigger input of the oscilloscope (item 1). Select the external trigger function of the oscilloscope.

• ***Note*** *If you are using a Tektronix 11800 Series oscilloscope or a Tektronix CSA803 Analyzer, use a 2X attenuator (item 12) on the trigger input for better trigger stability.*

5. Set the oscilloscope trigger to AC coupling and negative slope.

6. Using an SMA coaxial cable (item 14) and BNC adapter (item 15), connect the OCP **OUTPUT** to the appropriate sampling head (item 2) input.
7. Set the optical impulse generator to produce a low-energy impulse at a repetition rate of **1 MHz**.
8. Set the **Vert Size** of the oscilloscope to **20 mV/div** and adjust the vertical offset so that all of the impulse is on the screen.
9. To locate the impulse, expand the oscilloscope timebase.
10. Adjust the optical attenuator so that the impulse height on the oscilloscope is between **50 mV** and **100 mV**.
11. Adjust the **Main Size** of the oscilloscope to **1 nsec/div** and the **Main Position** so that the impulse starts at the third horizontal division.
12. Using the oscilloscope **Store/Recall** menu, store the impulse trace.
13. Remove the live trace and recall the stored waveform.
14. Using the oscilloscope **Measurement** menu, select the **Measurement** submenu and select **Mean**.
15. Select the **Mean** submenu and select the **Left Limit-Right Limit** function. Use the lower cursor knob to set the right limit to **20%**.
16. Note the displayed **Mean** value.
17. Select the **Def Tra** arrow in the upper-right side of the oscilloscope screen. Define the trace as **Intg(StoX-M)**, where **StoX** is the trace stored in step 10 and **M** is the mean value measured in step 13. A trace similar to that of Figure 4-4 should result. The actual curves will overlap but they are shown separately here for clarity.
18. Using the oscilloscope **Measurement** menu, measure the rise time of the integrated impulse response and verify that it is less than **260 picoseconds**. The rise time is measured from the 10% to the 90% amplitude points.
19. To measure aberrations, turn on the horizontal bar cursors of the oscilloscope and set one cursor at the 0% level of the waveform. Set the other cursor at the level **5 nanoseconds** after the **50%** point of the step. Note the difference between the two levels.

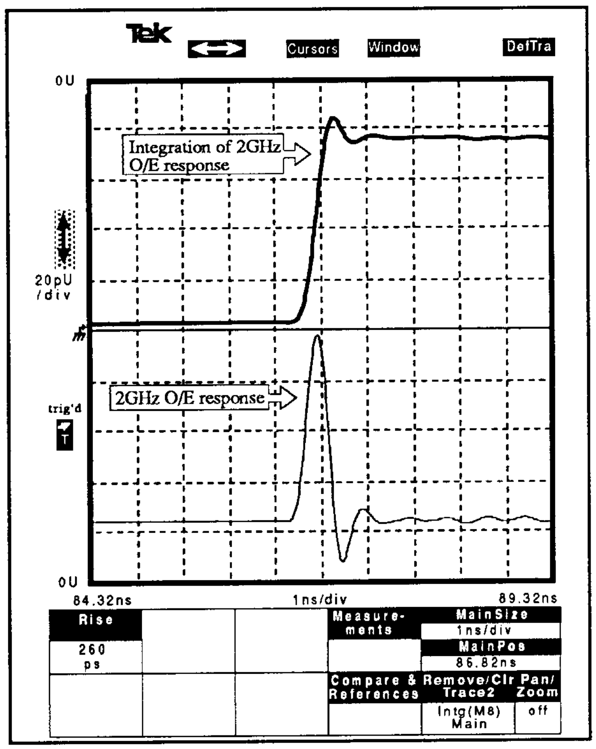


Figure 4-4. Integrated Response Curve.

20. Now set the cursors on the maximum overshoot and minimum undershoot points. Note the difference between the two levels.
21. Divide the measurement in step 20 by the measurement in step 19 and verify that the result is less than 15%.

Output Impedance

This procedure verifies the O/E converter output impedance.

1. Install the dust cover on the OCP **OPTICAL INPUT**.
2. Set the OCP **VIEW OFFSET** to **-100** μ**W**.
3. Using a coaxial cable (item 13) and 50 Ω termination (item 11), connect the digital voltmeter (item 4) to the OCP **OUTPUT** connector.
3. Measure the **OUTPUT** voltage with the digital voltmeter. Note the value.
4. Repeat step 3 without using the 50 Ω termination and note the value.
5. Divide the absolute value in step 3 by that of step 4. Verify that the result is **0.5** ±5%.
6. Repeat steps 3 through 5 using **VIEW OFFSET** values of **400** μ**W** and **800** μ**W**.
7. Set the **VIEW OFFSET** value back to zero.

Chapter 5: Maintenance and Troubleshooting

Chapter 5 describes how to perform routine maintenance on the OCP and how to use the diagnostic features. The OCP has no user-serviceable parts so, if the OCP needs service, contact your nearest Tektronix service representative.

MAINTENANCE PROCEDURES

The following maintenance procedures are discussed in this section.

- Cleaning the Optical Port
- Changing Optical Port Connectors
- Removing the OCP5502 Power Module
- Removing the OCP5002 Side Covers
- Replacing the Release Lever Assembly

Cleaning the Optical Port

If the OCP's optical sensitivity suddenly drops or if the OCP loses accuracy, the optical fiber or optical port may be dirty.

•*Note:* *To keep cleaning to a minimum, install the dust cover when no fiber is connected to the optical port.*

•*Note:* *Using an optical fiber jumper will extend the life of the OCP* ***OPTICAL INPUT*** *connector. The jumper reduces the possibility of scratching the surface of the internal OCP fiber when making connections to the instrument. See the Optional Accessories list in Chapter 1 for a list of available fiber jumpers.*

Use these steps to clean the optical port and fiber tip.

1. Turn the power supply off and unplug the AC line cord.
2. Use a Phillips screwdriver to remove the four screws that secure the bulkhead connector to the front panel (see Figure 5-1).
3. Gently pull the bulkhead out of the OCP and unscrew the fiber connector. Be careful not to pull beyond the fiber slack.

• *Note* *If you accidently push the disconnected fiber back into the instrument, remove the OCP from the power supply (the procedure is described later in this section), remove the right-hand instrument cover and pull the fiber connector back out.*

4. Clean the tip of the fiber cable using a soft, lint-free cloth and isopropyl alcohol of at least 95% purity.
5. If available, use low-pressure compressed air or canned air to blow any dirt out of the bulkhead connector. If compressed air is not available, then the bulkhead will have to be taken apart and cleaned. Refer to the "Changing the Optical Port Connectors" procedure later in this chapter for information about bulkhead disassembly.
6. After cleaning the bulkhead, reconnect the fiber and install the bulkhead. Be sure to reinstall the dust cover chain.

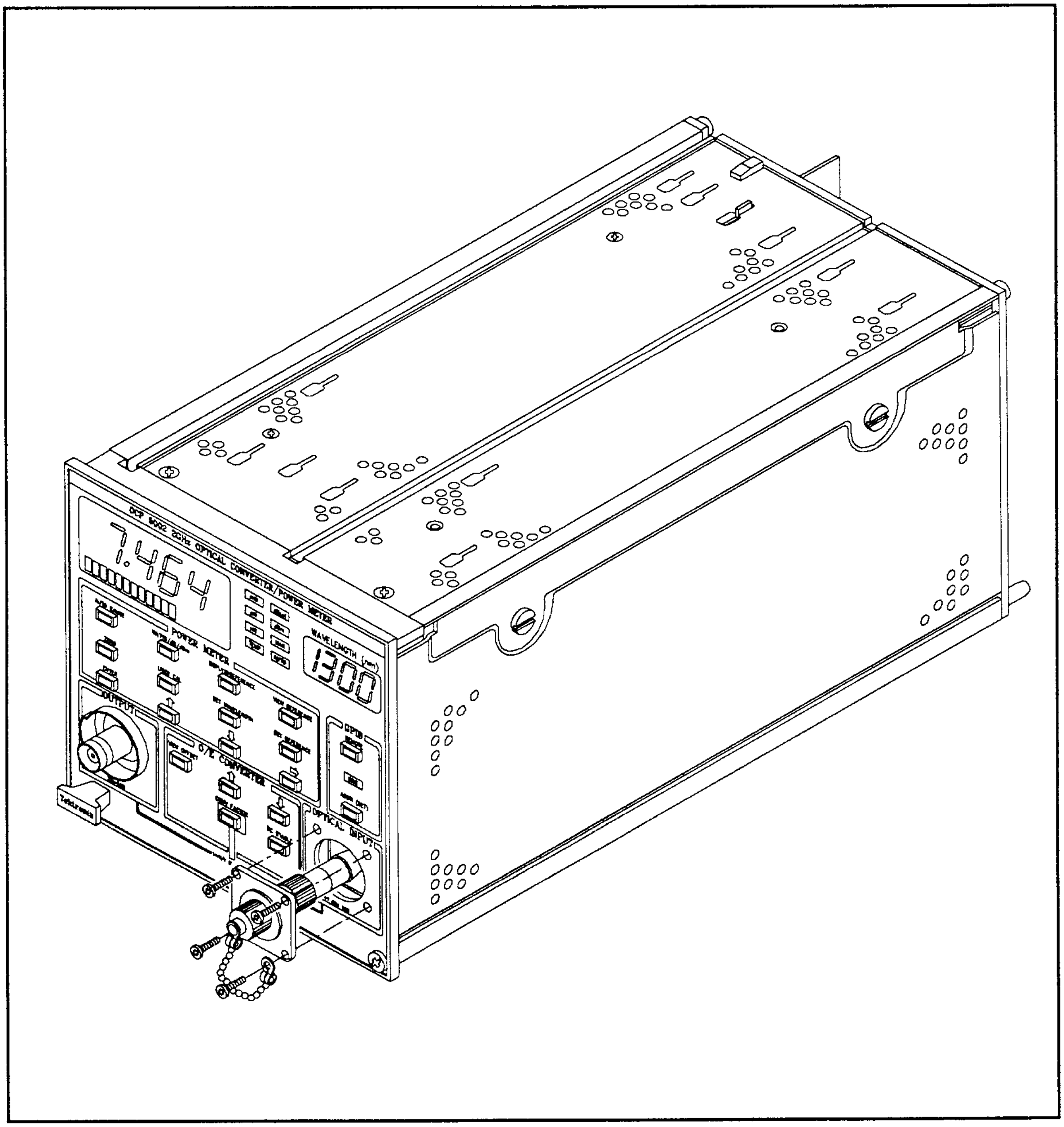


Figure 5-1. Removing the Optical Bulkhead Connector.

Changing the Optical Port Connectors

The OCP is shipped with the FC connector bulkhead and dust cover installed. To change to the ST or DIN connectors, perform the following procedure.

1. Turn the power supply off and unplug the AC line cord.
2. Use a Phillips screwdriver to remove the four screws that secure the bulkhead connector to the front panel (see Figure 5-1).
3. Gently pull the bulkhead out of the unit and unscrew the fiber connector. Be careful not to pull beyond the fiber slack. If you accidently push the disconnected fiber back into the instrument, then remove the unit from the power supply (described later in this section), remove the right-hand instrument cover and pull the fiber connector back out.
4. Disassemble the bulkhead. Figures 5-2 through 5-6 show the different connector assemblies including the SMA and Biconic connectors.
5. Replace the current bulkhead with the one you wish to use and re-assemble.
6. Installation is the reverse of steps 1 through 3.

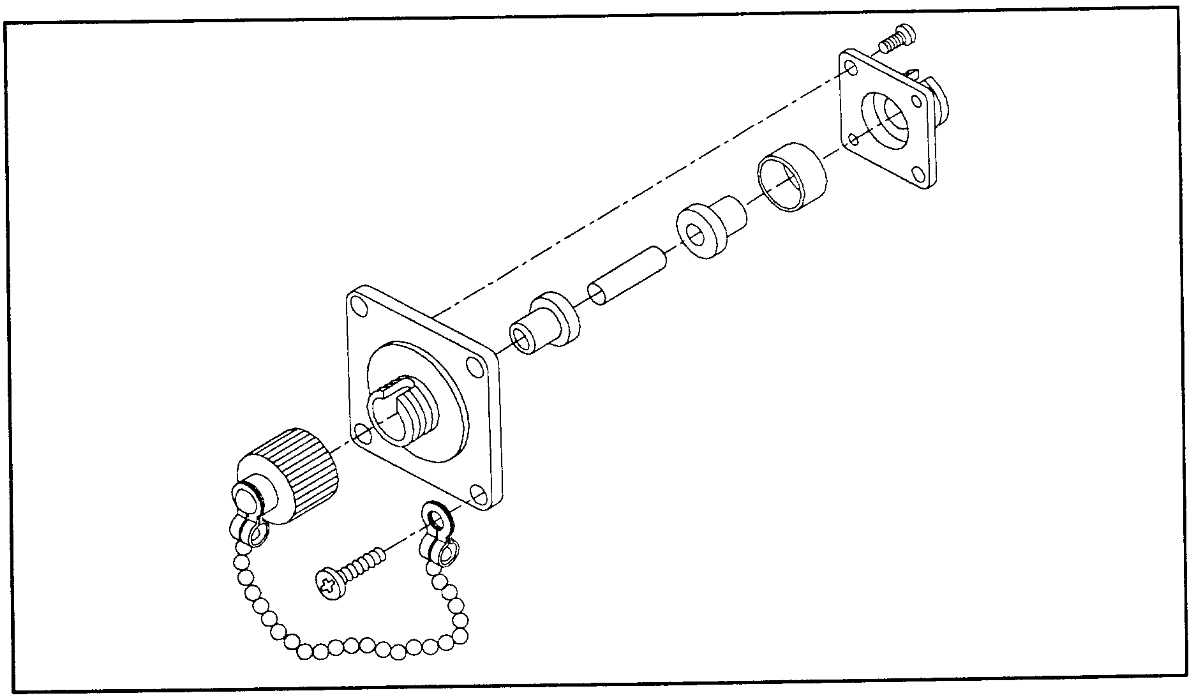


Figure 5-2. FC Optical Connector Assembly.

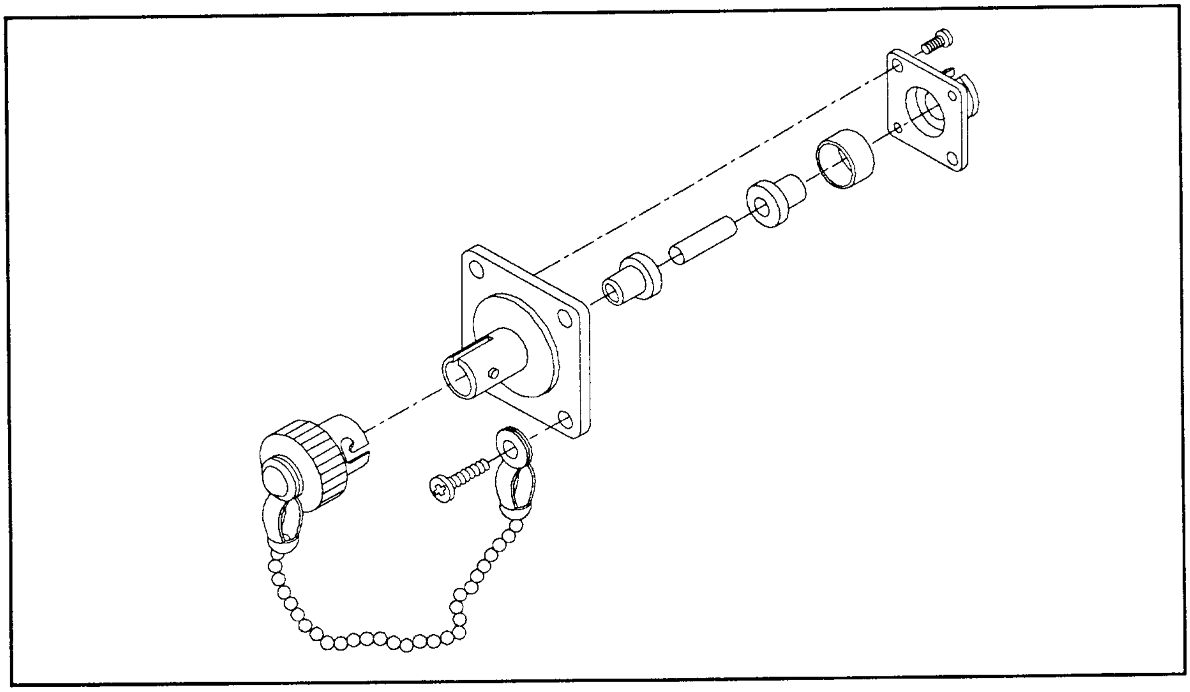


Figure 5-3. ST Optical Connector Assembly.

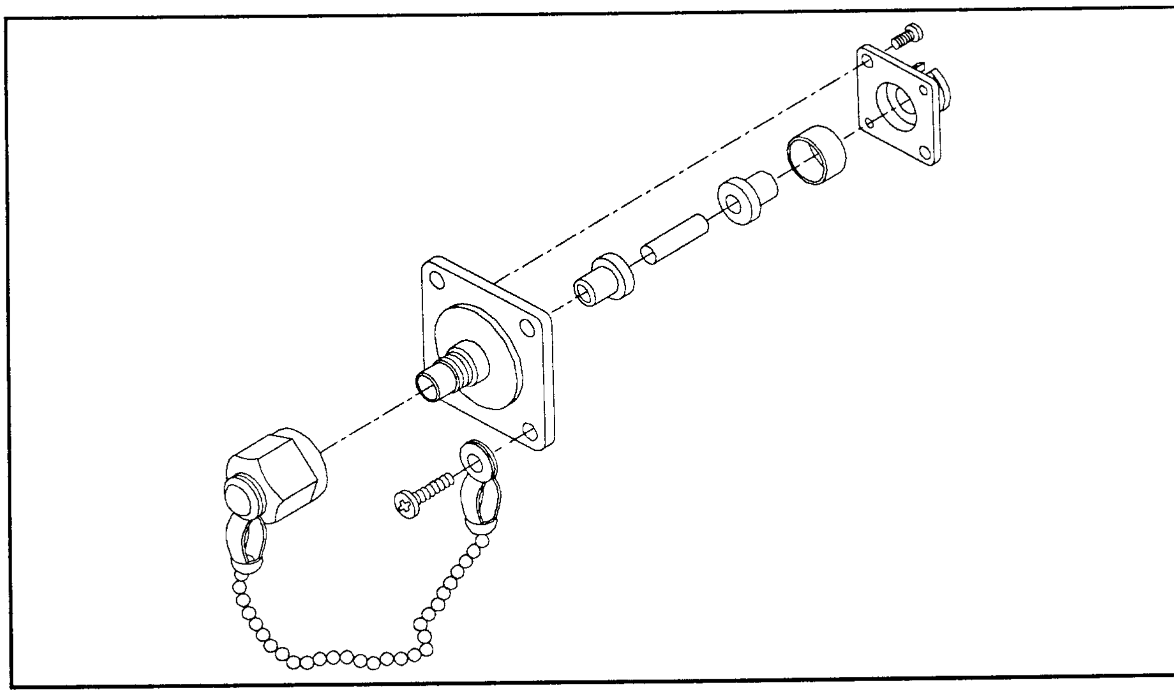


Figure 5-4. DIN Optical Connector Assembly.

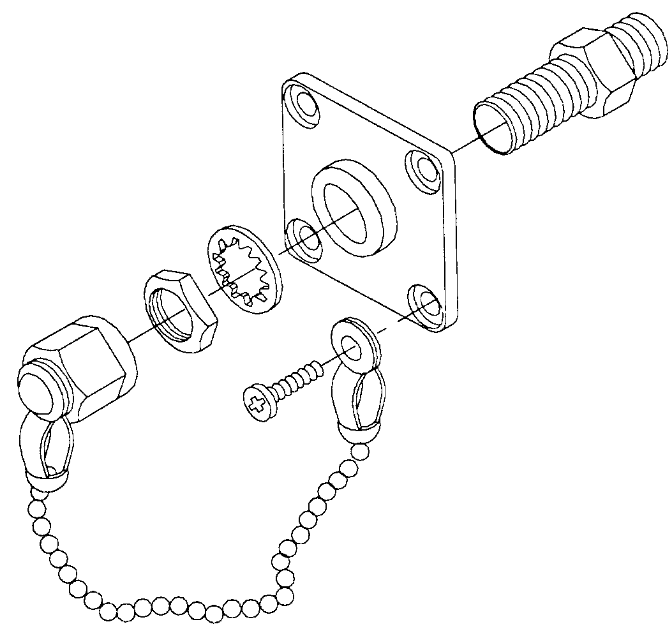


Figure 5-5. SMA Optical Connector Assembly.

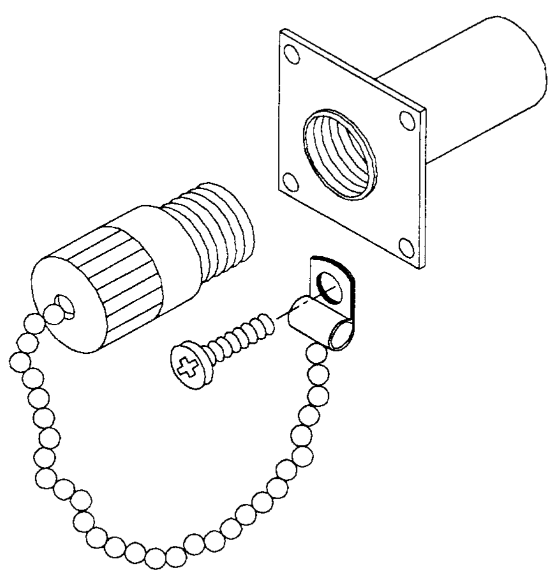


Figure 5-6. Biconic Optical Connector Assembly.

Removing the OCP5502 Plug-In from the Power Module

You may wish to remove the OCP5502 plug-in from the power supply if either the plug-in or the power supply fails to operate. To remove the plug-in, perform the following steps.

1. Unscrew the mounting screw on the bottom of the power supply as shown in Figure 5-7.
2. Grasp the release lever and pull the instrument out of the power supply.
3. To reinstall the plug-in, align the plug-in groove with the power supply rail and insert the plug-in. The front panel of the plug-in should be flush with the front of the power supply cabinet.

Removing the OCP Side Covers

This procedure describes how to remove the side covers from the OCP plug-in unit. Use this procedure to gain access to the optical fiber if you accidently push the fiber into the instrument while changing connectors.

1. Using a coin or a large flat-blade screwdriver, turn the two plastic securing screws located at the top of the cover 90° counter-clockwise.
2. Swing the top of the cover away from the instrument and pull the cover out.
3. Installation is the reverse of steps 1 and 2.

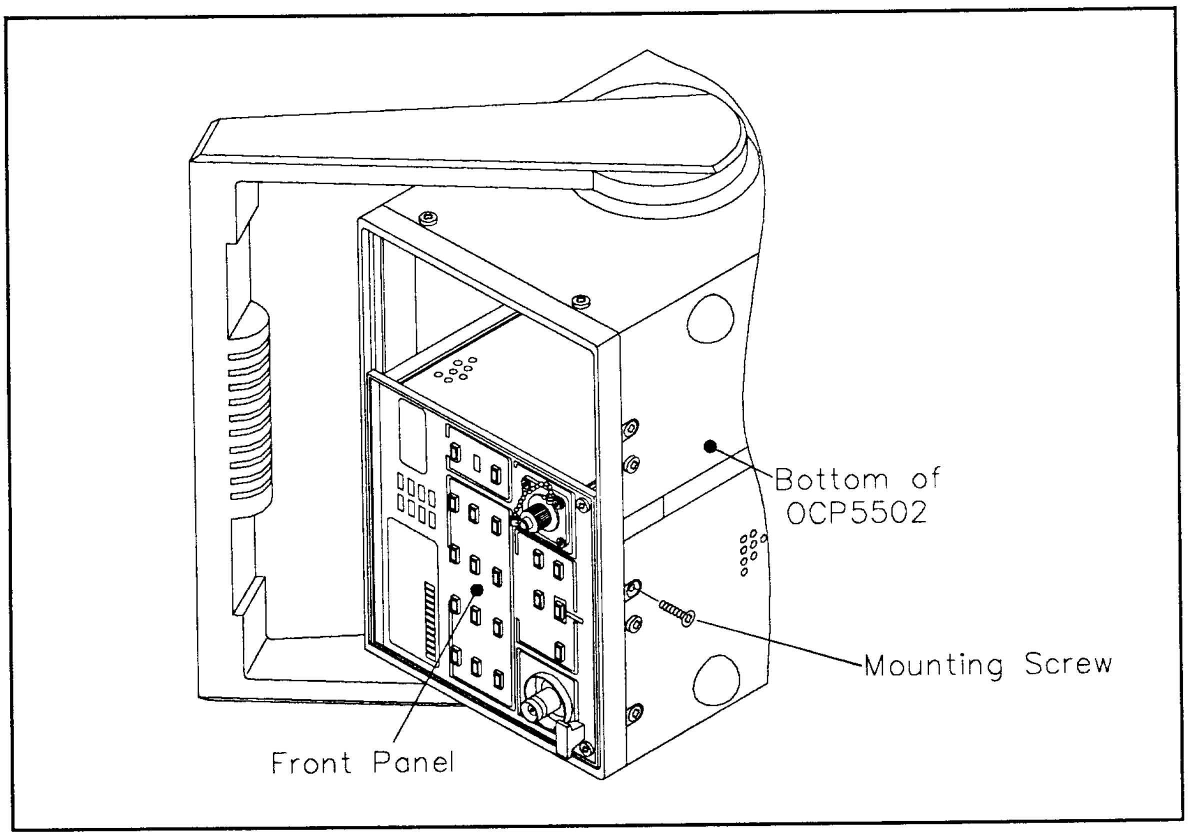


Figure 5-7. Location of the OCP5502 Mounting Screw.

Replacing the Release Lever Assembly

If the plastic release lever located at the lower left-hand side of the front panel breaks, it will need to be replaced. There are four pieces to the assembly (to order replacement parts, see Chapter 8: Replaceable Parts). These steps describe how to replace each piece of the assembly.

1. To remove the latch knob, push the latch bar forward slightly with your finger and lift the latch knob out of the bar as shown in Figure 5-8. Pull the latch knob out through the front panel.
2. Using long nosed pliers, unhook each end of the spring.
3. To remove the latch bar, remove the front panel by unscrewing the two top screws and the two front screws shown in Figure 5-9. Pull the front panel out just enough to remove the latch bar (about 1/2").
4. Slide the latch bar forward until it clears the retaining latch. Remove the latch bar.
5. Push the retaining latch up past the retaining clip, as shown in Figure 5-10, and pull the latch out.
6. Installation of the latch assembly is the reverse of steps 1 through 5.

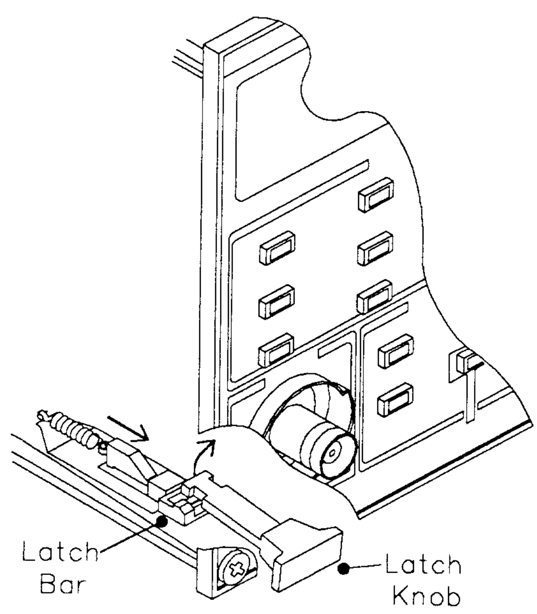


Figure 5-8. Removal of Latch Knob.

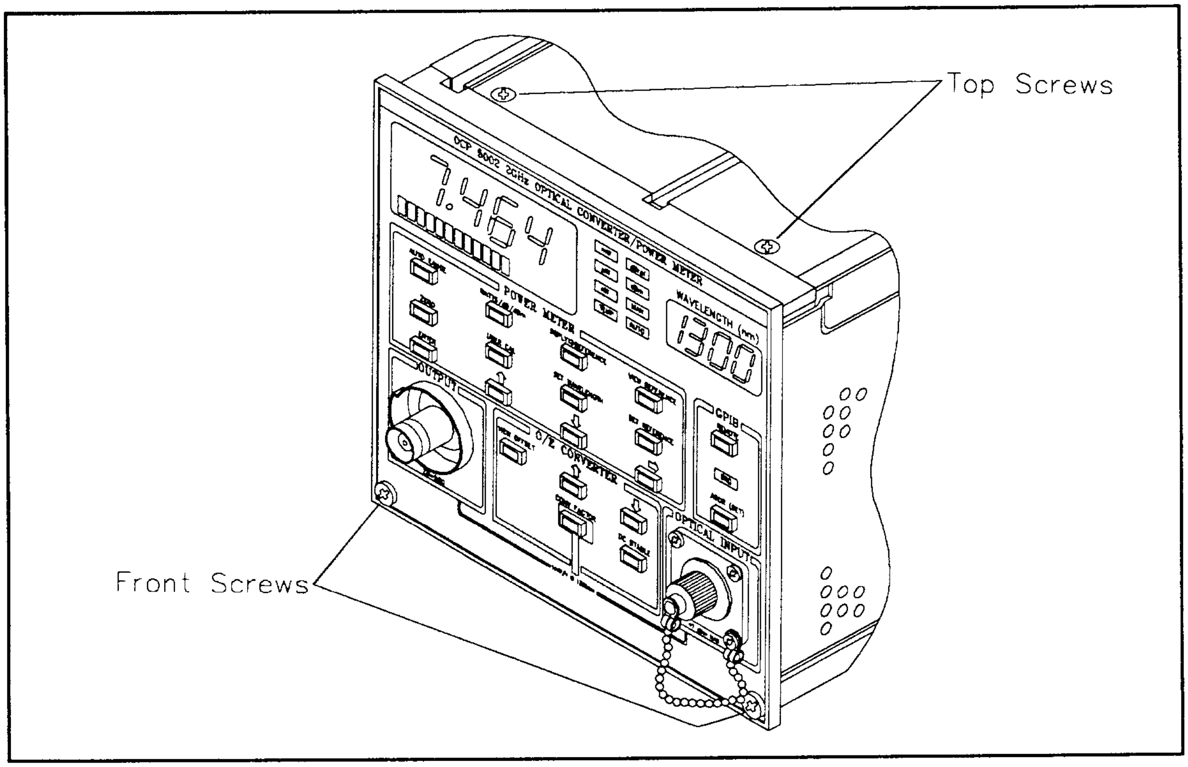


Figure 5-9. Location of Front Panel Screws.

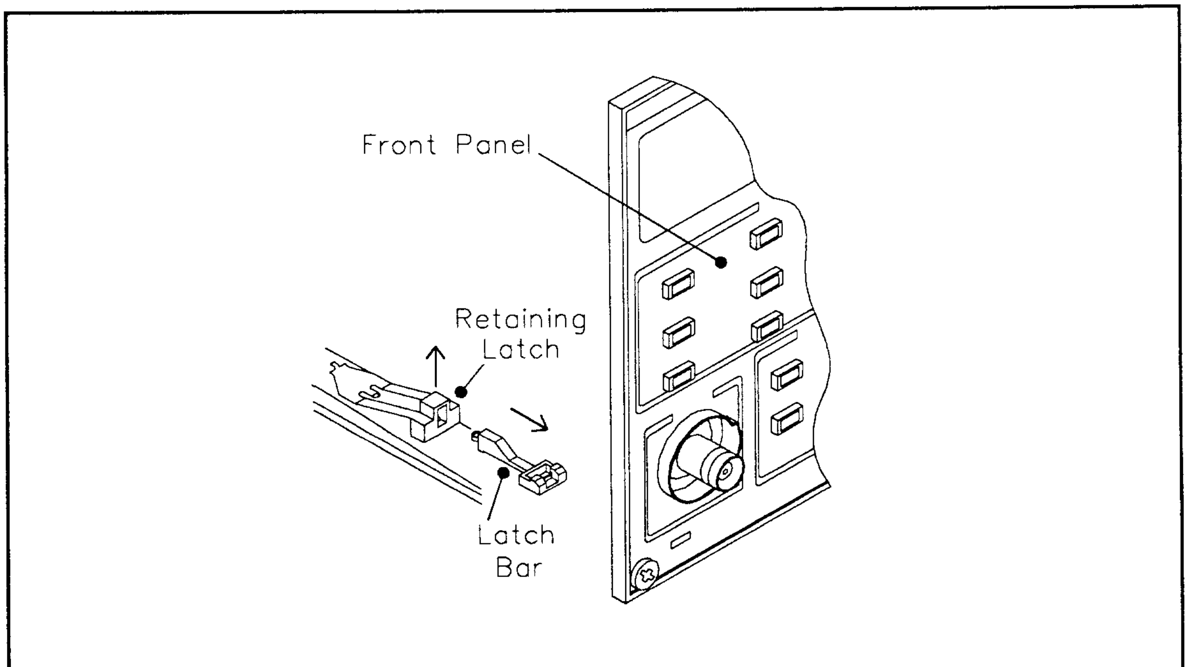


Figure 5-10. Removal of Retaining Latch.

TROUBLESHOOTING

This section describes the types of diagnostic routines available with the OCP. When a diagnostic routine fails, the OCP displays an error code in the wavelength display or on the GPIB bus. Look up the error code in Appendix B and note the recommended action. If the action involves user intervention, then perform the stated action. If the action involves instrument repair, contact your nearest Tektronix service representative.

• *Note* *There are no user-serviceable parts in the OCP. These diagnostic routines are available only to help you determine if you have a faulty instrument. Instrument repairs should be performed only by authorized Tektronix service personnel. Contact your nearest Tektronix Service Representative for more information.*

There are four categories of user-accessible diagnostics:

- Power-Up
- Front Panel
- Zero

Power-Up Diagnostics

Power-up diagnostics are performed every time the OCP is turned on. If a failure occurs, the power meter will display **FaIL** and the wavelength display will show the error code number.

• *Note* *If the error does not disable operation of the GPIB Interface, the error code is entered into the GPIB event queue Use a *ESR? and a *ALLEV? command to read the event codes on the GPIB bus (Chapter 6 provides more details about the *ESR? and ALLEV? commands).*

Pressing the **ENTER** key will exit the loop and allow the instrument to continue its power-up sequence in spite of the error.

Front Panel Diagnostics

You can perform a lamp check on all front panel indicators by holding the **ENTER** button down for two seconds or longer.

To check if the buttons are functioning, hold any button down while powering up the instrument. The power readout will display **bttn** and the wavelength readout will show the number of the last button pressed. Pressing a new button will display its number. If a button does not respond, there is a problem with that circuit. Contact your nearest Tektronix service representative for instrument repair or replacement.

To return to normal operation, press **ENTER** twice.

Zero Diagnostics

If a failure occurs after the **ZERO** button is pressed or a CAL command is issued from the GPIB Interface, an error code starting with a 2 is displayed in the Wavelength Display. The error code is also returned over the GPIB Interface bus. Look up the error code in Appendix B to find out what failed.

Chapter 6: GPIB Commands

Chapter 6 provides information about the OCP General Purpose Interface Bus (GPIB). We assume that you are familiar with computer programming and have the required GPIB controller hardware listed in the "Getting Started" section of this chapter.

This chapter includes four sections:

- General GPIB Information
- OCP GPIB Overview
- GPIB Command Descriptions
- GPIB Command Examples

GENERAL GPIB INFORMATION

You can use the GPIB feature to make automated measurements with the OCP, to remotely control the OCP in dangerous environments, or to write GPIB programs that allow non-technical personnel to test optical instruments.

The following equipment is required to use the GPIB interface:

- Computer with GPIB Interface Card and GPIB Software
- 24-Pin GPIB Interface Cable
- OCP

Connect one end of the interface cable to the GPIB connector located on the right-hand side of the OCP5502 or TM5000 Series Power Module rear panel. Connect the other end of the interface cable to the GPIB connector of the computer.

Before sending commands to the OCP, check the current GPIB address of the OCP. The GPIB address can be checked and set to any value within the range of 0-30 by using the **ADDR SET**, [↑], and [↓] keys (see Chapter 2 for more information about the **ADDR SET** function). You can also disable the OCP GPIB function by setting the address to a value displayed as **OFF** in the wavelength display. This is an "Off Line" state. Press the **ENTER** button to enter the address. The OCP remembers the address settings even after being powered down. The default GPIB address is 04.

After setting the desired address on the OCP, be sure that the computer controller sends the GPIB commands to that same address. The individual commands are described later in this section.

OCP GPIB OVERVIEW

The OCP's GPIB protocol conforms to the IEEE 488.2 standard. Table 6-1 lists the IEEE 488.1 Interface function subsets that the OCP supports.

Table 6-1.
Supported IEEE Interface Subsets.

Mnemonic	Description
T6	Basic Talker, Serial Poll, no Talk Only mode, unaddress if my listen address
SH1	Source Handshake capability
AH1	Acceptor Handshake capability
L4	Basic listener, no Listen Only Mode, unaddress if my talk address
SR1	Complete Service Request Capability
RL1	Complete Local/Remote Capability
PP0	No Parallel Polling Capability
DC1	Complete Device Clear Capability
DT0	No Group Event Trigger

In the OCP GPIB implementation, all queries generate a response when the command is parsed and all commands are sequential (non-overlapped).

Figure 6-1 shows how the OCP handles the GPIB status information. The length of the Event Queue is 32. The Input Buffer and Output Buffer share a common memory block of 8192 bytes. The memory is allocated to the buffers in 128-byte segments for each input command or output message.

The Device Event Status Enable Register (DESER) can mask a device event from setting its bit in the Standard Event Status Register (SESR) when the corresponding DESER bit is set to 0. When a DESER bit is set to 1, the corresponding event status bit can be read into the SESR and Event Queue.

The Event Status Enable Register (ESER) masks SESR bits from setting the Event Status Bit (ESB) in the Status Byte Register by setting the appropriate ESER bit to 0. When a ESER bit is set to 1, the corresponding event bit can set the ESB in the Status Byte Register.

To read the status of the Event Queue, use the EVEnt? or EVMsg? query command. A code of 0 means the queue is empty and a code of 1 means that the queue has at least one event message pending. Sending an *ESR? query prior to an EVEnt? or EVMsg? query allows messages in the Event Queue to be loaded into the Output Queue. The Message Available (MAV) bit is set after sending the *ESR? query or whenever the output queue has data.

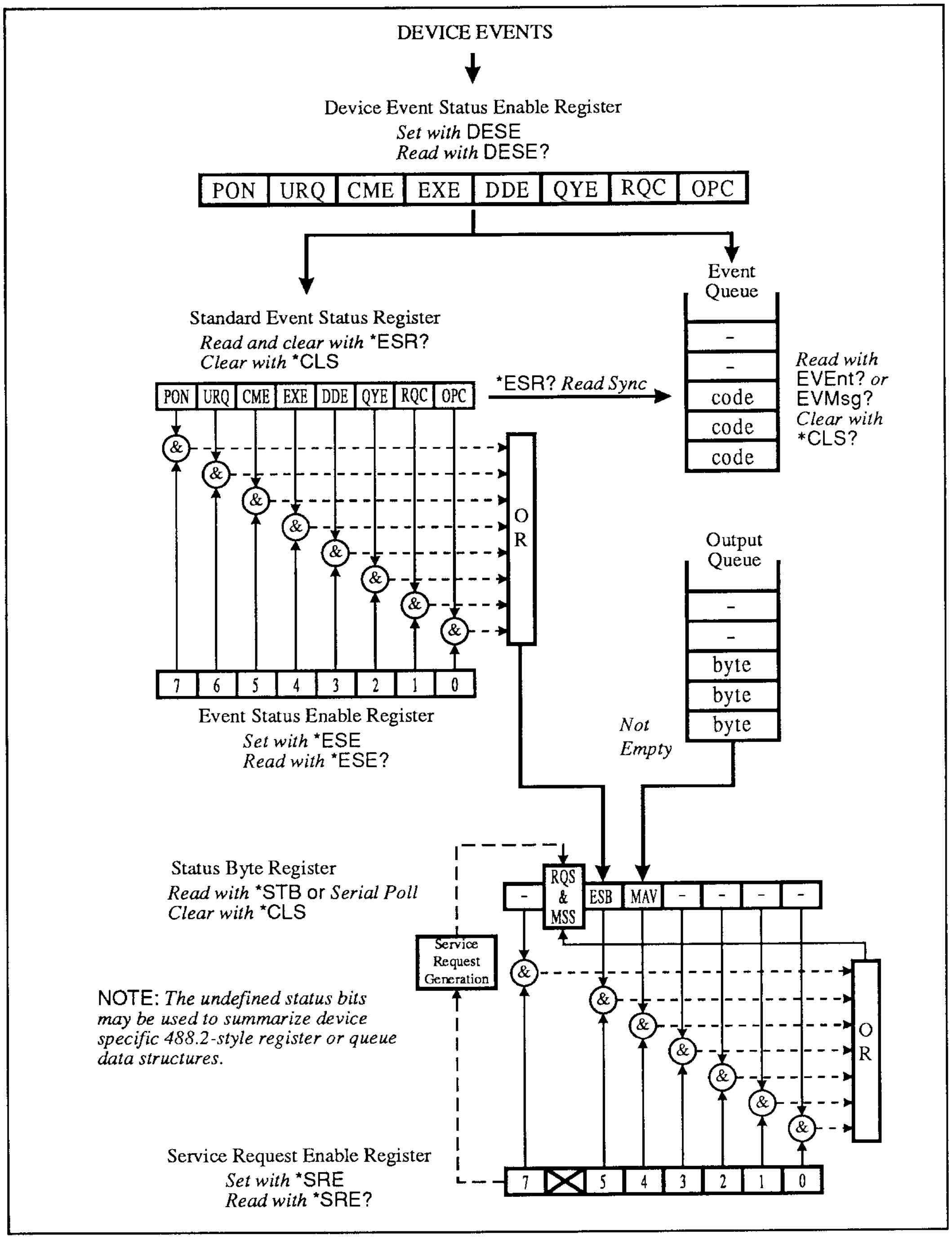


Figure 6-1. OCP GPIB Status Handling Overview.

The Service Request Enable Register (SRER) determines whether the ESB or MAV bits can set the service request bits (RQS and MSS).

The OCP stores configuration data in non-volatile memory; thus, configuration data is not lost when the instrument is turned off. The restored configuration data includes the Device Event Status Enable Register, the Event Status Enable Register, and the Service Request Enable Register when the PSC state is zero. If the PSC state is one, the Device Status Enable Register is set to 255 and the other two registers are set to 0 (see the *PSC command).

In addition to the IEEE 488.2 commands, there are GPIB commands unique to the OCP. Table 6-2 summarizes these commands. The table heads are defined below.

Parameter/Operation: This heading lists the operation being performed by an execution command or the parameter being measured by a query command.

Mnemonic: This heading refers to the command syntax. A command punctuated with a question mark indicates the query version of the command.

Data: This heading lists the arguments and numerical data that are sent to the OCP with an execution command or the data returned by the OCP from a query command. The | symbol indicates a choice of values on either side of the symbol. For example, 1 | 0 | ON | OFF indicates a choice of 1, 0, ON, or OFF.

NR1 is numerical data consisting of an integer. NR2 is a floating point number with no exponent. NR3 is a floating point number with an exponent.

Units: The Units heading describes the units of measurement that can be issued with a command or the units of the measurement returned by a query.

Comments: This heading provides supplemental information about the listed command.

The terms dBm and dBmW are synonymous. Both use a 1 mW reference.

Table 6-2.
Summary of OCP Unique GPIB Commands.

Parameter/Operation	Mnemonic	Data	Units	Comments
O/E Conversion Factor	CONV?	NR3	mW/V	Reads the conversion factor for the wavelength being measured.
Select DC Stable Mode	DCStable	1 | 0 | ON | OFF		1 turns the DC Stable mode on, 0 turns it off.
Select Preset Wavelength	LAM	CAL | W1 | W2 | W3 | W4 | W5 | USER		Sets wavelength stack to one of seven entries.
Set O/E Converter Offset	OFFSet	-CF≤NR3≤CF (In mW)	mW, µW*, nW	Limits depend on conversion factor (CF).
Set O/E Converter Offset in Volts	OEVolts	-1≤NR3≤1	V, mV, µV*	
Calibrate O/E Output for TEKPROBE®	OECAL	-.25≤NR3≤1.5	V, mV, µV*	Value is value from voltmeter connected to output.
Return Power Reading	PWR?	<NR3>,units	dBmW, dB, Watts	When UNITS is Watts, exponent indicates range.
Set Range for Watts Mode	RANge	AUTO | MAN | NR3 AUTO | MAN NR3	dBm, dBmW, mW, µW*, nW, W	A value of zero with no units is also Auto-Range. If UNITS is dB or dBm RANGE is always AUTO.
Set Reference for dB Mode	REFerence	0<NR3<1E37	dBm, dBmW, mW, µW*, nW, Watts	If no units are defined, the default is Watts.
Temperature Controller	TEMP?	-1 | 0 | 1		Returns the state of the temperature controller.
TEKPROBE® Interface Query	TPI?	0 | 1		1 indicates active, 0 indicates inactive.
Initiate a New Power Reading	TRIG			

Table 6-2 (continued).
Summary of OCP Unique GPIB Commands.

<table>
<tr><th>Parameter/Operation</th><th>Mnemonic</th><th>Data</th><th>Units</th><th>Comments</th></tr>
<tr><td>Select Units</td><td>UNIts</td><td>W | dBm | dBmW | dB | dBr | dBref</td><td></td><td>Sets the default units for power measurements</td></tr>
<tr><td>Set User Calibration</td><td>USERcal</td><td>NR3 | POWer | RESPonsivity</td><td>dBm, dBmW, mW, μW*, nW</td><td>POW selects Power and RESP selects responsivity.</td></tr>
<tr><td>Set arbitrary Wavelength</td><td>WAVelength</td><td>:CAL | W1 | W2 | W3 | W4 | W5

1100<NR3<1650</td><td>m, mm, μm*, nm</td><td>If no units are specified, nm is used as the default.</td></tr>
<tr><td>Wavelength Table</td><td>WTBL</td><td>NR1, NR3, <NR1, NR3>, NR1, NR3</td><td>nm</td><td>Calibrates responsivity of photodiode to wavelength being measured.</td></tr>
<tr><td>Compensate for zero drift</td><td>ZERO?</td><td><NR1></td><td></td><td>Optical Power input must be zero.</td></tr>
</table>

* μ is sent over the GPIB as U.

GPIB COMMAND DESCRIPTIONS

This section describes all the GPIB commands implemented by the OCP. For a more complete description of the IEEE 488.2 commands refer to the ANSI/IEEE Standard 488.2-1987 document. The commands unique to the OCP are designated with a † symbol. The commands can be entered in upper- or lower-case. The capitalized portion of the command name indicates the abbreviated syntax form.

Most of the commands have a query (question) version and a command version. The query allows you to read the instrument status while the command lets you change parameters. Data in arrow brackets (< >) indicates the type of information, not literal data.

The data returned from a query depends on the format selected. If the Header command is on, then the command name will be returned with each query except for commands preceded by a *. If the Verbose command is on, then the full parameter names will be returned with each query. The following information represents data returned with the Header and Verbose commands on. If you turn Header or Verbose off, the responses will be abbreviated.

All Events - ALLev?

Syntax: ALLev?

Response: <event number> <event message string>

Description: The ALLev? command reads (and removes) all codes from the Event Queue associated with results of the last Standard Event Status Register read. This command allows the reading of all the events rather than having to perform multiple EVEnt? or EVMsg? queries. You must first send a *ESR? command to get the text string from the ALLev? command. The event number definitions are listed in Appendix A: GPIB Error Codes.

Binary Learn - BLRN?

Syntax: BLRN <binary block data>
BLRN?

Response: :BLRN <binary block data>

Description: The query version of this command reads the instrument configuration in binary form. The command version configures the instrument using the binary data format. The configuration data is 110 bytes long.

Calibration - *CAL?

Syntax: *CAL?

Response: 0 - (successful)
2421 - (unsuccessful)

Description: The *CAL? command causes the OCP to recalibrate its Analog-to-Digital Converter. If a failure occurs, a 300-type event is generated. The returned failure codes are described in Appendix A, GPIB Error Codes.

The *CAL? command requires about 5 seconds to complete. After completion the instrument is returned to state prior to the *CAL? command.

Clear Status - *CLS

Syntax: CLS

Description: The *CLS command clears the Standard Event Status Register and flushes the Event Queue.

†Conversion Factor - CONVersion?

Syntax: CONV?

Response: :CONVERSION <floating point number>

Description: The CONV? command returns the conversion factor for the O/E converter in mW per volt. This value is a function of wavelength.

†Set DC Stable Mode - DCStable?

Syntax: DCStable?
DCStable OFF or DCStable 0
DCStable ON or DCStable 1

Response: :DCSTABLE 0
:DCSTABLE 1

Description: This command sets the DC Stable mode on or off. A value of 0 is off and a non-zero value is on.

Device Event Status Enable - DESe?

Syntax: DESe?
DESe <integer>

Response: <integer representing the Device Event Status Enable Register contents>

Description: This command sets and reads the contents of the Device Event Status Enable Register. This command enables or disables events from being entered into the Event Queue and reported in the Standard Event Status Register. Figure 6-1 shows the bit significance of these registers.

Event Status Enable - *ESE?

Syntax: *ESE?
*ESE <integer>

Response: <integer representing the Standard Event Status Enable Register contents>

Description: This command sets and reads the contents of the Standard Event Status Enable Register. For each bit set with this command, the corresponding bit in the Standard Event Status Register will be summarized in the Event Status Bit (ESB) of the Status Byte Register. Figure 6-1 shows the bit significance of these registers.

Event Status Register - *ESR?

Syntax: *ESR?

Response: <integer>

Description: The *ESR? command reads the contents of the Standard Event Status Register and clears the register. The register contents show the events that occurred since the last read of the register. Table 6-3 defines the event numbers.

Table 6-3.
Standard Events Register Data.

Bit	ID	Description
7	PON	Power On
6	URQ	User Request (unused)
5	CME	Command Error
4	EXE	Execution Error
3	DDE	Device Dependent Error
2	QYE	Query Error
1	RQC	Request Control (unused)
0	OPC	Operation Complete

Get Next Event Code - EVEnt?

Syntax: EVEnt?

Response: :EVENT <integer>

Description: If *ESR? has not been received prior to the EVEnt? query, then the EVEnt? query returns the status of the event queue. A state of 0 means the queue is empty and a state of 1 means it is not empty. Receiving an *ESR? query just prior to the EVEnt? query will enable the EVEnt? query to remove event codes (NR1, an integer) from the Event Queue and place them into the Output Queue.

Get Next Event Message - EVMsg?

Syntax: EVMsg?

Response: :EVMSG <event number>,<event message string>

Description: This command is similar to the EVEnt? command except that it also includes the message string with the error code number. The error code numbers are listed in Appendix A: GPIB Error Codes.

If *ESR? has not been received prior to the EVMsg? query, then the EVMsg? query returns the status of the event queue as the following message string: "Event queue is empty new events pending." Receiving an *ESR? query just prior to the EVMsg? query will enable the EVMsg? query to remove the event code and message from the head of the event queue and place it into the output buffer. Subsequent EVMsg? queries can then be performed without the need to issue an *ESR? command to empty the queue.

Event Quantity - EVQty?

Syntax: EVQty?

Response: :EVQTY <integer representing the number of events>

Description: The EVQty? command returns the number of events associated with the last Standard Event Status Register read and thus the length of a subsequent response to an ALLev? query. The maximum number of event queue items is 32.

Response Header - HEADer or HDR

Syntax: HEADer?
HEADer 0 or HEADer OFF
HEADer 1 or HEADer ON

Response: :HEADER 0
:HEADER 1

Description: This command controls the header sent at the beginning of each response. When set to ON or 1, the command is returned in the response to the query. When set to OFF or 0, commands are not echoed with responses. The header state is maintained in non-volatile RAM.

Identification Query - *IDN?

Syntax: *IDN?

Response: TEKTRONIX,OCP5002,0,CF:89.1CN RM:01.2

Description: The identify command causes the instrument to return four fields separated by commas: manufacturer, model, serial number, and implementation standard with software version number.

†Set Lambda - LAMbda?

Syntax: LAMbda?
LAMbda <wavelength stack number>

Response: :LAMBDA <wavelength stack number>

Description: This command sets the instrument to one of the seven possible wavelength entry names from the wavelength stack. The choices are: CAL, W1, W2, W3, W4, W5, and USER. The numbers 0 through 6 can also be used for the wavelength entries. Table 6-4 provides a cross reference between the names and numerical designations of the wavelength stack locations. This command is coupled with the OFFSet command because changing the wavelength changes the conversion factor.

Table 6-4.
Cross Reference for Wavelength Stack.

Stack Name	Numerical Designation
CAL	0
W1	1
W2	2
W3	3
W4	4
W5	5
USER	6

Learn - *LRN?

Syntax: *LRN?

Response: :<configuration data>

Description: The *LRN? command returns a sequence of commands and corresponding arguments that completely describes the instrument configuration. These commands can be sent back to the instrument. The following settings are included in the *LRN? command:

1. DC Stable mode
2. Wavelength selected
3. O/E converter offset value
4. Auto/Man mode
5. Reference value
6. Units mode
7. User Calibration value
8. Wavelength Stack values

†Offset - OFFSet?

Syntax: OFFSet?
OFFSet <floating point number and units in NW, UW, or MW>
OFFSet <floating point number>E±<integer>

Response: :OFFSET <floating point number>E-06

Description: This command allows the user to set the O/E converter's DC offset. The units are always in Watts because negative values can be entered. Valid offset values are ±1V X the conversion factor. The minimum offset value that can be entered is 100 nW. Since the conversion factor can be changed by a LAMbda or WAVelength command, the OFFSet command is affected by these other two.

If the TEKPROBE® interface is active this command is ignored and a 221 event is generated (Settings Conflict).

• *Note* *Due to differences in OCP amplifier characteristics, the OCP may not be able to adjust to the upper limit of the offset range.*

†Converter offset Cal - OECAL?

Syntax: OECAL?

Response: :OECAL <floating point number>

Description: The OECAL command returns the offset gain factor used by any device connected to TEKPROBE® Interface.

†Converter offset Volts- OEVolts?

Syntax: OEVolts?
OEVolts <voltage>V

Response: :OEVOLTS <voltage>E-03

Description: This command sets the O/E converter offset to the specified level in volts. The valid range for the argument is ±1 V. A query returns the offset in volts.

If the TEKPROBE® interface is active, this command is ignored and a 221 error event is generated (Settings Conflict).

• *Note* *Due to differences in OCP amplifier characteristics, the OCP may not be able to adjust to the upper limit of the offset range.*

Operation Complete - *OPC?

Syntax: *OPC?
*OPC

Response: 1

Description: Attach this command to the end of another command to set bit 0 in the Standard Event Status Register when all pending operations are complete. The query form of this command places a 1 in the OCP output queue when all pending operations are completed and does not set bit 0 of the Standard Events Status Register.

Power-On Status Clear - *PSC?

Syntax: *PSC?
*PSC 0
*PSC 1

Response: 0
1

Description: This command reads and sets the value of the PSC state. If the PSC state is 0, the OCP restores the previous status of the Device Event Status Enable Register, the Event Status Enable Register, and the Service Request Enable Register at power-up. If the PSC state is 1, the OCP sets the Device Status Enable Register to 255 and the other two registers to 0 at power up.

†Power - PWR?

Syntax: PWR?

Response: :PWR <floating point number>E-03,WATTS
:PWR <floating point number>E-06,WATTS
:PWR <floating point number>E-09,WATTS
:PWR -<floating point number>E+00,DBMW
:PWR -<floating point number>E+00,DBREF

Description: The PWR? command returns the measured power in the units currently set by the UNITS command. The current range of the instrument is indicated by the exponent. The three exponents shown in the examples above are the only values returned by the OCP.

An overflow condition returns a value of 9.9E+37,W or 9.9E+37,DBM (DB). An underflow condition returns a value of -9.9E+37,DBM (DB). An overflow generates a 6010 event in Watts, dBm, and dB modes. An underflow generates a 6011 event only in dBm and dBref modes.

†Range - RANge?

Syntax: RANge AUTO
RANge MAN,-<floating point number>DBM
RANge MAN,<floating point number>MW
RANge?

Response: :RANGE AUTO,<floating point number>E-03
:RANGE MAN,<floating point number>E-03

Description: The RANge command will set the range to one of six ranges shown in the table below that is larger than the command argument. The response to the query is always in watts. The RANge command has no effect if UNITS is set to dBm or dBref and a 200 error event is generated. Table 6-5 lists a summary of the range values.

Any attempts to set the range outside of the OCP capabilities will set the range to its highest or lowest range and generate a 500 (Execution Warning) event.

Table 6-5.
Summary of Range Values.

Range	Maximum Power		Minimum Power	
10 mW	10 mW	10 dBm	0.1 μW	-40 dBm
1 mW	1.0 mW	0 dBm	0.1 μW	-40 dBm
100 μW	100 μW	-10 dBm	1 nW	-60 dBm
10 μW	10 μW	-20 dBm	1 nW	-60 dBm
1μW	1.0μW	-30 dBm	10 pW	-80 dBm
100 nW	100 nW	-40 dBm	10 pW	-80 dBm

†Reference - REFerence?

Syntax: REFerence <positive or negative floating point number>DBM
REFerence <floating point number>NW, UW, or MW
REFerence <floating point number>E-06
REFerence?

Response: :REFERENCE <floating point number>E-06

Description: This command sets the reference used when UNITS is set to dBref. If no units are sent with the command the units are Watts. Reference values may be in the range of ≥0 to 1E37W,; however, values outside the range of 1E-12W to 1E-1W produce a 500 (Execution Warning) event due to inability of the OCP power display to represent values greater than 99.99 dB or less than -99.99 dB. If the argument is ≤ 0, a 222 error (Data Out of Range) event is generated and the reference is not changed.

Reset - *RST

Syntax: *RST

Description: The *RST command sets the OCP to the factory default settings. It also aborts all pending operations and forces the instrument to forget about any OCP commands. Table 6-6 lists the settings that result after an *RST command.

Table 6-6.
Settings after an *RST Command.

Parameter	Setting
AUTO	On
UNITS	Watts
LAMBDA	CAL
REFERENCE	1 mW
OFFSET	0 W
DC STABLE	Off

Service Request Enable - *SRE?

Syntax: *SRE?
*SRE <integer from 0 to 255>

Response: <integer representing the register contents>

Description: This command sets and reads the contents of the Service Request Enable Register. See Figure 6-1 for bit definition of this register.

Read Status Byte Query - *STB?

Syntax: *STB?

Response: <integer representing the register contents>

Description: The STB? command returns the Status Byte Register with the Master Summary Status bit. Table 6-7 defines the Status Byte Register bits.

Table 6-7.
Status Byte Register Contents.

Bit	ID	Description
0 - 3	-	UNUSED
4	MAV	Message Available
5	ESB	Event Status Bit
6	MSS	Logical OR of bits 0-5 and 7
7	-	UNUSED

†Temperature Controller - TEMP?

Syntax: TEMP?

Response: :TEMP 0
:TEMP 1

Description: The TEMP? command returns the status of the temperature controller on the OCP photodiode. If the controller is functioning properly, a 0 is returned. If the photodiode is too hot, a 1 is returned and a 6020 event is generated. If the diode is too cold, a -1 is returned and a 6021 event generated.

The events are generated any time the temperature is not stabilized and the instrument receives a PWR? or TEMP? query. This may occur during the first 30 seconds after power on.

†Tektronix Probe Interface - TPI?

Syntax: TPI?

Response: :TPI 0
:TPI 1

Description: The TPI? command returns a 1 if the TEKPROBE® Interface is in use and a 0 if it is not.

†Initiate a New Measurement - TRIG

Syntax: TRIG

Description: The TRIG command aborts the current measurement and starts a new one. Data will be available with the PWR? command 200 msec after the TRIG command is issued.

Self-Test Query - *TST?

Syntax: *TST?

Response: 0

Description: The *TST? command causes the OCP to perform self-diagnostics. The returned value is 0 if all diagnostics passed. A non-zero number indicates the failed diagnostic. See Appendices A and B for error code information. The number is also displayed in the wavelength display and a Internal Error Event is generated.

The *TST? operation requires about ten seconds to complete. The following diagnostics run when this command is received:

- ROM Checksum
- Non-Volatile RAM
- Timer
- Logic Cell Array
- Calibration EEPROM
- TEKPROBE® Interface EEPROM
- V to F Zero
- V to F Vref
- V to F 5V Vref

†Units - UNIts?

Syntax: UNIts?
UNIts W
UNIts DBMw
UNIts DBref

Response: :UNITS WATTS
:UNITS DBMW
:UNITS DB

Description: The UNIts command sets the OCP to return power measurements in Watts, dBm, or dB. dBref and dBr are acceptable synonyms for dB while dBmW is a synonym for dBm.

†User Calibration Constant - USERcal?

Syntax: USERcal?
USERcal <floating point number>UW,POWer
USERcal <floating point number>DBM,POWer
USERcal <floating point number>,RESPonsivity

Response: :USERCAL <floating point number>E-01,Responsivity

Description: This command sets the user definable wavelength calibration constant. If the second parameter is RESP, then the first parameter is taken to be the responsivity of the photodiode in watts/amps. If the second parameter is POWER, then the OCP will calculate the responsivity by dividing the first parameter by the measured power.

The query form of the command returns the responsivity value.

Command Header Style - VERBose?

Syntax: VERBose?
VERBose OFF or VERBose 0
VERBose ON or VERBose 1

Response: :VERBOSE 0
:VERBOSE 1

Description: If VERBose is set to OFF or 0, only the abbreviated form of the commands is returned in a query response. If set to ON or 1, the full length command is echoed in the query response.

Wait to Complete - *WAI

Syntax: *WAI

Description: The *WAI command forces sequential execution of overlapped commands. The OCP commands are sequential regardless of this command.

†Wavelength - WAVelength?

Syntax: WAVelength?
WAVelength:<stack location>?
WAVelength:<stack location> <wavelength value>

Response: :WAV:<stack location> <wavelength value>

Description: The first parameter of this command determines which location in the Lambda (wavelength) stack is to be changed or read back. The second parameter sets that location to the given wavelength. If no units are specified the default is nanometers. The valid stack locations are CAL, W1, W2, W3, W4, and W5. Include a space between the stack location and wavelength value.

This command is coupled with the OFFSet command if the Lambda stack entry being changed is the one currently in use (see LAMbda command).

The valid range for the wavelength argument is the range of wavelengths in the Wavelength Calibration Table (see the WTBL command) which is nominally 1100 to 1650 nm. An attempt to set the wavelength outside of this range generates a 222 error event (Data Out of Range).

If a query is sent with no stack location parameter the entire stack of wavelengths is returned.

†Wavelength Cal Table - WTBL?

Syntax: WTBL?

Response: :WTBL <table numbers>

Description: The WTBL? query returns the calibration table of the OCP.

†Compensate for Dark Currents - ZERo?

Syntax: ZERo?

Response: :ZERO 0

Description: The ZERo? query zeroes the OCP. (This command performs the same function as pressing the front panel ZERo key.) The ZERo? command will fail if the OCP optical input power is greater than 1 nW. Install the dust cap or turn off the optical source connected to the OCP to be sure that no optical power is present.

The ZERo? command takes about 15 seconds to complete. If the operation is successful, the OCP returns a response of 0. If the operation is unsuccessful, a type 300 error event will be generated with a secondary message.

GPIB COMMAND EXAMPLES

The following program examples describe how to execute GPIB commands with the OCP. These examples use a National Instruments GPIB controller and command library. The OCP is addressed as the device named "OCP" using the ibconf program supplied with the controller.

Identification Query example

Run either the following BASIC or the following C program to get identification data from the OCP.

BASIC Program for GPIB Identification Query

```
10   REM This is a sample program to check OCP GPIB operation
20   REM  This is achieved through sending the *IDN? query to the OCP
30   REM and printing the response on the system monitor.
40   CLEAR    ,58900!      'IBM BASICA Declarations; =BYTES FREE -size(bib.m)
50   IBINIT1 = 58900!       'a smaller than calculated # is OK in lines 1 & 2
60   IBINIT2 = IBINIT1 +3   'Lines 1 thru 6 MUST be included in your program
70   BLOAD "\gpib\bib.m",IBINIT1
80   CALL IBINIT1(IBFIND,IBTRG,IBCLR,IBPCT,IBSIC,IBLOC,IBPPC,IBBNA,IBONL,
     IBRSC,IBSRE,IBRSV,IBPAD,IBSAD,IBIST,IBDMA,IBEOS,IBTMO,IBEOT,IBRDF,
     IBWRTF,IBTRAP)
90   CALL IBINIT2(IBGTS,IBCAC,IBWAIT,IBPOKE,IBWRT,IBWRTA,IBCMD,IBCMDA,IBRD,
     IBRDA,IBSTOP,IBRPP,IBRSP,IBDIAG,IBXTRC,IBRDI,IBWRTI,IBRDIA,IBWRTIA,
     IBSTA%,IBERR%,IBCNT%)
100  REM ************** END DECLARATIONS FOR GPIB INTERFACE **********
110  BD%=0: DEV%=0:RESPONSE$=SPACE$(255)
120  BD$="gpib0": CALL IBFIND(BD$,BD%)           ' set up gpib interface bd 0
130  CALL IBSIC(BD%)                             'Send Interface clear
140  DEV$="ocp": CALL IBFIND(DEV$,DEV%)    'set up tek device 1 on board 0
150  CLS
160  CMD$="*IDN?" : CALL IBWRT(DEV%,CMD$)
170  CALL IBRD(DEV%,RESPONSE$)
180  RESPONSE1$=LEFT$(RESPONSE$,IBCNT%)
190  PRINT RESPONSE1$
200  CALL IBLOC(DEV%)
210  END
```

C Program for GPIB Identification Query

```
#include <dos.h>
#include <stdio.h>
#include <string.h>
#include "c:\gpib\tc\decl.h"

void idquery(void)
{
        int ocpaddr;
        char wrt[50];
        ocpaddr = ibfind("ocp");
        ibclr(ocpaddr);
        strcpy(wrt,"*idn?");
        ibwrt(ocpaddr,wrt,strlen(wrt));
        ibrd(ocpaddr,wrt,50);
        printf("\n %s \n",wrt);
        ibloc(ocpaddr);

}
main()
{
        idquery();
}
```

When either program is run, the computer will display a message similar to the following:

```
Tektronix, OCP5002,0,CF:89.ICN ROM:V01.00
```

See the IDN command for information explaining the significance of the Identification data.

Power Measurement Example

The following BASIC and the following C programs zero the OCP, ask for a wavelength value, and read the power at the **OPTICAL INPUT** of the OCP.

BASIC Program for GPIB Power Reading

```
10   REM This program prompts the user to zero the power meter then
20   REM set the wavelengthand take a reading. The reading is displayed on
30   REM system monitor.
40   CLEAR    ,58900!        'IBM BASICA Declarations; =BYTES FREE -size(bib.m)
50   IBINIT1 = 58900!        'a smaller than calculated # is OK in lines 1 & 2
60   IBINIT2 = IBINIT1 +3    'Lines 10 thru 90 MUST be included in your program
70   BLOAD "\gpib\bib.m",IBINIT1
80   CALL IBINIT1(IBFIND,IBTRG,IBCLR,IBPCT,IBSIC,IBLOC,IBPPC,IBBNA,IBONL,
     IBRSC,IBSRE,IBRSV,IBPAD,IBSAD,IBIST,IBDMA,IBEOS,IBTMO,IBEOT,IBRDF,
     IBWRTF,IBTRAP)
90   CALL IBINIT2(IBGTS,IBCAC,IBWAIT,IBPOKE,IBWRT,IBWRTA,IBCMD,IBCMDA,IBRD,
     IBRDA,IBSTOP,IBRPP,IBRSP,IBDIAG,IBXTRC,IBRDI,IBWRTI,IBRDIA,IBWRTIA,
     IBSTA%,IBERR%,IBCNT%)
100  REM ************** END DECLARATIONS FOR GPIB INTERFACE **********
110  BD%=0: DEV%=0:RESPONSE$=SPACE$(255)
120  BD$="gpib0": CALL IBFIND(BD$,BD%)          ' set up gpib interface bd 0
130  CALL IBSIC(BD%)                            'Send Interface clear
140  DEV$="ocp": CALL IBFIND(DEV$,DEV%)   'set up OCP on board 0
150  CLS
160  PRINT "OCP 5002/5502 GPIB power meter reading "
170  PRINT "Block the OCP input connector for power meter zeroing"
180  PRINT "Hit return when ready to proceed"
190  INPUT READY$
200  CMD$="zero?" : CALL IBWRT(DEV%,CMD$)
210  PRINT : PRINT "What is the wavelength for the measurement?"
220  INPUT LAMBDA$
230  CMD$="units watts" : CALL IBWRT(DEV%,CMD$)
240  CMD$="range auto; wavelength:wl "+LAMBDA$ : CALL IBWRT(DEV%,CMD$)
250  CMD$="lambda wl" : CALL IBWRT(DEV%,CMD$)
260  CMD$="headers off" : CALL IBWRT(DEV%,CMD$)
270  CMD$="pwr?" : CALL IBWRT(DEV%,CMD$)
280  CALL IBRD(DEV%,RESPONSE$)
290  COMMA=INSTR(RESPONSE$,",")
300  PWR$=LEFT$(RESPONSE$,COMMA-1)
310  PRINT "Power = "+PWR$+" Watts"
320  PRINT "Would you like to take another reading (y/n)?"
330  INPUT ANOTHER$
340  IF ANOTHER$="y" THEN GOTO 220
350  PRINT "Please type 'system' to return to DOS"
360  CALL IBLOC(DEV%)
370  END
```

C Program for GPIB Power Reading

```
#include <dos.h>
#include <stdio.h>
#include <string.h>
#include "c:\gpib\tc\decl.h"

void zero(int ocpaddr)
{
        char cmd[50];

        printf("\n OCP 5002/5502 power meter reading example program\n");
        printf("Install the OCP dust cover for power meter zeroing\n");
        printf("Hit return when ready to proceed\n");
        while (!kbhit());
        strcpy(cmd,"*cls");
   ibwrt(ocpaddr,cmd,strlen(cmd));
        strcpy(cmd,"zero?");
        ibwrt(ocpaddr,cmd,strlen(cmd));
        ibrd(ocpaddr,cmd,50);
}

void ex2(int ocpaddr)
{
        char cmd[50],rd[100],ch;
        char pwr[100],lambda[50];

        printf("What is the wavelength for the reading?(in nanometers)\n");
        scanf("%s",&cmd);
        strcpy(lambda,"wavelength:wl ");
        strcat(lambda,cmd);
        strcat(lambda,"nm");
        ibwrt(ocpaddr,lambda,strlen(lambda));
        strcpy(cmd,"units watts; lambda wl; headers off");
        ibwrt(ocpaddr,cmd,strlen(cmd));
        strcpy(cmd,"pwr?");
        ibwrt(ocpaddr,cmd,strlen(cmd));
        ibrd(ocpaddr,rd,100);
        strncpy(pwr,rd,strcspn(rd,","));
        pwr[strcspn(rd,",")]=0;
        printf("\n %s%s%s \n","Power=",pwr," Watts");

}
main()
{

        char another[10];
        int ocpaddr;

        ocpaddr = ibfind("ocp");
        ibclr(ocpaddr);
        zero(ocpaddr);
        strcpy(another,"Y");
        while (!stricmp(another,"y"))
        {
                ex2(ocpaddr);
                printf("\n %s \n","Do you want another power meter reading?(y/n)");
                scanf("%s",&another);
        }
        ibloc(ocpaddr);
}
```

Both programs have a similar user interaction. The BASIC program runs as follows.

When the program is started, the computer displays the following prompt

```
OCP 5002/5502 GPIB power meter reading
Install the OCP dust cover for power meter zeroing
Hit return when ready to proceed
?
```

Make sure the dust cover is installed and press the return key. The computer will then respond with

```
What is the wavelength for the measurement?
?
```

Connect the optical source to be measured to the OCP **OPTICAL INPUT** and enter the wavelength number of the optical source (the acceptable wavelength range is from 1100 to 1650 nm). In this example, a wavelength of 1350 nm was entered as follows

```
What is the wavelength for the measurement?
? 1350
```

After entering the wavelength value and pressing the return key, the computer will return with

```
Power = 175.05E-9 Watts
Would you like to take another reading (y/n)?
?
```

The returned power reading is expressed in exponential form. Our example had a power reading of 175.05 nW.

Entering a "y" returns the following response

```
What is the wavelength for the measurement?
? 1400
```

Another measurement can be made. In the second example, a wavelength of 1400 nm was entered.

```
What is the wavelength for the measurement?
? 1400
```

After entering the wavelength and pressing the return key, the computer responds with

```
Power = 168.20E-9 Watts
Would you like to take another reading (y/n)?
?
```

The measured power in this example was 168.20 nW.

If "n" is entered, the following response will be returned

```
Please type 'system' to return to DOS
```

Entering the word "system" returns the system to DOS.

Chapter 7: Specifications

Chapter 7 contains eight tables that list OCP performance specifications. These specifications are only valid for an instrument calibrated at an ambient temperature between +20° C and +30° C and operated within the environmental specifications listed in Table 7-7. The instrument should have a minimum warm-up period of 20 minutes.

- Table 7-1 lists the O/E Converter Optical Specifications.
- Table 7-2 lists the O/E Converter Electrical Specifications.
- Table 7-3 lists the Power Meter Specifications.
- Table 7-4 lists the TEKPROBE® Interface Specifications.
- Table 7-5 lists the OCP5502 Power Requirement Specifications.
- Table 7-6 lists the Physical Specifications.
- Table 7-7 lists the Environmental Specifications.
- Table 7-8 lists the Reliability Specifications.

Table 7-1.
O/E Converter Optical Specifications.

CHARACTERISTICS	PERFORMANCE REQUIREMENTS	SUPPLEMENTAL INFORMATION
Wavelength Range	1100 nm to 1650 nm	O/E Converter calibrated at 1300 nm.
Input	Accepts fiber up to 62.5 μm core diameter Numerical Aperture: ≤0.29	
Input Offset Cancellation	0 to 1 mW	See Output Zero Drift and Output Dynamic Range specifications in Table 7-2.
Optical Input Dynamic Range	0.9 mW to 2 mW 0 to 1 mW	with -1 mW offset with 0 mW offset
Noise Equivalent Power	Referenced to Input: ≤1 μW RMS	30 Hz - 2 GHz @ 1300 nm.
Absolute Maximum Nondestructive Optical Input	10 mW	

Table 7-2.
O/E Converter Electrical Specifications.

CHARACTERISTICS	PERFORMANCE REQUIREMENTS	SUPPLEMENTAL INFORMATION
Conversion Gain	1 V/mW ±8% at DC	1300nm, ≤100 mV p-p output
Non-Linearity	<3%	-0.1 V to +0.9 V
Small Signal Bandwidth	DC to 2 GHz: -3 dB optical (-6 dB electrical)	1300 nm, ≤100 mV p-p output
Rise Time	< 260 picoseconds	1300 nm, <100 mV p-p output (Using integrated impulse)
Aberrations	15% p-p total ±10% peak < 1 ns 5% p-p total 1 ns - 4 ns <1% >4 ns	Using integrated impulse
Output Zero	DC Stable: On: < ±0.5 mV Off: < ±5.0 mV	Within 5 degrees of zeroing operation
Output Zero Drift	DC Stable On : < ±1.5 mV DC Stable Off: < -30 mV, +15 mV	0° C to 55° C
Output Dynamic Range	-0.25 to 1 V	
Output Load Requirements	50 Ω ±1%	
Output Impedance	50 Ω ±5%	
Output Voltage Standing Wave Ratio (VSWR)	< 3:1 to 2 GHz	

Table 7-3.
Power Meter Specifications.

CHARACTERISTICS	PERFORMANCE REQUIREMENTS	SUPPLEMENTAL INFORMATION
Wavelength Range	1100 nm to 1650 nm	Calibration done at 10 nm intervals
Input	Accepts optical fiber up to 62.5 μm core diameter Numerical Aperture: ≤ 0.29	
Maximum Input	5 mW (+7 dBm)	
Absolute Accuracy	±5% of reading	1300 nm, 50 μW using Tektronix P/N 174-2322-00 optical cable
Linearity	1% from 1 nW to 5 mW range	
Maximum Resolution	0.01 nW	
Power Meter Stability	±0.05 nW in 30 second period	
Absolute Maximum Nondestructive Optical Input	10 mW	Tested by forward biasing the photodiode
Input Zero	±0.05 nW	
Update Rate	Readout : 5 Hz Bargraph: 20 Hz	
Input Filter	1.6 Hz	
Settling Time	500 msec	
Temperature Coefficient	0.05% of reading ±.05 nW/°C	

Table 7-4.
TEKPROBE® Interface Specifications.

CHARACTERISTICS	PERFORMANCE REQUIREMENTS	SUPPLEMENTAL INFORMATION
Implementation	Level II	EEPROM
Offset Voltage	Used	
Resistor Coding	3.54 K ±1%	
+15 V Max Current	0 mA	
+5 V Max Current	0 mA	
-15 V Max Current	0 mA	
-5 V Max Current	0 mA	

Table 7-5.
OCP5502 Power Requirement Specifications.

CHARACTERISTICS	PERFORMANCE REQUIREMENTS	SUPPLEMENTAL INFORMATION
Voltage Ranges	100 V, 120 V, 220 V, and 240 V	User selectable (See Chapter 1 about voltage selector)
Maximum Power Consumption	120 Watts	
Line Frequency	48 to 400 Hz	
Fuses:		
100 V, 120 V Range	1.0 A, 3AG, Fast Blow, 250 V	
220 V, 240 V Range	0.5 A, 3AG, Slow Blow, 250 V	

Table 7-6.
Physical Specifications.

CHARACTERISTICS	PERFORMANCE REQUIREMENTS	SUPPLEMENTAL INFORMATION
Net Weight:		
OCP5002	1.3 kg (2.86 lbs)	
OCP5502	4.5 kg (9.9 lbs)	
Outside Dimensions:		
OCP5002		
Height Width Length	14.0 cm (5.0 in) 13.4 cm (5.3 in) 29.2 cm (11.5 in)	
OCP5502		
Height Width Length	14.0 cm (5.5 in) 23.4 cm (9.2 in) 44.4 cm (17.5 in)	

Table 7-7.
Environmental Specifications.

CHARACTERISTICS	PERFORMANCE REQUIREMENTS	SUPPLEMENTAL INFORMATION
Temperature		Meets MIL-T-28800D, class 5
Operating	0° C - 50° C (32° F - 122° F)	
Non-Operating	-40° C - 70° C (-77° F - 160° F)	
Humidity		
Operating and Non-Operating	95% RH: 11° C to 30° C (52° F to 86° F) 75% RH: 11° C to 40° C (52° F to 104° F) 45% RH: 11° C to 50° C (52° F to 122° F)	Exceeds MIL-T-28800D, class 5, non-condensing
Altitude		
Operating	4.6 km (15,000 ft)	Exceeds MIL-T-28800D, class 5
Non-Operating	15 km (50,000 ft)	

Table 7-7 (Continued).
Environmental Specifications.

CHARACTERISTICS	PERFORMANCE REQUIREMENTS	SUPPLEMENTAL INFORMATION
Vibration	0.38 mm (0.015 in) p-p, 5 Hz to 55 Hz for 75 minutes	Meets MIL-T-28800D, class 5 when installed in qualified power modules[1]
Shock	30 g's (1/2 sine), 11 ms duration, 3 shocks in each direction along 3 major axes, 18 total shocks	Meets MIL-T-28800D, class 5 when installed in qualified power modules[1]
Bench Handling[2]	12 drops from 45 degrees, 4 inches or equilibrium, whichever occurs first	Meets MIL-T-28800D class 5, when installed in qualified power modules[1]
Packaged Product Vibration and Shock[2]	The packaged product qualifies under the National Safe Transit Association's Pre-shipment Test Procedures, Project 1A-B-1 and 1A-B-2	
Electro-Magnetic Interference (EMI)	Within limits of FCC Regulations Part 15, Subpart J, Class A; VDE 0871 Class B, and MIL-461B (1980) for RE01, RE02, CE01, CE03, RS03, CS01, CS02 and CS06	
Electrostatic Discharge	6 kV maximum discharge applied to operating instrument from an ESD source per IEC 801-2 (150 Ohms/150 pF)	

[1]Refer to TM5000 power module specifications listed in TM5000 Instruction Manual.
[2]Without power module.

Table 7-8.
Reliability Specifications.

CHARACTERISTICS	PERFORMANCE REQUIREMENTS	SUPPLEMENTAL INFORMATION
Mean Time Between Failures (MTBF)	>50,000 hours	Calculated value
Connector Life	BNC Connector: 5,000 cycles. No connection shall show more than 0.1 Ω increase after the rated number of cycles. Optical: 5,000 cycles with less than 0.25 dB loss	

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ITEM NAME

In the Parts List, an item Name is separated from the description by a colon(:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component
END ATTACHING PARTS

Detail Part of Assembly and/or Component
Attaching parts for Detail Part
END ATTACHING PARTS

Parts of Detail Part
Attaching parts for Parts of Detail Part
END ATTACHING PARTS

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Attaching parts must be purchased separately, unless otherwise specified.

ABBREVIATIONS

Abbreviations conform to American National Standards Institute YI.I

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
70903	COOPER BELDEN ELECTRONICS WIRE AND C SUB OF COOPER INDUSTRIES INC	2000 S BATAVIA AVE	GENEVA IL 60134-3325
71400	BUSSMANN DIV OF COOPER INDUSTRIES INC	114 OLD STATE RD PO BOX 14460	ST LOUIS MO 63178
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077-0001
TK1373	PATELEC-CEM (ITALY)	10156 TORINO	VAICENTALLO 62/45S ITALY

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-	----- -----			1	OCP5002 O/E CONV/PWR MTR:INGAAS,PLUG-IN		
-1	020-1885-00			1	ACCESSORY PKG:O/E CONVERTER (STANDARD ONLY)	80009	020-1885-00
-4	337-3213-00			2	SHIELD,ELEC:	80009	337-3213-00
-5	366-1851-01			1	KNOB,LATCH:IVORY GY,0.625 X 0.25 X 1.09	80009	366-1851-01
-6	105-0865-00			1	BAR,LATCH RLSE:	80009	105-0865-00
-7	105-0866-00			1	LATCH,RETAINING:SAFETY	80009	105-0866-00
-8	214-3143-00			1	SPRING,HLEXT:0.125 OD X 0.545 L,XLOOP	80009	214-3143-00
	159-0019-00			1	FUSE,CARTRIDGE:3AG,1A,250V,SLOW BLOW	71400	MDL 1
	620-0057-00			1	PWR SPLY ASSY:OCP5502 MAINFRAME (OCP5502 ONLY)	80009	620-0057-00
					STANDARD ACCESSORIES		
	159-0032-00			1	FUSE,CARTRIDGE:3AG,0.5A,250V,SLOW BLOW (OPTIONS A1 THRU A5 ONLY)	71400	MDL 1/2
	161-0066-09			1	CABLE ASSY,PWR,:3,0.75MM SQ,220V,99.0 L (OPTION A1 - EUROPEAN)	80009	161-0066-09
	161-0066-10			1	CABLE ASSY,PWR,:THREE 0.75MM SQ,250V,2.5 ME TERS LONG,UNITED KINGDOM (OPTION A2 - UNITED KINGDOM)	TK1373	24230
	161-0066-11			1	CABLE ASSY,PWR,:3,0.75MM,240V,96.0 L (OPTION A3 - AUSTRALIAN)	80009	161-0066-11
	161-0066-12			1	CABLE ASSY,PWR,:3,18 AWG,250V,99.0 L (OPTION A4 - NORTH AMERICAN)	70903	CH-77893
	161-0154-00			1	CABLE ASSY,PWR,:3,0.75MM SQ,240V,6A,2.5M L (OPTION A5 - SWISS)	80009	161-0154-00
	070-7817-00			1	MANUAL,TECH:INSTR,OCP5002	80009	070-7817-00
					OPTIONAL ACCESSORIES		
	174-2322-00			1	CABLE,FIBER OPT:JUMPER,2 METER,62.5 MICRON, FC/PC TO FC/PC	80009	174-2322-00
	174-2323-00			1	CABLE,FIBER OPT:JUMPER,2 METER,62.5 MICRON, FC/PC TO BICONIC	80009	174-2323-00
	174-2324-00			1	CABLE,FIBER OPT:JUMPER,2 METER,62.5 MICRON, FC/PC TO SMA 906	80009	174-2324-00
	012-1372-00			1	CABLE ASSY,RF:11K TEKPROBE INTERFACE,60.0L	80009	012-1372-00

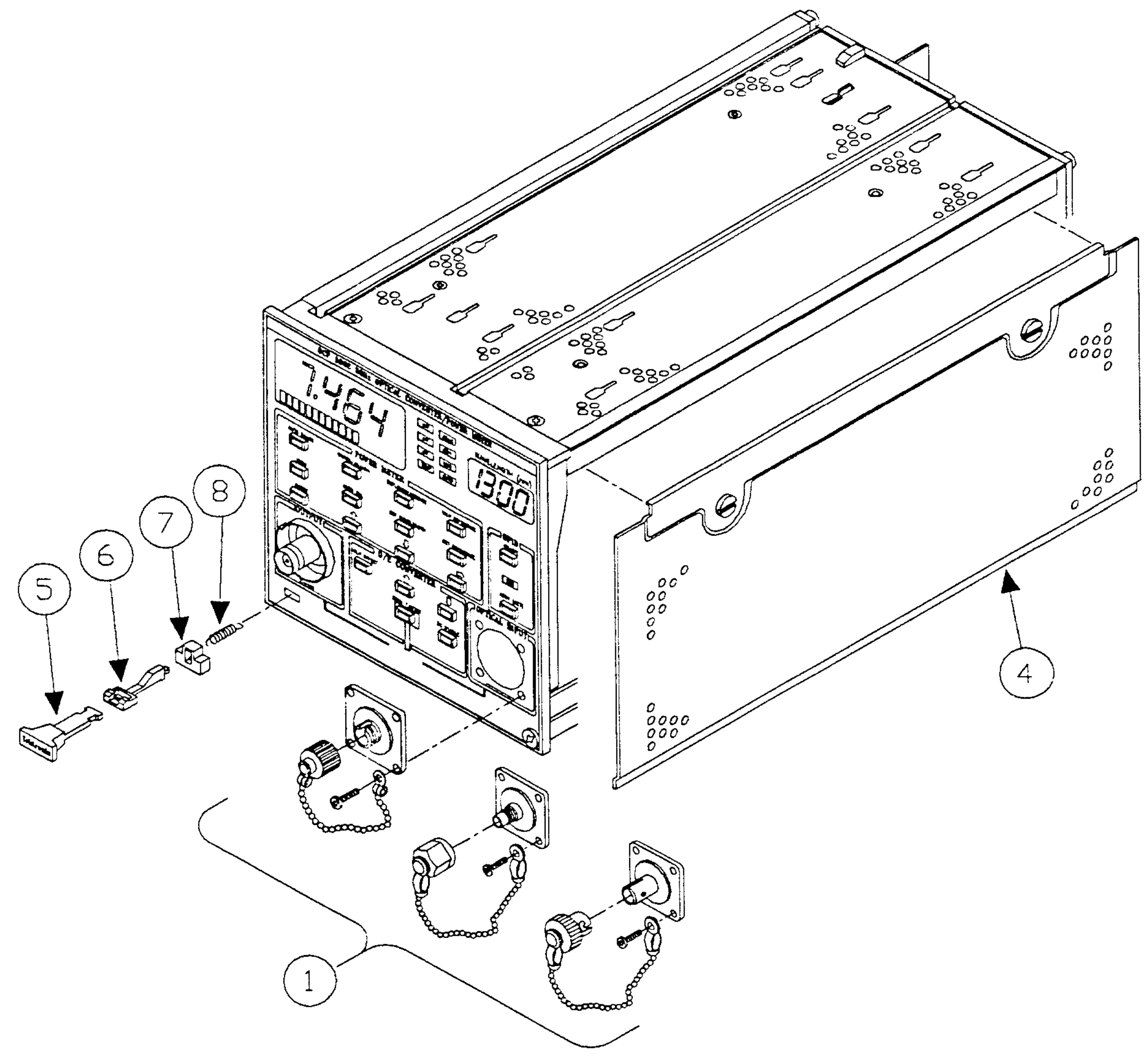


FIGURE 8-1.Exploded View

Appendix A: GPIB Error Codes

The tables in Appendix A list the error codes that can be generated when using the GPIB Interface.

Table A-1.
GPIB Command Error Codes.

Error Number	Description
100	Command error Unrecognized token Command not allowed after <arb> output Keyword argument not allowed
101	Invalid character
102	Syntax error
103	Invalid message unit separator
104	Data type error
105	GET not allowed
106	Invalid program data separator
108	Parameter not allowed
109	Missing parameter Expecting program data
110	Command header error Command not allowed Unrecognized common command Expecting common command identifier Expecting start of header Expecting identifier in compound header Expecting separator or terminator
111	Header separator error
112	Program mnemonic too long
	Identifier too long
	Exponent must have at least one digit

Table A-1 (Continued).
GPIB Command Error Codes.

Error Number	Description
113	Undefined header Unrecognized command
118	Query not allowed
120	Numeric data error EOI reading exponent Must have a digit before or after decimal point EOI after sharpsign At least one digit required in non-decimal data Decimal argument not allowed Integer argument not allowed
121	Invalid character in number Invalid radix indicator after sharpsign
123	Numeric overflow Exponent magnitude must be less than 32000 Number too large for specified format
124	Too many digits Too many characters in decimal number
128	Numeric data not allowed
130	Suffix error Suffix required Bad suffix or suffix not allowed
131	Invalid suffix
134	Suffix too long
138	Suffix not allowed
140	Character data error
141	Invalid character data Expression argument not allowed
144	Character data too long
148	Character data not allowed
150	String data error

Table A-1 (Continued).
GPIB Command Error Codes.

Error Number	Description
151	Invalid string data
158	String data not allowed String argument not allowed
160	Block data error
161	Invalid block data EOI in binary block length
168	Block data not allowed Block argument not allowed
170	Expression error Unexpected end of expression
171	Invalid expression data
178	Expression data not allowed

Table A-2.
GPIB Execution Error Codes.

Error Number	Description
200	Execution error
201	Remote only
220	Parameter error
221	Settings conflict
222	Data out of range Offset Range is +- Conversion Factor * 1V. OECAL Limits are -.25V - +1.2V. OEVolts Range is +- 1V. Reference value must be > 0 Wavelength must be within the range of table values.
223	Too much data
230	Data corrupt or stale
240	Hardware error
241	Hardware missing

Table A-3.
GPIB Internal Error Codes.

Error Number	Description
300	Internal Error
310	System error
311	Memory error
312	PUD memory lost
313	Calibration memory lost
314	Save/recall memory lost
315	Configuration memory lost
350	Too many events

Table A-4.
GPIB System Error Codes.

Error Number	Description
400	System event
401	Power on
402	Operation complete
403	User request
404	Power fail
405	Request control
410	488.2 query INTERRUPTED error
420	488.2 query UNTERMINATED error
430	488.2 query DEADLOCKED error
440	488.2 query UNTERMINATED error after indefinite response

Table A-5.
GPIB Miscellaneous Error Codes.

Error Number	Error Type	Description
500	Execution Warning	Execution warning
600	Internal Warning	Internal warning
6010	Device Specific	Measurement Overflow
6011	Device Specific	Measurement Underflow
6020	Device Specific	Photodiode Temperature High
6021	Device Specific	Photodiode Temperature Low

Appendix B: Front Panel Diagnostic Error Codes

Table B-1 lists the OCP front panel diagnostic codes. The numbers in the Error Code column appear in the wavelength display of the front panel.

For any actions that require instrument repair, contact your nearest Tektronix service representative for instrument repair or replacement.

Table B-1.
Diagnostic Error Codes.

Error Code	Problem	Action
0101	ROM Checksum Error	Return OCP for repair
0102	ROM Checksum Error (defective processor board)	Return OCP for repair
0103	RAM Test Error (defective processor board)	Return OCP for repair
0104	Non-Volatile Checksum Error (defective processor board)	Return OCP for repair
0110	Timer Read/Write Error (defective processor board)	Return OCP for repair
0115	Timer Period Error (defective processor board)	Return OCP for repair
0120	LCA Counter Test Error (defective processor board)	Return OCP for repair
0401	Calibration EEPROM Checksum Error	Return OCP for repair
0402	TPI EEPROM Checksum Error (defective measurement board)	Return OCP for repair
2411	V to F zero High (defective measurement board)	Return OCP for repair
2412	V to F zero low (defective measurement board)	Return OCP for repair
2413	V to F gain high (defective measurement board)	Return OCP for repair
2414	V to F gain low (defective measurement board)	Return OCP for repair
2415	V to F ref too high (defective measurement board)	Return OCP for repair
2416	V to F ref too low (defective measurement board)	Return OCP for repair

**Table B-1 (Continued).
Diagnostic Error Codes.**

Error Code	Problem	Action
2421	1K zero high (defective measurement board)	Insure optical input is 0 and retry zero. If failure persists, return OCP for repair.
2422	1K zero low (defective measurement board)	Return OCP for repair
2423	100K zero high (defective measurement board)	Insure optical input is 0 and retry zero. If failure persists, return OCP for repair.
2424	100K zero low (defective measurement board)	Return OCP for repair
2425	10MΩ zero high (defective measurement board)	Insure optical input is 0 and retry zero. If failure persists, return OCP for repair.
2426	10MΩ zero low (defective measurement board)	Return OCP for repair
2431	O/E open loop zero failed (possible defective measurement board)	Insure optical input is 0 and retry zero. If failure persists, return OCP for repair.
2432	O/E closed loop zero failed (possible defective measurement board)	Insure optical input is 0 and retry zero. If failure persists, return OCP for repair.
2433	O/E open loop zero high (possible defective measurement board)	Insure optical input is 0 and retry zero. If failure persists, return OCP for repair.
2434	O/E closed loop zero high (possible defective measurement board)	Insure optical input is 0 and retry zero. If failure persists, return OCP for repair.
2435	O/E closed loop zero high (possible defective measurement board)	Insure optical input is 0 and retry zero. If failure persists, return OCP for repair.
2436	O/E closed loop zero low (possible defective measurement board)	Insure optical input is 0 and retry zero. If failure persists, return OCP for repair.

Table B-1 (Continued).
Diagnostic Error Codes.

Error Code	Problem	Action
3411	Calibration level too high (possible defective measurement board)	Insure optical power and Wavelength are correct. If failure persists, return OCP for repair.
3412	Calibration level too low (possible defective measurement board)	Insure optical power and Wavelength are correct. If failure persists, return OCP for repair.
4401	O/E open loop offset gain high (possible defective measurement board)	Insure a 50 Ω ±1% load is attached to the Voltmeter. If failure persists, return OCP for repair.
4402	O/E open loop offset gain low (possible defective measurement board)	Insure a 50 Ω ±1% load is attached to the Voltmeter. If failure persists, return OCP for repair.
4403	O/E closed loop offset gain high (possible defective measurement board)	Insure a 50 Ω ±1% load is attached to the Voltmeter. If failure persists, return OCP for repair.
4404	O/E closed loop offset gain low	Insure a 50 Ω ±1% load is attached to the Voltmeter. If failure persists, return OCP for repair.
4405	O/E converter gain is incorrect (possible defective measurement board)	Insure Optical Connector is clean. If failure persists, return OCP for repair.

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