Instruction Manual

Tektronix

OIG 501 & OIG 502
Optical Impulse Generators

070-7818-03

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.

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Printed in the U.S.A.

Tektronix, Inc., P.O. Box 1000, Wilsonville, OR 97070–1000

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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.

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General Information

This chapter is divided into four sections:

- Product Description
- Safety Summary
- Instrument Setup
- Specifications

Please read the safety and instrument setup sections before powering-up your unit. Chapters 2 through 6 of this manual contain the following information:

- Chapter 2 describes front-panel operation
- Chapter 3 details typical applications
- Chapter 4 details acceptance test procedures
- Chapter 5 provides basic maintenance information
- Chapter 6 lists the replaceable parts for the OIG 501/502

Product Description

The Tektronix OIG 501 and OIG 502 Optical Impulse Generators are pulsed laser light sources for testing and troubleshooting optical fiber components, modules, and links. The OIG 501/502 includes the following features:

- A High-Energy Pulse with a minimum of 30 mW (OIG 501) or 15 mW (OIG 502) peak power for high dynamic response.
- A Low-Energy Pulse with a ≤35 ps (OIG 501) or ≤40 ps (OIG 502) pulse width for measuring sub-millimeter reflections, fiber dispersion, and optical equipment calibration.
  User-selectable internal trigger rates of 10 kHz, 100 kHz, or 1 MHz.
- External trigger input for signals from DC to 1 MHz with continuously adjustable trigger level from −3 V to +3 V.
- Simple and easy-to-understand front panel operation.
- Compatibility with Tektronix TM 500 and TM 5000 Series Power Modules.

Standard Accessories

The OIG 501/502 comes with two standard accessories.

1 Instruction Manual

2 Connectors

1 Package containing field-installable bulkhead adapters for FC, ST, and DIN 47256 optical connector types with dust covers for each

NOTE

The OIG comes with the FC adapter installed. Chapter 5 describes how to change bulkhead adapters.

Optional Accessories

Five optional accessories are available for the OIG 502 and three optional accessories are available for the OIG 501; see the Replaceable Parts List for more information.

OIG 502—

1 Single-mode fiber optic cable, 2 meter, 8/125 μm, with FC-to-Diamond 2.5 Connector

1 Single-mode fiber optic cable, 2 meter, 8/125 μm, with FC-to-Diamond 3.5 Connector

1 Single-mode fiber optic cable, 2 meter, 8/125 μm, with FC-to-FC Connector

1 Single-mode fiber optic cable, 2 meter, 8/125 μm, with FC-to-ST Connector

1 Single-mode fiber optic cable, 2 meter, 8/125 μm, with FC-to-BICONIC Connector

OIG 501—

1 Fiber optic cable, 2 meter, 62.5 μm, with FC-to-FC Connector

1 Fiber optic cable, 2 meter, 62.5 μm, with FC-to-BICONIC Connector

1 Fiber optic cable, 2 meter, 62.5 μm, with FC-to-SMA 906 Connector

Safety Summary

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

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

Terms Used in This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

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

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.

Optical Output

The OIG 501 and OIG502 are both rated as Class 1 laser devices as defined by the IEC825-1 and 21-CFR-1040 standards. The average optical output power level is not hazardous; however, you should avoid looking directly into the optical output port while the instrument is operating. The optical output of this instrument is not in the visible light spectrum.

Power Source

The OIG 501/502 is designed for operation in a Tektronix TM 500 or TM 5000 Series Power Module. Do not attempt to operate these units with any other power source.

Grounding

To maintain proper grounding of the OIG 501/502, operate the power module according to the instructions provided in the power module instruction manual.

Danger from Loss of Ground

Upon loss of the ground connection, all accessible conductive parts (including controls that appear to be insulated) can cause electric shock.

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. Do not spill any liquids into the instrument.

Covers and Panels

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

Instrument Setup

The OIG 501/502 is designed to operate in a Tektronix TM 500 or TM 5000 Series Power Module.

CAUTION

Turn the Power Module off before inserting the OIG 501/502 to prevent possible instrument damage.

Figure 1-1 shows how to install the OIG 501/502 into the Power Module. Align the top and bottom grooves of the OIG 501/502 with the rails of the Power Module and slide the OIG 501/502 in until the edge connector snaps into place. The OIG 501/502 front panel should be flush with the Power Module cabinet.

To remove the OIG 501/502 plug-in, grab the release lever and pull the instrument out.

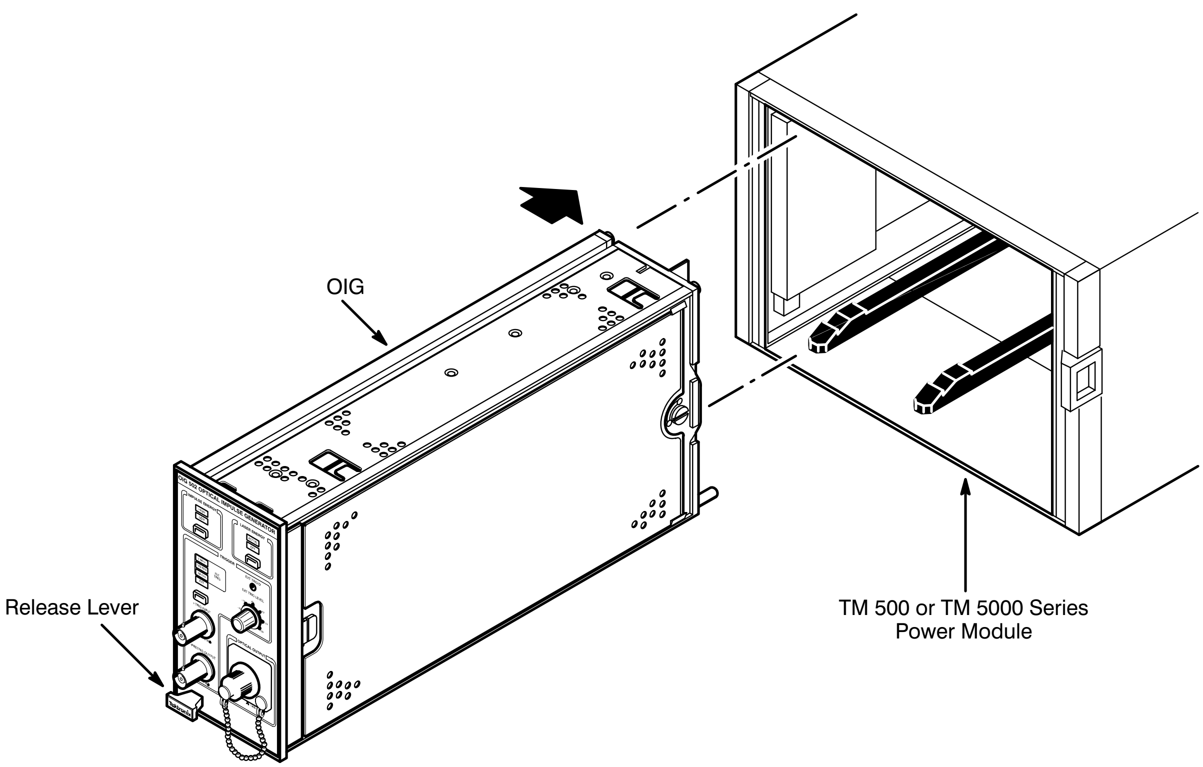

Figure 1-1: Installing the OIG into the Power Module.

Specifications

The following tables list performance specifications of the OIG 501 and OIG 502. These specifications are only valid for an instrument calibrated at an ambient temperature between +20°C and +30°C. The instrument must also be operated within the environmental specifications and have a warm-up period of at least 20 minutes.

The following tables list the performance specifications of the OIG 501/502:

- Table 1-1 lists the optical specifications
- Table 1-2 lists the electrical specifications
- Table 1-3 lists the physical specifications
- Table 1-4 lists the environmental specifications
- Table 1-5 lists the reliability specifications

Table 1-1: Optical Specifications

Characteristic	Performance Requirements	Supplemental Information
Wavelength	OIG 502: 1300 nm ±20 nm OIG 501: 850 nm ±55 nm	Not checked.
Peak Optical Power, Low-Energy Pulse	OIG 502: ≥5 mW peak OIG 501: ≥15 mW peak	
Optical Pulse Power, High-Energy Pulse	OIG 502: ≥2.0 pJ per impulse[1]; ≥15 mW peak OIG 501: ≥5.0 pJ per impulse[1]; ≥30 mW peak	
Pulse Duration:		
Low-Energy Pulse	≤35 ps (OIG 501) ≤40 ps (OIG 502)	Full width half maximum (FWHM). See Chapter 4 for more information about pulse width.
High-Energy Pulse	<300 ps max	Full width half maximum (FWHM). See Chapter 4 for more information about pulse width.
Pulse Amplitude	≤10% variation in peak from 10 kHz to 1 MHz	Referenced at 100 kHz.

[1]**Energy per impulse is equal to total average output power (Watts) divided by impulse repetition rate (Hz)**

Table 1-2: Electrical Specifications

Characteristic	Performance Requirements	Supplemental Information
Trigger Output	1 V min step into 50 Ω falling-edge pre-trigger	TTL output.
Minimum Trigger Input Step	0.5 V at 5 ns rise	With trigger level set at mesial point of trigger input signal.
Trigger Level	−3.0 V to +3.0 V	With hysteresis of 20 mV min, 100 mV max.
−PRETRIG OUTPUT Timing	−PREtrig OUTPUT precedes optical pulse by 60 ns ±10 ns	
−PRETRIG OUTPUT vs. Optical Impulse Jitter	≤5 ps rms	Measured at 50% crossover point of rising edge.

Table 1-3: Physical Specifications

Characteristic	Performance Requirements	Supplemental Information
Net Weight	875 g (1 lb, 15 oz)	
Outside Dimensions:		
Height	13 cm (5 in)	Single-wide TM 500 or TM 5000 compatible.
Width	7 cm (2.75 in)	
Length	31 cm (12 in)	
Optical Output Fiber Size	OIG 502: core, 9 µm singlemode OIG 501: core, 50 µm multimode	

Table 1-4: Environmental Specifications

Characteristic	Performance Requirements
Temperature:	Pulse width and power guaranteed +20°C to +30°C (68°F to 86°F)
Operating	0°C to +50°C (32°F to 122°F) (Meets MIL-T-28800D, Class 5)
Non-operating	−40°C to +71°C (−40°F to 160°F) (Meets MIL-T-28800D, Class 5)
Humidity:	Pulse width and power guaranteed +20°C to +30°C (68°F to 86°F)
Operating	95% RH at +11°C to +30°C (52°F to 77°F) 75% RH at +11°C to +40°C (52°F to 104°F) 45% RH at +11°C to +50°C (52°F to 122°F) (Exceeds MIL-T-28800D, Class 5, non-condensing)
Non-operating	75% RH at −40°C to +71°C (−40°F to +160°F) (Exceeds MIL-T-28800D, Class 5, non-condensing)
Altitude:	
Operating	4570 km (15,000 ft) (Exceeds MIL-T-28800D, Class 5)
Non-operating	9140 km (30,000 ft) (Exceeds MIL-T-28800D, Class 5)
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)
Shock	30 g's (1/2 sine) for 11 ms duration, 3 shocks in each direction along 3 major axes, 18 shocks total (Meets MIL-T-28800D, Class 5 when installed in qualified power modules)
Bench Handling	12 drops from 45°, 4 inches, or equilibrium, whichever occurs first (Meets MIL-T-28800D, Class 5 when installed in qualified power modules)
EMI	Meets FCC regulations Part 15, Subpart J, Class A; VDE 0871, Class B; MIL-461B (1980) for RE01, RE02, CE01, CE03, RS03, CS01, CS02, and CS06
Electrostatic Discharge	6 kV maximum applied to instrument from an ESD source per IEC 801-2 (150 Ω /150 pF)

Table 1-5: Reliability Specifications

Characteristic	Performance Requirements
Mean Time Between Failure	>50,000 hours (calculated value)
BNC Connector Life	5000 connection cycles with less than 0.1 Ω increase in resistance
Optical Bulkhead Connector Life	1000 cycles with less than 10% change in optical output. (Connector may require periodic cleaning. See Chapter 5 for instructions.)

Table 1-6: Certifications and compliances

Catagory	Standards or description	
EC Declaration of Conformity – EMC	Meets 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 Union:	
	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
Australia/New Zealand Declaration of Conformity – EMC	Complies with EMC provision of Radiocommunications Act per the following standard(s):	
	AS/NZS 2064.1/2	Industrial, Scientific, and Medical Equipment: 1992
Laser Safety Classification	Class 1: IEC825-1 and 21-CFR-1040	

Front Panel Operation

This chapter describes the function of each front panel control, indicator, and connector of the OIG. Figure 2-1 shows the location of the front panel components.

The front panel is divided into four areas, labeled as follows:

- IMPULSE ENERGY
- LASER ENABLE
- TRIGGER
- OPTICAL OUTPUT

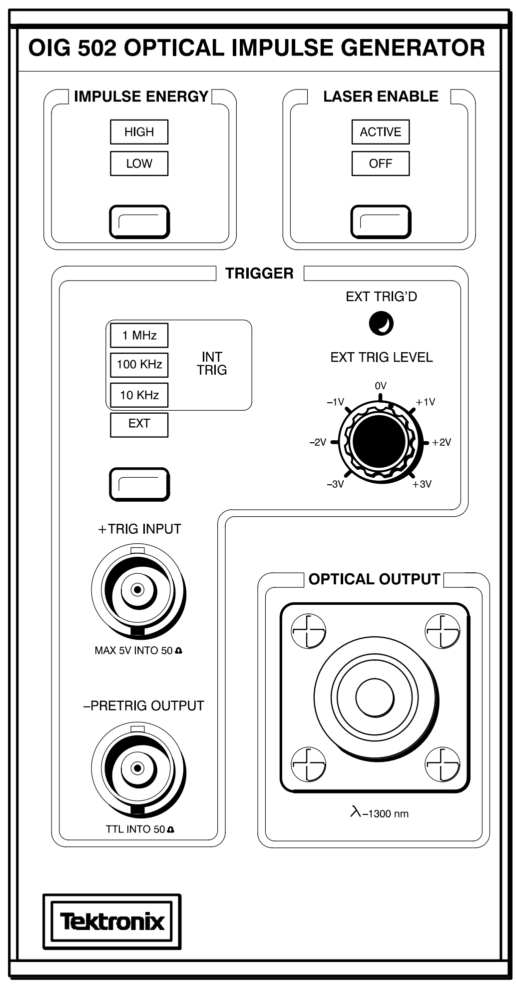

Figure 2-1: The OIG 502 Front Panel.

Impulse Energy

The **IMPULSE ENERGY** area consists of a momentary pushbutton switch and two indicator lights: **HIGH** and **LOW**. The switch alternately selects between high- and low-energy modes and the lighted indicator identifies the selected mode. At power-up, the **LOW** indicator is normally lit.

The low-energy mode is capable of producing a $\geq$5 mW peak (OIG 502) or $\geq$15 mW peak (OIG 501) pulse at $\leq$35 ps (OIG 501) or $\leq$40 ps (OIG 502) full width at half maximum (FWHM). The high-energy mode can produce a pulse of $\geq$15 mW peak (OIG 502) or $\geq$30 mW peak (OIG 501) at $\leq$300 ps FWHM.

Laser Enable

The **LASER ENABLE** area consists of a momentary pushbutton switch and two indicators: **ACTIVE** and **OFF**. The switch alternately selects the active and off modes and the lighted indicator identifies the selected mode. At power-up, the **OFF** indicator is normally lit.

When the **OFF** indicator is lit, the OIG laser is disabled. When the **ACTIVE** indicator is lit, the OIG outputs a high-energy or low-energy laser pulse, depending on which impulse energy mode is selected.

Trigger

The TRIGGER area consists of the following components:

- Trigger Indicators and Select Switch
- **EXT TRIG LEVE**L Control
- **EXT TRIG'D** Indicator
- **+TRIG INPUT**
- **−PRETRIG OUTPUT**

Trigger Indicators and Select Switch

The lighted trigger indicator identifies the selected trigger mode of the OIG. The **1 MHz**, **100 kHz**, and **10 kHz** indicators refer to internally generated repetition rates. The **EXT** indicator corresponds to the external trigger input (**+TRIG INPUT**) of the OIG. At power-up, the **EXT** indicator is normally lit.

The trigger select switch is a momentary pushbutton switch that sequentially selects the **1 MHz**, **100 kHz**, **10 kHz**, and **EXT** trigger modes.

EXT TRIG LEVEL

The **EXT TRIG LEVEL** knob controls the voltage level that the OIG will trigger from an external rising-edge trigger source. The trigger level is continuously adjustable from −3 V to +3 V. It should be set for approximately half of the external trigger input voltage range. For example, if the external trigger input voltage range is from 0 V to +3 V, set the **EXT TRIG LEVEL** control to +1.5 V.

EXT TRIG'D Indicator

The **EXT TRIG'D** Indicator will light when the OIG is successfully triggering from an external trigger source.

+TRIG INPUT

The **+TRIG INPUT BNC** connector is the connection point for the external trigger source. The maximum input voltage range is from −5 V to +5 V and the frequency range is from DC to 1 MHz. The OIG triggers an optical impulse on the rising edge of the **+TRIG INPUT** signal.

NOTE

*The trigger jitter specification does not apply to the **+TRIG INPUT**. Using the **+TRIG INPUT** as the master trigger source will degrade jitter performance.*

−PRETRIG OUTPUT

The **−PRETRIG OUTPUT BNC** connector is the trigger output of the OIG. Since the trigger jitter specification applies to the **−PRETRIG OUTPUT**, use this output for triggering other signal sources or acquisition devices.

The falling edge of the **−PRETRIG OUTPUT** is the active edge and it precedes the optical impulse by approximately 60 ns.

The **−PRETRIG OUTPUT** is at TTL voltage levels. Make sure the device connected to the **−PRETRIG OUTPUT** is capable of triggering at 50% of the TTL level (approximately 2 V). To satisfy the trigger requirements, you may need to connect an attenuator to the trigger cable. For example, if you are triggering a Tektronix CSA 803 Communications Signal Analyzer, you will need to insert a 5X attenuator in the trigger line.

OPTICAL OUTPUT

The **OPTICAL OUTPUT** port is the connection point for the optical fiber or optical device under test. Pulsed laser light is emitted from this port during instrument operation.

WARNING

Do not look directly into the optical output port. Laser light can be harmful to your eyes.

The **OPTICAL OUTPUT** pulse lags the **–PRETRIG OUTPUT** by approximately 60 ns. This feature is useful when triggering acquisition devices, such as an oscilloscope.

The OIG is shipped with the FC bulkhead connector and dust cover installed. An ST bulkhead and a DIN 47256 bulkhead (each with a dust cover) are included as standard accessories. Chapter 5 of this manual includes instructions for changing the bulkhead adapters.

Always install the supplied dust cover when there is nothing connected to the OIG **OPTICAL OUTPUT** port. Using the dust cover minimizes the need to clean the **OPTICAL OUTPUT** port. Cleaning instructions are provided in Chapter 5 of this manual.

Typical Applications

This chapter provides information about interpreting the OIG 502 pulse and examples of typical measurement applications using the OIG 502. The following subjects are discussed:

- OIG 502 Pulse Interpretation
- Recommended Test Equipment
- Testing Response Time of High-Speed Optical Detectors (O/E Converters)
- Measuring Optical Reflections
- Testing Dispersion of Multimode Fiber Cable
- Testing Length of Fiber Cable

OIG 502 Pulse Interpretation

Before using the OIG 502 in applications, it is important to understand the differences between the low-energy and high-energy impulse waveshapes. It is also important to understand how each component of the measurement system affects the impulse waveform.

Figures 3-1 and 3-2 show low-energy and high-energy impulse waveforms, respectively. These waveforms were measured using a Tektronix 11801A digital sampling oscilloscope with an SD-26 sampling head and an SD-46 O/E Converter. The SD-26 and SD-46 each have a 20 GHz bandwidth.

The low energy impulse typically produces 5 mW of peak power with 35 ps full width at half maximum (FWHM) as measured with the SD-26 and SD-46. The low-energy pulse has an essentially Gaussian shape.

The high-energy impulse typically produces a peak power of 15 mW with 250 ps FWHM. Notice the high-energy pulse has a more complicated structure. This structure is caused by the turn-on characteristics of the laser device and varies somewhat from device to device. The high-energy impulse (normally used with lower bandwidth equipment) works well in applications requiring higher total pulse energy, such as reflection testing.

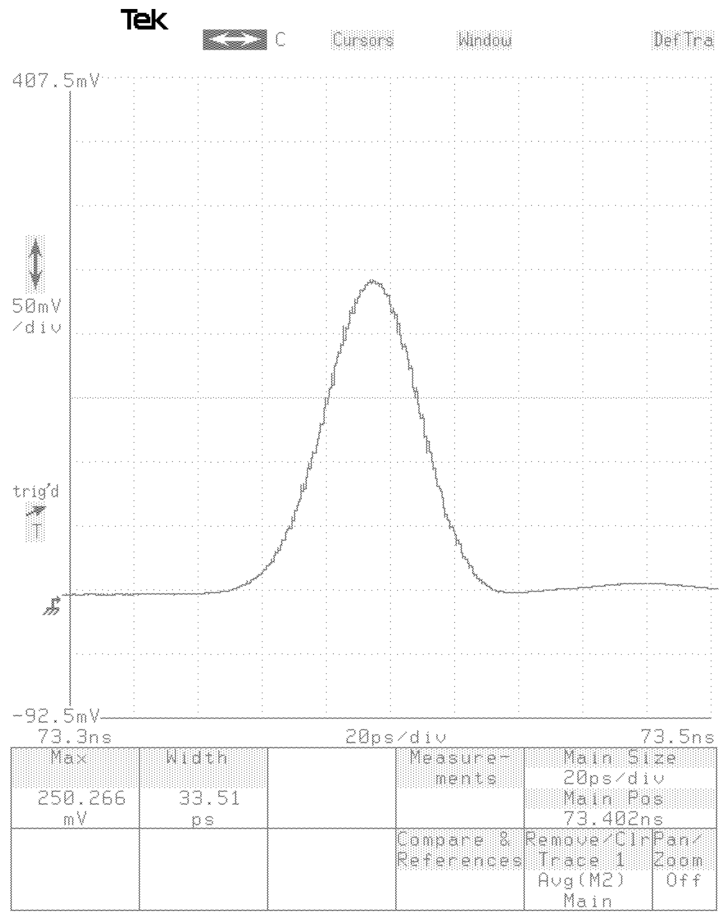

Figure 3-1: OIG 502 Low-Energy Impulse.

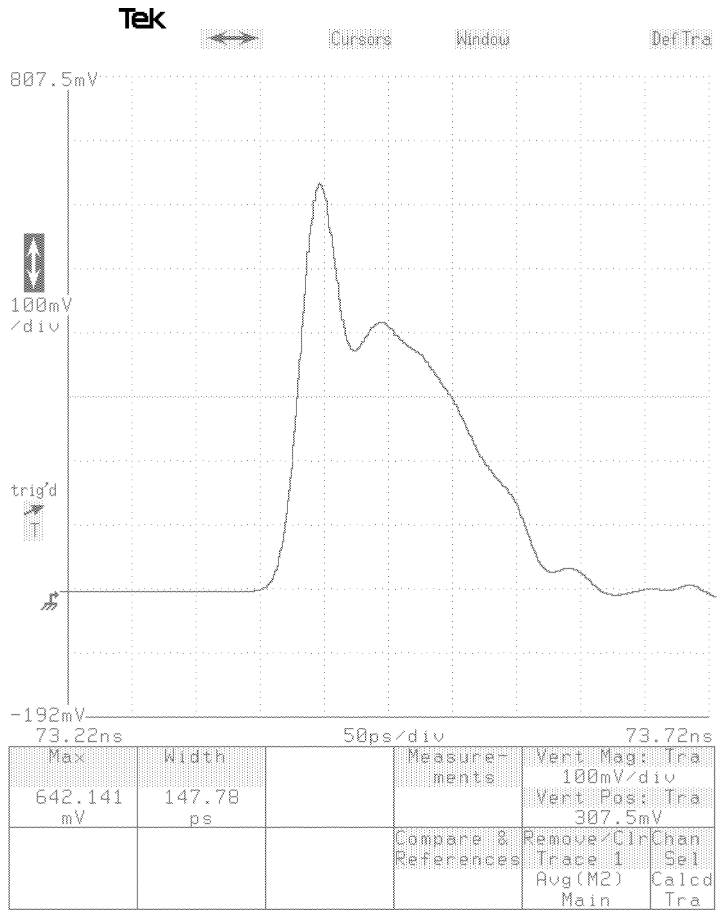

Figure 3-2: OIG 502 High-Energy Impulse.

Both the low-energy and high-energy impulses will appear somewhat broader than the specified value due to the total rise time of the measurement system. Figure 3-3 shows how the pulse response of various measurement systems affects the low-energy impulse waveshape. Figure 3-4 shows the same effect on the high-energy impulse. The pulse tends to flatten out and broaden with lower bandwidth O/E converters and sampling heads. Always consider the measurement system's pulse response when making optical measurements with the an OIG.

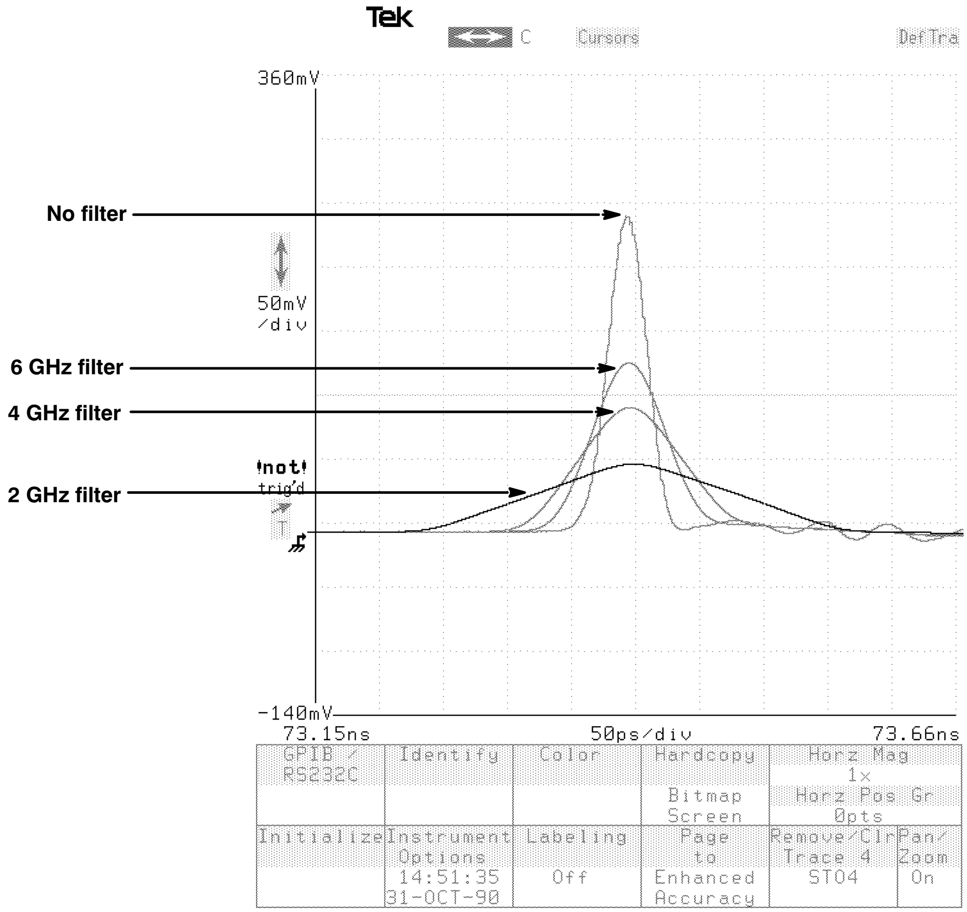

Figure 3-3: Effect of Measurement System on Low-Energy Impulse Shape.

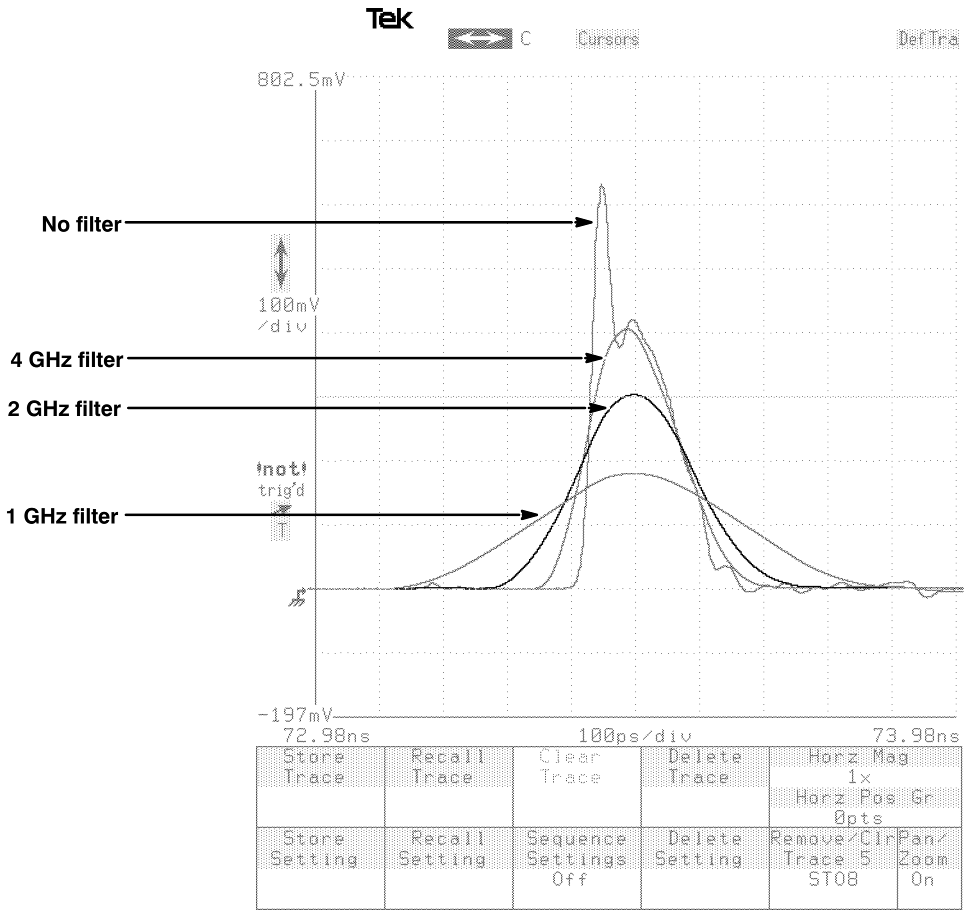

Figure 3-4: Effect of Measurement System on High-Energy Impulse Shape.

Recommended Test Equipment

The OIG 502 can be used with various measurement systems. The measuring equipment you use will depend largely on the desired application.

For high-resolution measurements, we recommend using an SD-46 20 GHz O/E Converter and an SD-26 20 GHz sampling head with the Tektronix 11800 Series Digital Sampling Oscilloscope or CSA 803 Analyzer.

The Tektronix 11800 Series oscilloscopes and CSA 803 Analyzer have built-in integration capability for measuring step responses of O/E Converters. The Tektronix CSA 803 can also record signal histograms, a feature that is useful for measuring signal jitter. The 11800 Series oscilloscopes and CSA 803 Analyzer allow you to make complex measurements without external computer equipment.

Testing Response of High-Speed Optical Detectors (O/E Converters)

The narrow pulse width of the OIG low-energy pulse is an excellent source for testing high-speed optical detectors (O/E Converters). This application example describes how to measure O/E Converter rise time within its linear response range.

The following equipment is required for this application:

- OIG 501/502 Optical Impulse Generator (use appropriate OIG to best suit the responsivity of the O/E converter under test).
- Digital signal acquisition equipment with a rise time specification of less than 50% of that for the O/E Converter-under-test. The acquisition equipment must be capable of performing signal integration. This example uses a Tektronix CSA 803 Communications Signal Analyzer with an SD-26 Sampling Head. An external computer may be necessary with other types of acquisition equipment.
- Adjustable optical attenuator to match the OIG output to the O/E Converter-under-test. The attenuator is not necessary if the OIG output falls within the O/E Converter's dynamic range.
- Fiber jumpers and electrical cables.
- 5X electrical attenuator

Perform the following procedure to measure the step-response of O/E Converters using discrete photodetectors or photodetector and amplifier combinations. Figure 3-5 shows the equipment connections.

1. Connect the OIG 501/502 **OPTICAL OUTPUT** to an adjustable optical attenuator (if needed) and connect the attenuator output to the optical detector-under-test.
2. Connect the OIG 501/502 **–PRETRIG OUTPUT** to the 5X attenuator and connect the attenuator to the trigger input of the acquisition equipment.

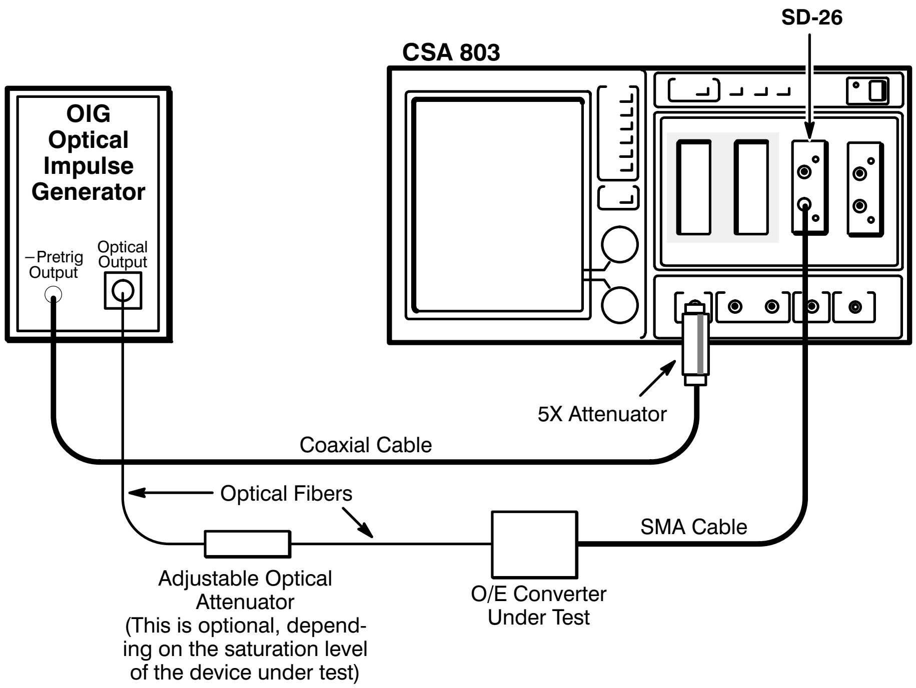

Figure 3-5: Measuring Optical Detector Rise Time.

3. Set the OIG 501/502 trigger select switch to **1 MHz INT** and the **IMPULSE** switch to **LOW**. (You may want to use the **HIGH** impulse for slow optical detectors.)
4. Set the OIG 501/502 **LASER ENABLE** switch to **ACTIVE**.
5. Connect the output of the optical detector to the signal acquisition input. Adjust the waveform display so that impulse response is centered in the time window and the full width at half maximum (FWHM) is approximately 5% of the record length.
6. Adjust the optical attenuator to assure that the photoreceiver output remains within its linear dynamic range. If necessary, readjust the acquisition equipment time base.
7. Store the data record and determine the mean data value for the period preceding the laser impulse. Subtract this mean data value from the waveform data and integrate the remainder.

The result is the step response of the optical detector. Figure 3-6 shows a typical step response curve. If the procedure has been performed correctly, the baseline preceding the step will be flat.

8. The total measured rise time is measured from the 10% point to the 90% point of the step response curve. To calculate the rise time of the optical detector, use the following formula:

$$T_{r(opt\ det)} = \sqrt{T^2_{r(meas)} - T^2_{r(sys)}}$$

where:

$T^2_{r(opt\ det)}$ = the rise time of the optical device-under-test,
$T_{r^2(meas)}$ = the total measured rise time, and
$T_{r^2(sys)}$ = the rise time of the measurement system (the OIG and signal acquisition equipment).

Aberrations should also be noted. An aberration is the percentage value of overshoot or undershoot compared to the final (100%) value. Aberrations are measured in the period occurring after the waveform first crosses the 100% point.

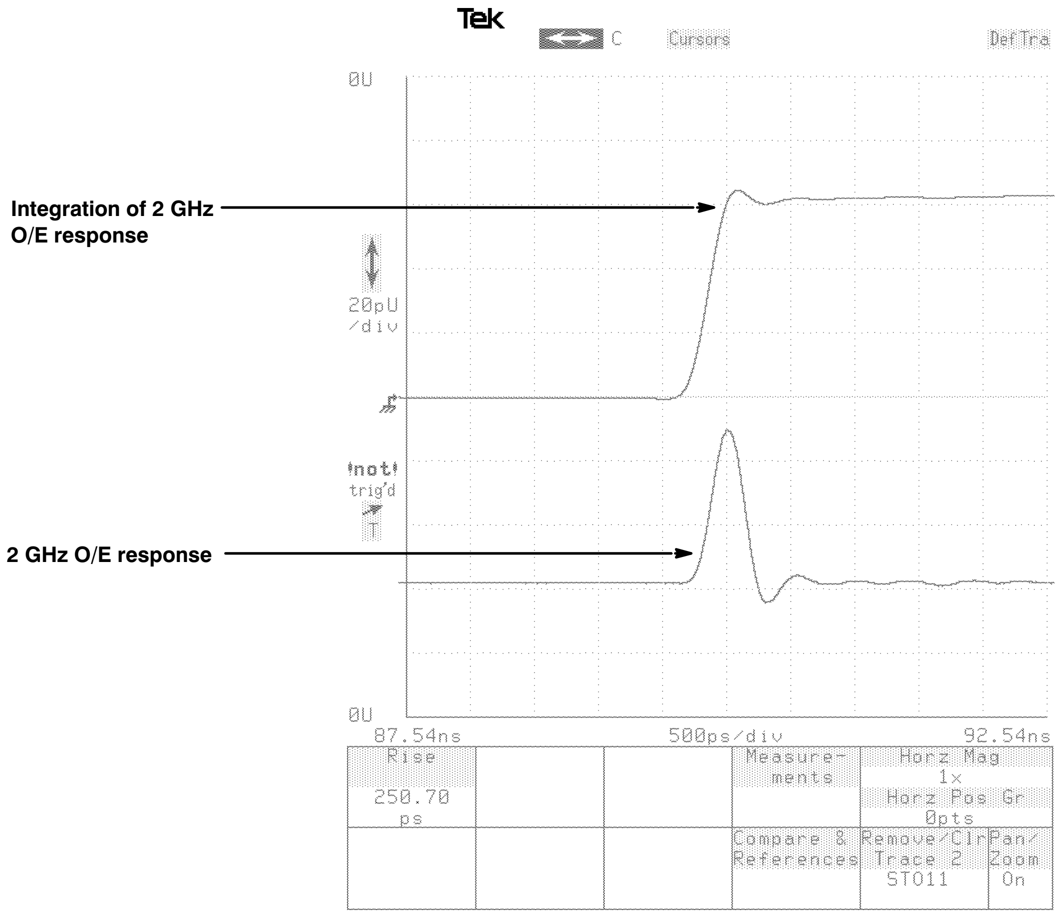

Figure 3-6: Step-Response Curve of Optical Detector.

The measurement system's rise time must always be considered. Table 3-1 lists the rise time parameters of some Tektronix acquisition systems.

Table 3-1: Rise Times of Various Tektronix Measurement Systems

Acquisition System	Approximate System Rise Time
CSA 803 or 11800 Series Oscilloscope with SD-22 Sampling Head	38 ps
CSA 803 or 11800 Series Oscilloscope with SD-26 Sampling Head	31 ps
CSA 803 or 11800 Series Oscilloscope with SD-30 Sampling Head	27 ps
11403 Oscilloscope with 11A72 Amplifier	350 ps
DSA601/602 Digital Signal Analyzers	350 ps
2440 Oscilloscope with 2402A TekMate	1.17 ns

Measuring Optical Reflections

The OIG 502 lets you make a wide range of reflection measurements. The low-energy impulse resolves distances as close as 4 mm when used with the appropriate acquisition system. The high-energy impulse allows you to detect reflections below −40 dB with certain measurement systems. Table 3-2 lists the performance capabilities of the OIG 502 when used with several different Tektronix acquisition systems.

The following equipment is required for this application:

- OIG 502 Optical Impulse Generator.
- 3 dB optical splitter.
- O/E Converter. (This example uses a Tektronix SD-46.)
- Signal acquisition system (oscilloscope). This example uses a Tektronix CSA 803 Communications Signal Analyzer with an SD-26 Sampling Head.
- Fiber jumpers and electrical cables.
- 5X electrical attenuator.

Table 3-2: Reflection Measurement Performance of Selected Tektronix Acquisition Systems

Acquisition System	Single Event Distance Resolution	Typical FWHM Distance Resolution	Typical Reflection Sensitivity[1]
CSA 803 or 11800 Series Oscilloscope with SD-26 Sampling Head and SD-46 O/E Converter	<0.1 mm[2]	<3.4 mm[2]	−28 dB[2]
CSA 803 or 11800 Series Oscilloscope with SD-22 Sampling Head and SD-46 O/E Converter	<0.1 mm[2]	<6.4 mm[2]	−32 dB[2]
CSA 803 or 11800 Series Oscilloscope with SD-26 Sampling Head and SD-42 O/E Converter	<0.1 mm[2]	<5.5 mm[2]	−27 dB[2]
CSA 803 or 11800 Series Oscilloscope with SD-22 Sampling Head and SD-42 O/E Converter	<0.1 mm[2]	<5.9 mm[2]	−34 dB[2]
CSA 803 or 11800 Series Oscilloscope with SD-22 Sampling Head and P6703 O/E Converter	<0.1 mm[3]	<4.5 cm[3]	−47 dB[3]
11403 Oscilloscope with 11A72 Amplifier and P6703 O/E Converter	<1.0 mm[3]	<5.5 cm[3]	−46 dB[3]
2440 Oscilloscope with P6703 O/E Converter	<4.0 mm[3]	<12 cm[3]	−43 dB[3]

[1] **All measurements made after averaging 512 traces.**
[2] **Measurements using the OIG 502 low-energy impulse.**
[3] **Measurements using the OIG 502 high-energy impulse.**

The following procedure describes a typical method for measuring optical reflections. Figure 3-7 shows the equipment connections.

1. Connect the OIG 502 **OPTICAL OUTPUT** to one output of the 3 dB optical splitter.

2. Connect the other splitter output to the O/E Converter using a fiber jumper and connect the O/E Converter to the oscilloscope.

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 will provide the −14 dB Fresnel reflection reference.

4. Connect the OIG 502 **-PRETRIG OUTPUT** to the 5X attenuator and connect the attenuator to the oscilloscope trigger input.
5. Select the desired OIG 502 energy pulse and internal trigger rate (the **1 MHz INT** rate normally works best).
6. Search for the optical reflection at the end of the jumper by adjusting the time window of the oscilloscope. Often, the high-energy impulse is useful to initially find the reflection.
7. Verify that the reflection in Step 6 is the correct one by changing the reflectance at the fiber end. Pouring a drop of water on the fiber end will drastically reduce the Fresnel reflection.
8. Once you have verified the correct reflection, clean the fiber end and average the display. Note the value of the −14 dB reflection and use it to calibrate other reflections. Also note the time value of the reflection if distance measurements are to be made.

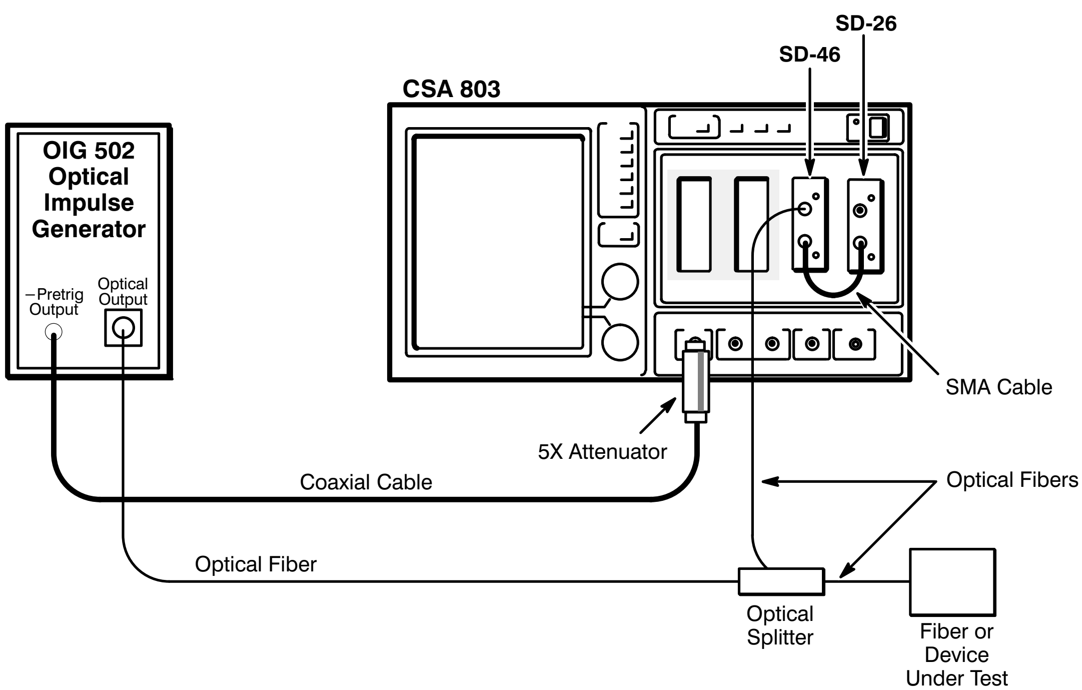

Figure 3-7: Measuring Optical Reflections.

9. Connect the device-under-test to the jumper end and search for reflections. Compare this reflection value to the −14 dB reference value and calculate the device's return loss.

NOTE

The accuracy of this value depends on the surface condition of the fiber end (cleavage angle, dust particles, etc.).

10. To calculate reflection distances, divide the measured propagation delay by twice the propagation velocity figure of the fiber being used. Be sure to compensate for jumper (or pigtail) lengths.

Figure 3-8 shows a waveform of an optical reflection. The electrical pulses displayed on the oscilloscope will be attenuated by losses introduced from two passes through the optical splitter.

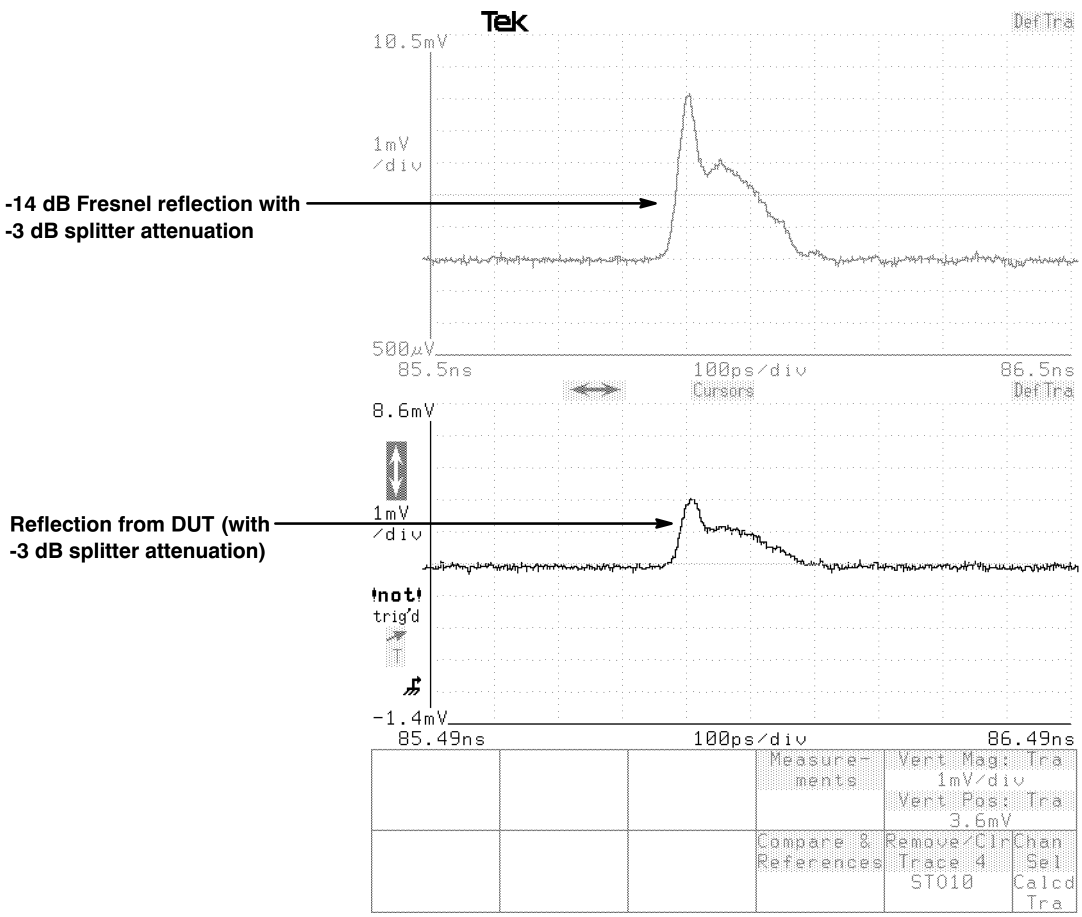

Figure 3-8: Optical Reflection Display.

Testing Dispersion of Multimode Fiber Cable

Multimode fiber tends to broaden optical pulses because of multimode dispersion. The application described here shows one method of measuring multimode dispersion.

The following equipment is required for this application:

- OIG 501 Optical Impulse Generator.
- O/E Converter and oscilloscope of sufficient bandwidth and minimum jitter. This example uses a Tektronix 11801A Digital Sampling Oscilloscope with an SD-26 Sampling Head and an SD-46 O/E Converter. The 11801A typically has a trigger jitter of less than 20 ppm of the delay.
- Mode scrambler (a 1 meter length of step-index fiber wrapped several times around a 1 inch diameter mandrel).
- 50 Ω coaxial cable.
- 2X attenuator.
- Digital signal processor capable of performing the desired mathematical analysis of the signal. (This equipment is optional.)

Perform the following procedure to measure multimode fiber dispersion. Figure 3-9 shows the equipment connections.

1. Connect the O/E Converter to the oscilloscope.
2. Connect the OIG 501 **–PRETRIG OUTPUT** to the 2X attenuator and connect the attenuator to the oscilloscope trigger input.
3. Connect one end of the mode scrambler to the OIG 501 **OPTICAL OUTPUT** and the other end to the O/E Converter input.
4. Select the desired impulse energy level and internal trigger rate (the **1 MHz INT** setting generally works best).
5. Adjust the oscilloscope to display the launch pulse. Store the display.

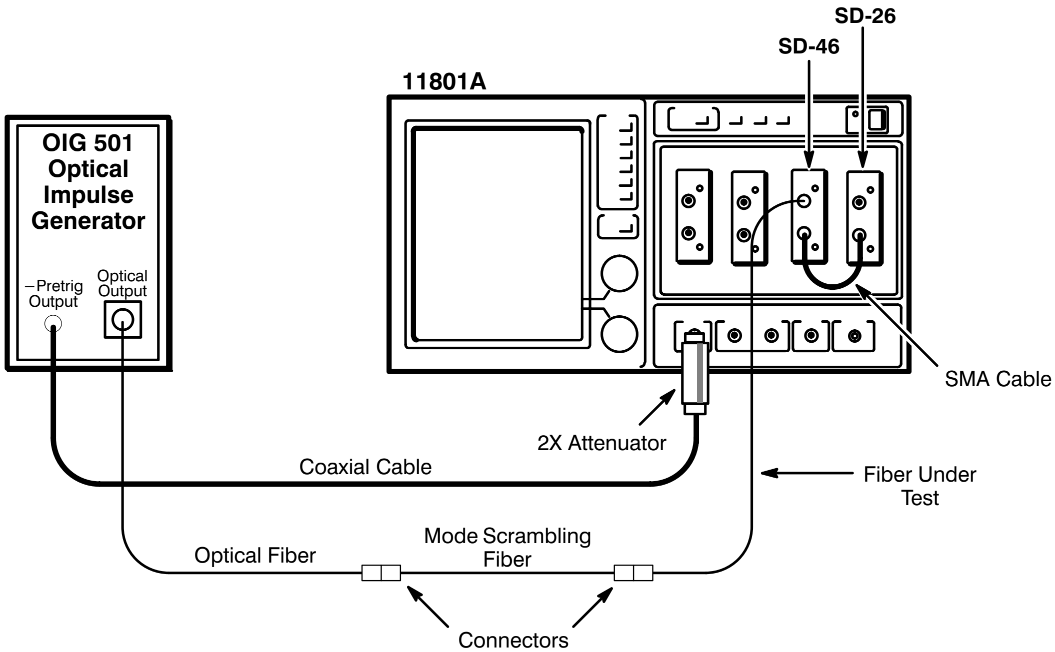

Figure 3-9: Measuring Multimode Fiber Dispersion.

6. Connect the fiber-under-test between the mode scrambler and the O/E Converter input. Adjust the oscilloscope to display the exit pulse. To minimize jitter, carefully adjust for the optical pulse that the trigger is referenced to.
7. Compare the exit pulse to the launch pulse to see the effects of the dispersive medium.
8. If desired, submit the waveform to digital signal processing equipment to quantify the dispersive effects observed.

Figure 3-10 shows a waveform comparison of a launch pulse to an exit pulse.

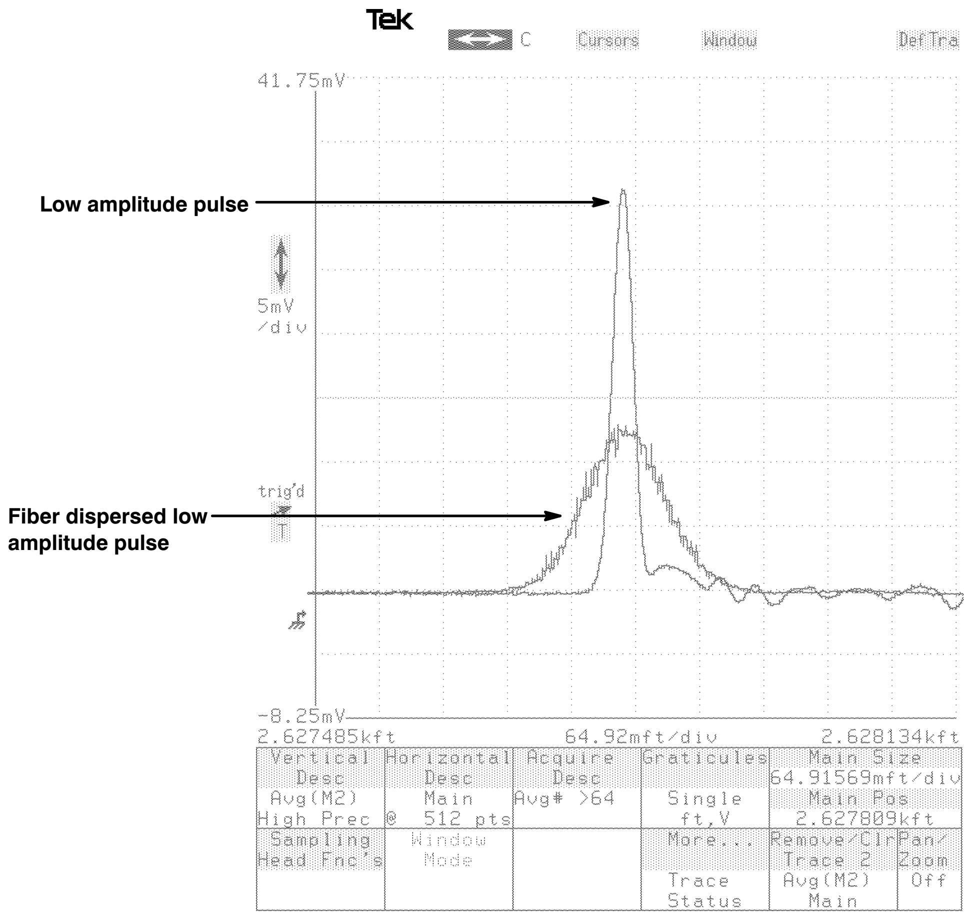

Figure 3-10: Display of Multimode Fiber Dispersion.

Testing Length of Fiber Cable

The OIG 502 can measure fiber lengths with less than 4 mm precision when used with the appropriate measurement system. Table 3-2 lists the measurement precision characteristics of several Tektronix measurement systems.

This application example describes one method used for fiber length measurement. The following equipment is required for this application:

- OIG 502 Optical Impulse Generator.
- 3 dB optical splitter.
- Two O/E Converters. This example uses two Tektronix SD-46 O/E Converters.
- Signal acquisition system (oscilloscope). This example uses a Tektronix 11801A Digital Sampling Oscilloscope with two SD-26 Sampling Heads.
- Fiber jumpers and electrical cables.
- 2X attenuator.

The following procedure describes a typical method of measuring fiber length. Figure 3-11 shows the test equipment configuration.

1. Connect the O/E Converters to the oscilloscope.
2. Connect the OIG 502 **–PRETRIG OUTPUT** to the 2X attenuator and connect the attenuator to the oscilloscope trigger input.
3. Connect the OIG 502 **OPTICAL OUTPUT** to the input of the optical splitter.
4. Connect one splitter output to the O/E Converter input with a fiber pigtail or jumper. This connection will provide the reference pulse.
5. Connect the other splitter output to the fiber-under-test using a pigtail of equal length to the first one.
6. Connect the end of the fiber-under- test to the other O/E Converter.

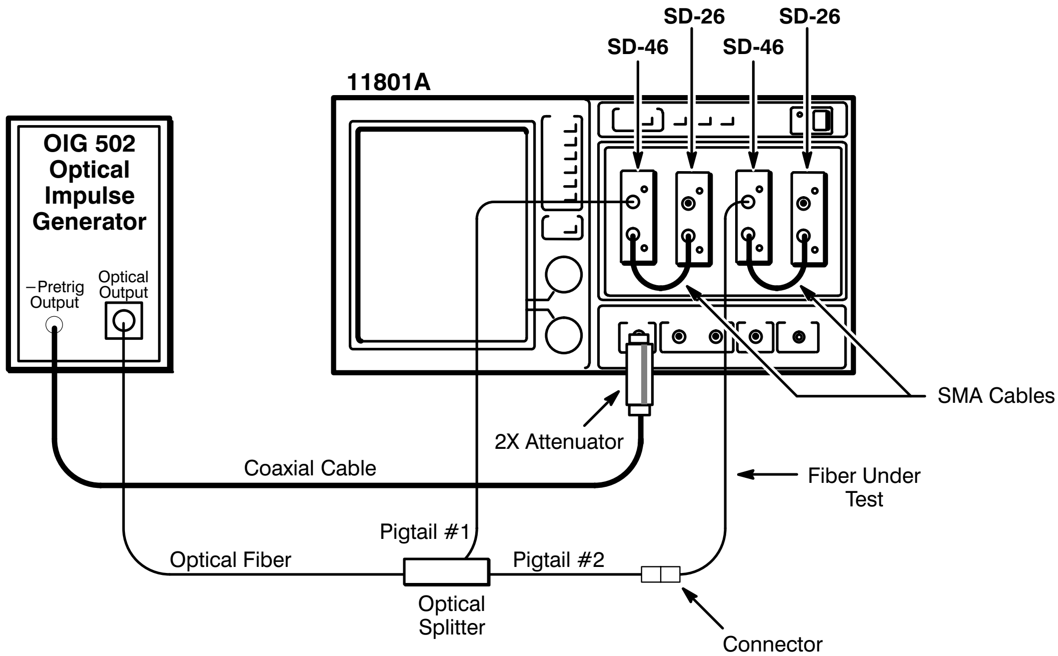

Figure 3-11: Measuring Fiber Length.

7. Select the desired OIG 502 impulse energy level and internal trigger rate (the **1 MHz INT** rate generally works best).

8. Calculate the cable length by measuring the time differential between the reference pulse and the pulse of the fiber-under-test. Use the propagation velocity specifications of the fiber-under-test to convert the time differential into distance.

Figure 3-12 shows an oscilloscope display of a precision length measurement.

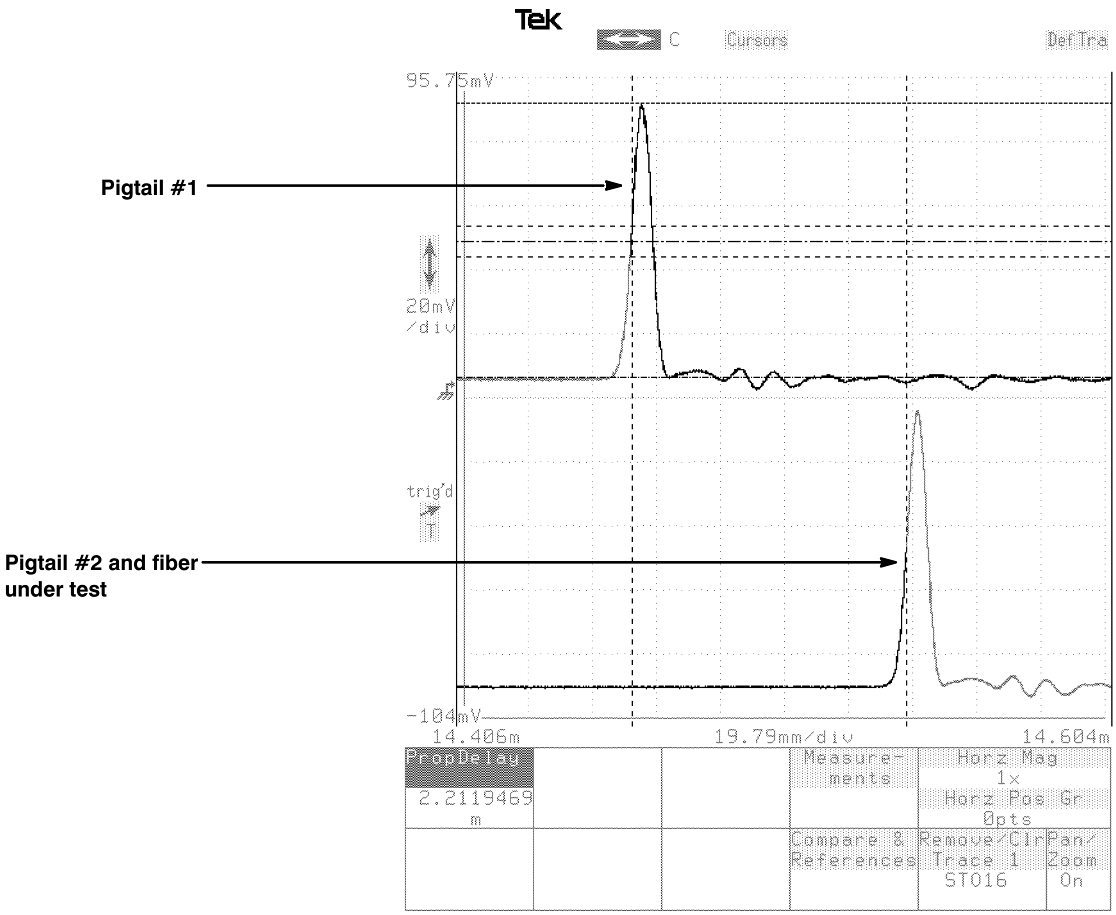

Figure 3-12: Display of Fiber Length Measurement.

Acceptance Tests

This chapter details test procedures that you can use to verify the OIG 501 and OIG 502's performance. There are five categories of tests:

- Power-Up Test
- Impulse Duration and Amplitude Tests
- Laser Enable Tests
- External Trigger Tests
- **−PRETRIG OUTPUT** versus **OPTICAL OUTPUT** Jitter

Table 4-1 lists the test equipment required to perform acceptance tests for the OIG 501 and OIG 502. 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	20 GHz with integration	Tektronix 11800 Series Oscilloscopes or CSA 803 Analyzer
2	Sampling Head	20 GHz bandwidth	TEKTRONIX SD-26
3	Optical-to-Electrical (O/E) Converter	20 GHz bandwidth	TEKTRONIX SD-46
4	Electrical Jumper	SMA jumper that connects SD-46 output to SD-26 input	Tektronix part number 174-1635-00
5	Pulse Generator	0−1 MHz pulse output	TEKTRONIX PG 502
6	Digital Multimeter	3½ digit, 1 mV resolution	TEKTRONIX DM 511
7	OIG 502: Single-mode Optical Fiber OIG 501: Multi-mode Optical Fiber	Connectors: OIG 502 bulkhead type to FC Core size 50 μm to 62.5 μm with OIG 501 bulkhead type to FC Maximum length of 3 meters	See Optional Accessories List
8	5X Attenuator	Connectors: BNC male to BNC female	Tektronix part number 011-0060-XX (015-1018-00 adapter required if using a Tektronix 11800 Series Oscilloscope or CSA 803 Analyzer)

Table 4-1: Required Acceptance Test Equipment (Cont.)

Item	Description	Minimum Specification	Recommended Equipment
9	Coaxial Cable (2 required)	50 Ω impedance, BNC female connectors	Tektronix part number 012-0076-00
10	Optical Power Meter (optional)	0–300 nW with –60 dBm (1 nW) resolution	

Power-up Test

The OIG requires a Tektronix TM 500 or TM 5000 Series power supply to meet its performance specifications. The OIG will work in any open slot of the power supply. Perform the following procedures to test the OIG for proper power-up.

1. Insert the OIG into an unpowered TM 500 compatible power supply. The OIG should latch securely into the power supply frame and should not pull out unless the release latch (located in the lower left-hand corner of the OIG front panel) is pulled.
2. Turn the TM 500 power supply on.
3. The OIG front panel should power up with the **LOW**, **OFF**, and **EXT** indicators lit.

Impulse Duration and Amplitude Tests

The Impulse Duration and Amplitude Tests verify the performance of the **HIGH** and **LOW** energy impulses.

Figure 4-1 shows the equipment connections for the Impulse tests and the following procedure describes how to make these connections.

1. Connect the OIG **OPTICAL OUTPUT** to the O/E Converter (Item 3) with a single mode optical fiber (OIG 502) or multi mode optical fiber (OIG 501) (Item 7). The fiber should not be interrupted with any splices, attenuators, etc.
2. Connect the OIG **–PRETRIG OUTPUT** to the oscilloscope trigger input with a 50 Ω coaxial cable (Item 9) and a 5X attenuator (Item 8). (The attenuator drops the OIG trigger voltage to the midpoint of the oscilloscope trigger range.)
3. Connect the O/E Converter output to the Sampling Head (Item 2) input using the SMA jumper (Item 4).

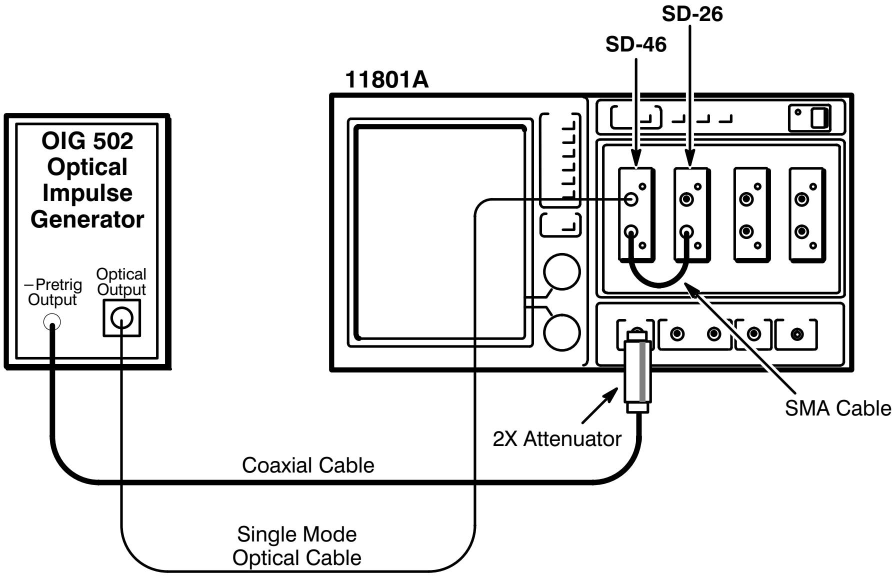

Figure 4-1: Equipment Connections for Impulse Tests.

The following tests are included in the Impulse Duration and Amplitude tests.

- Peak optical power of **HIGH** Impulse
- **HIGH** impulse duration
- **HIGH** impulse energy
- **HIGH** impulse amplitude repetition rate dependency
- Peak optical power of **LOW** Impulse
- **LOW** impulse duration
- **LOW** impulse energy
- **LOW** impulse amplitude repetition rate dependency

Peak Optical Power of HIGH Impulse

1. Set the OIG **IMPULSE** to **HIGH**, the trigger to **1MHz INT**, and the **LASER ENABLE** to **ACTIVE**.
2. Set the oscilloscope trigger to **450 mV** (when using a 5X attenuator), **DC coupled**, and **negative slope**.
3. Locate the impulse on the oscilloscope trace. Adjust the time base and vertical divisions to optimize the trace picture (100 mV/div (OIG 502) or 5 mV/div (OIG 501)).
4. Average the waveform a minimum of 32 times.

5. Select **MAX** from the oscilloscope measurement menu.

6. The **MAX** value should exceed 430 mV if testing an OIG 502 and 4.3 mV per % responsivity (for example: 8.6 mV for 2% responsivity) if testing an OIG 501.[1]

HIGH Impulse Duration

1. Set the OIG **IMPULSE** to **HIGH**, the trigger to **1MHz INT**, and the **LASER ENABLE** to **ACTIVE**.

2. Set the oscilloscope trigger to **450 mV** (when using a 5X attenuator), **DC coupled**, and **negative slope**.

3. Average the waveform a minimum of 32 times.

4. Select **WIDTH** from the oscilloscope measurement menu.

5. The **WIDTH** value should not exceed 300 ps with the measurement point set at the mesial (50%-of-peak) value (full-width-half-maximum definition).

HIGH Impulse Energy

1. Set the OIG **IMPULSE** to **HIGH**, the trigger to **1MHz INT**, and the **LASER ENABLE** to **ACTIVE**.

2. Set the oscilloscope trigger to **450 mV** (when using a 5X attenuator), **DC coupled**, and **negative slope**.

3. Connect the Digital Multimeter (Item 6) to the O/E Converter power monitor output.

4. Set the O/E Converter power monitor output for **1 V/μW**.

5. Verify that the Digital Multimeter reads $\geq$**2.0 V** for an OIG 502 (corresponds to $\geq$2.0 picoJoules) and 20 mV per % responsivity (for example: 40 mV for 2% responsivity) for an OIG 501 (corresponds to $\geq$5.0 picoJoules).[2]

   Power = Energy $\times$ Rate $\times$ (Relative wavelength responsivity of SD-46)[3]

HIGH Impulse Amplitude Repetition Rate Dependency

1. Set the OIG **IMPULSE** to **HIGH**, the trigger to **1MHz INT**, and the **LASER ENABLE** to **ACTIVE**.

2. Set the oscilloscope trigger to **450 mV** (when using a 5X attenuator), **DC coupled**, and **negative slope**.

3. Average the trace of the impulse with the oscilloscope 32 times and record the **MAX** value from the measurement menu.

[1, 2, & 3] **The procedure for determining responsivity of an SD-46 is on page 4-8.**

4. Discontinue averaging the waveform.
5. Select 1**00kHz INT TRIG** from the **TRIGGER** control.
6. Repeat steps 2 and 3 for the **100 kHz** setting.
7. Select **10kHz INT TRIG** from the **TRIGGER** control.
8. Repeat steps 2 and 3 for the **10 kHz** setting.
9. The **MAX** value for the **1 MHz** and **10 kHz** settings should not differ by more than 10% from the **MAX** value measured at the **100 kHz** setting.

Peak Optical Power of LOW Impulse

1. Set the OIG **IMPULSE** to **LOW**, the trigger to **1MHz INT**, and the **LASER ENABLE** to **ACTIVE**.
2. Set the oscilloscope trigger to **450 mV** (when using a 5X attenuator), **DC coupled**, and **negative slope**.
3. Locate the impulse on the oscilloscope trace. Adjust the time base and vertical divisions to optimize the trace picture (≈**50 ps/div** and **50 mV/div** OIG 502) or **5 mV/div** (OIG 501)).
4. Average the waveform a minimum of 32 times.
5. Select **WIDTH** from the oscilloscope measurement menu and note the value as measured at the mesial (50%-of-peak) value. This value is the FWHM (full width at half maximum) value.
6. Select **MAX** from the oscilloscope measurement menu and note the value.
7. To compensate for the measurement system, multiply the **MAX** value by the following:

   $$\frac{FWHM}{\sqrt{FWHM^2 - PR_{(O/E)}{}^2 - PR_{(H)}{}^2}}$$

   where:

   FWHM is the WIDTH value from the oscilloscope menu,

   $PR_{(O/E)}$ is the pulse response of the O/E Converter (18 ps for an SD-46), and

   $PR_{(H)}$ is the pulse response of the Sampling Head (18 ps for an SD-26).
8. Compensated Max value should exceed 143 mV for an OIG 502 or 1.43 mV per % responsivity (for example: 2.86 mV for 2% responsivity) for an OIG 501[1].

[1]. **The procedure for determining the responsivity of an SD-46 is on page 4-8.**

LOW Impulse Duration

1. Set the OIG **IMPULSE** to **LOW**, the trigger to **1MHz INT**, and the **LASER ENABLE** to **ACTIVE**.
2. Set the oscilloscope trigger to **450 mV** (when using a 5X attenuator), **DC coupled**, and **negative slope**.
3. Average the waveform a minimum of 32 times.
4. Select WIDTH from the oscilloscope measurement menu.
5. The **WIDTH** value should not exceed **47.5 ps** (OIG 501) or **43.2 ps** (OIG 502)[1] with the measurement point for the width calculated at the 50%-of-peak value (full-width-half-maximum definition).

LOW Impulse Amplitude Repetition Rate Dependency

1. Set the OIG **IMPULSE** to **LOW**, the trigger to **1MHz INT**, and the **LASER ENABLE** to **ACTIVE**.
2. Set the oscilloscope trigger to **450 mV** (when using a 5X attenuator), **DC coupled**, and **negative slope**.
3. Average the trace of the impulse with the oscilloscope 32 times and record the **MAX** value from the measurement menu.
4. Discontinue averaging the waveform.
5. Select **100kHz INT TRIG** from the **TRIGGER** control.
6. Repeat steps 2 and 3 for the **100 kHz** setting.
7. 7.Select **10kHz INT TRIG** from the **TRIGGER** control.
8. Repeat steps 2 and 3 for the 10 kHz setting.
9. The **MAX** value for the **1 MHz** and **10 kHz** settings should not differ by more than 10% from the **MAX** value measured at the **100 kHz** setting.

[1]The width limit is derived by including the limited bandwidth of the optical (SD-46) and electrical (SD-26) sampling heads to the maximum width specification of the optical impulse generator.

Laser Enable Test

The Laser Enable test checks the operation of the **ACTIVE** and **OFF** modes. Refer to Figure 4-2 and connect the equipment as follows:

1. Connect the OIG **OPTICAL OUTPUT** to the O/E Converter (Item 3) with a single mode optical fiber (OIG 502) or multi mode optical fiber (OIG 501) (Item 7). The fiber should not be interrupted with any splices, attenuators, etc.
2. Connect the OIG **–PRETRIG OUTPUT** to the oscilloscope trigger input with a 50 Ω coaxial cable (Item 9) and a 5X attenuator (Item 8). (The attenuator drops the OIG trigger voltage to the midpoint of the oscilloscope trigger range.)
3. Connect the O/E Converter (Item 3) output to the Sampling Head (Item 2) input using the SMA jumper (Item 4).
4. Connect the O/E Converter monitor output to the Digital Multimeter (Item 6) voltage input.

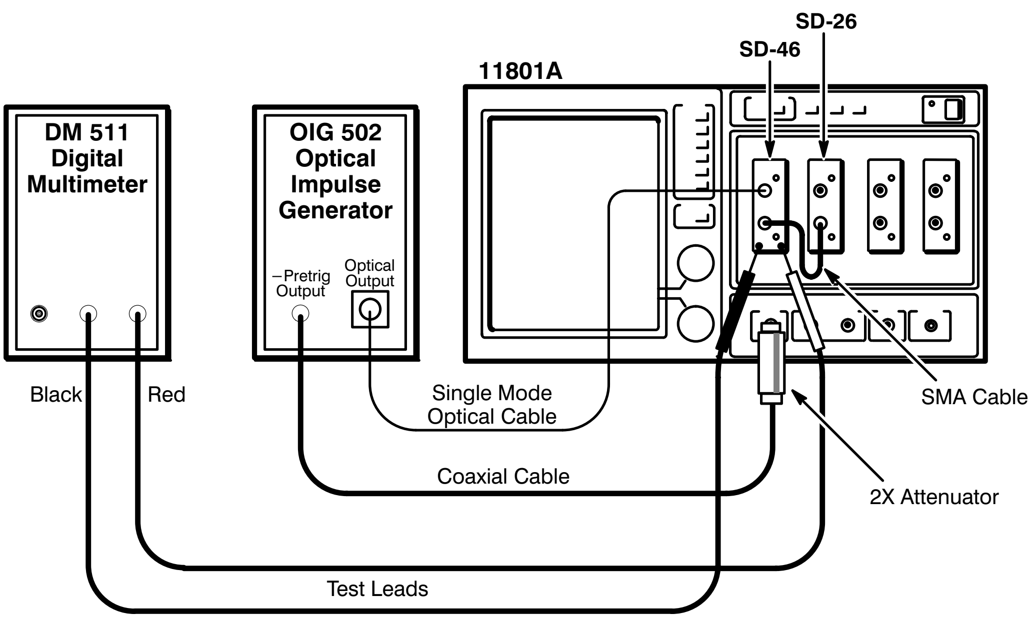

Figure 4-2: Equipment Connections for Laser Enable Test Using an SD-46 O/E Converter.

5. Set the O/E Converter monitor switch to **1 V/μW**.
6. Make sure the Digital Multimeter is properly zeroed.

If you prefer to use an optical power meter, disconnect the OIG **OPTICAL OUTPUT** from the previously described setup and connect it directly to the optical power meter (be sure to use appropriate conversion factors and detectors on the power meter for the wavelength being measured).

Once you have connected the equipment, proceed with the following test.

Active and OFF Conditions

1. Set the OIG **IMPULSE** to **HIGH**, the trigger to **1MHz INT**, and the **LASER ENABLE** to **ACTIVE**. Set the oscilloscope trigger to **450 mV** (when using a 5X attenuator), **DC coupled**, and **negative slope**. The Digital Multimeter should read approximately **2.0 V** or greater for an OIG 502 (corresponds to −27 dBm or greater, 1300 nm) or 20 mV per % responsivity (for example: 40 mV for 2% responsivity) for an OIG 501 (corresponds to −23 dBm or greater, 850 nm). The procedure for determining the responsivity of the SD-46 is given in the following section.

2. Set the OIG **LASER ENABLE** to **OFF**. The Digital Multimeter should read less than a few millivolts (this corresponds to a power of less than a few nanowatts). Be sure the meter is zeroed properly.

3. Set the OIG **IMPULSE ENERGY** to **LOW** and the **LASER ENABLE** to **ACTIVE**. The Digital Multimeter should read approximately **100 mV** to **500 mV** (this value corresponds to a power value of 100 nW to 500 nW or −70 dBm to −63 dBm) for an OIG 502 (lower by the conversion factor for an OIG 501).

4. Set the OIG **LASER ENABLE** to **OFF**. The Digital Multimeter should read less than a few millivolts (this corresponds to a power of less than a few nanowatts). Be sure the meter is zeroed properly.

Determining the Responsivity of an SD-46

The Tektronix SD-46 is a high-speed (20 GHz, −3 dB Opt.) optical to electrical converter. The specifications for an SD-46 are only valid for 1300 nm ±20 nm wavelength optical input from a single mode fiber. The OIG 502 produces single mode output impulses with an optical wavelength of 1300 nm ±20 nm, therefore the normal conversion factors of the SD-46 may be used when testing the OIG 502. The OIG 501 produces multimode (50 μm core diameter) output impulses with an optical wavelength of 850 nm ±55 nm, therefore the normal conversion factors of the SD-46 are not valid when testing the OIG 501.

The responsivity of an SD-46 to OIG 501 impulses will be low due to two main factors: first, the relative responsivity of the photodiode within the SD-46 to optical wavelengths at 850 nm is roughly one fifth of that for wavelengths at 1300 nm; second, the SD-46 is designed to accept input from a single mode fiber with a core diameter of 9 μm or less. Output from a larger diameter input fiber (such as the OIG 501's 50 μm multimode output) will be attenuated.

Optical loss from the OIG 501 when launching into an SD-46 may not be consistent from one instrument to another. Variations in the optical mode structure of an OIG 501 multimode output and slight concentricity variations of the fiber connectors will result in different coupling efficiencies from one particular OIG 501 to another particular SD-46. It is necessary to calibrate the response of a particular SD-46 to a particular OIG 501 before confident quantitative measurements can be taken. Below is a procedure for determining an SD-46's conversion factor for light launched into from an OIG 501 via a $\leq$3 m 50 µm core diameter multimode fiber jumper cable (this procedure is not necessary for light launched from an OIG 502 via a single mode fiber).

1. Set the OIG **IMPULSE** to **HIGH**, the trigger to **1 MHz INT**, and the **LASER ENABLE** to **ACTIVE**.
2. Connect the **OPTICAL OUTPUT** of the OIG 501 to the optical input of the SD-46 using a 50 µm core multimode fiber.

NOTE

The conversion factor calculated from this procedure will be valid only for this particular jumper cable when used with this particular OIG 501 and SD-46.

3. Connect the digital multimeter (item 6) to the O/E Converter power monitor output of the SD-46.
4. Set the O/E Converter power monitor output for 1 V/µW.
5. Calculate the power the O/E Converter is reading with this formula:

$$Power\ Reading = Multimeter\ Reading \times 1\ V/\mu W$$

6. Disconnect the fiber from the SD-46 and connect it to an average optical power meter (item 10). Make sure that the average optical power meter is using the appropriate calibration factors and optical detector for a wavelength of 850 nm. Record the average power read (for example: 6 µW average power).
7. Calculate the ratio of the power from step 5 to that of step 6 (for example: 0.12 µW/6.0 µW= 2%). The result is the conversion factor for the particular SD-46 for measuring the output from the particular OIG 501 and jumper cable (for example: a conversion factor of 2% corresponds to an SD-46 converter response of 1500 µW/mV as opposed to the standard 30 µW/mV (that is: (30 µW/mV)/0.02= 1500 µW/mV)). The O/E Converter power monitor ranges of the SD-46 for 2% responsivity are 20 mV/µW and 20 mV/mW (for example: (0.02 $\times$ (1 V/µW)), and (0.02 $\times$ (1 V/mW))). This conversion factor should be used when checking the impulse amplitudes and energies of an OIG 501 against the Acceptance Test using an SD-46.

External Trigger Tests

The tests contained in this section verify the performance of the OIG external trigger circuits. The following tests are included in the External Trigger tests.

- External Trigger Level
- External Trigger Bandwidth

Refer to Figure 4-3 and connect the equipment as follows:

1. Connect the OIG **OPTICAL OUTPUT** to the O/E Converter (Item 3) with a single mode optical fiber (OIG 502) or multi mode optical fiber (OIG 501) (Item 7). The fiber should not be interrupted with any splices, attenuators, etc.
2. Connect the OIG **−PRETRIG OUTPUT** to the oscilloscope trigger input with a 50 Ω coaxial cable (Item 9) and a 5X attenuator (Item 8). (The attenuator drops the OIG trigger voltage to the midpoint of the oscilloscope trigger range.)
3. Connect the O/E Converter output to the Sampling Head (Item 2) input using the SMA jumper (Item 4).
4. Connect a 50 Ω coaxial cable (Item 9) from the pulse generator (Item 5) output to the OIG **+TRIG INPUT**.

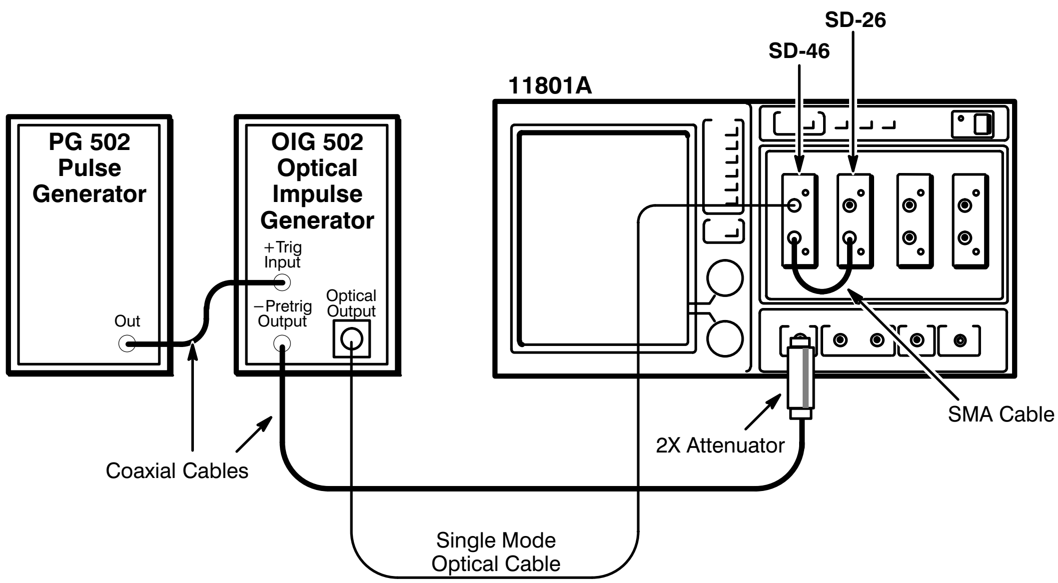

Figure 4-3: Equipment Connections for Trigger Tests.

External Trigger Level

1. Set the OIG **IMPULSE** to either **HIGH** or **LOW** (the **HIGH** setting generally works better), the trigger to **EXT**, and the **LASER ENABLE** to **ACTIVE**.
2. Set the oscilloscope trigger to **450 mV** (when using a 5X attenuator), **DC coupled**, and **negative slope**.
3. Adjust the electrical pulse generator to produce a **1 MHz** square wave with a low voltage of **−3 V** and a high voltage of **0 V**.
4. Adjust the OIG **EXT TRIG LEVEL** knob to approximately **−1.5V**.
5. The **EXT TRIG'D LED** indicator (located directly above the **EXT TRIG LEVEL** knob) should be lit. This condition indicates that the OIG is successfully triggering off of the externally supplied signal.
6. Adjust the oscilloscope to acquire a trace of the impulse to confirm that the external trigger input is working properly.
7. Adjust the electrical pulse generator to produce a **1 MHz** square wave with a low voltage of **0 V** and a high voltage of **+3 V**.
8. Adjust the OIG **EXT TRIG LEVEL** knob to approximately **+1.5V**.
9. The **EXT TRIG'D LED** indicator (located directly above the **EXT TRIG LEVEL** knob) should be lit. This condition indicates that the OIG is being successfully triggered from the externally supplied signal.
10. Adjust the oscilloscope to acquire a trace of the impulse to confirm that the external trigger input is working properly.

External Trigger Bandwidth

1. Set the OIG **IMPULSE** to either **HIGH** or **LOW** (the **HIGH** setting generally works better), the trigger to **EXT**, and the **LASER ENABLE** to **ACTIVE**.
2. Set the oscilloscope trigger to **450 mV** (when using a 5X attenuator), **DC coupled**, and **negative slope**.
3. Adjust the electrical pulse generator to produce a **1 MHz** square wave with a low voltage of **0 V** and a high voltage of **+3 V**.
4. Adjust the OIG **EXT TRIG LEVEL** knob to approximately **+1.5 V**.
5. Adjust the oscilloscope to acquire a trace of the impulse. Adjust the oscilloscope time base to display the **HIGH** impulse near the center of the trace at about **200 ps** per division.

6. Decrease the repetition rate of the electrical pulse generator (maintaining the square wave shape and the same voltage levels) in approximately **100 kHz** increments, stopping after each increment to observe the impulse trace on the oscilloscope. The impulse shape or amplitude should not change significantly (<10%). As the repetition rate of the trigger signal is decreased, the oscilloscope update of the trace may appear to slow and the phase location of the impulse may shift (the shift should be <1 ns).

–PRETRIG OUTPUT vs. OPTICAL OUTPUT Jitter Tests

The tests contained in this section verify the jitter between the **–PRETRIG OUTPUT** and the optical output. There are various methods for testing jitter, depending on the test equipment used. This procedure uses an 11800 Series Digital Sampling Oscilloscope.

Refer back to Figure 4-1 and connect the equipment as follows:

1. Connect the OIG **OPTICAL OUTPUT** to the O/E Converter (Item 3) with a single mode optical fiber (OIG 502) or multi mode optical fiber (OIG 501) (Item 7). The fiber should not be interrupted with any splices, attenuators, etc.

2. Connect the OIG **–PRETRIG OUTPUT** to the oscilloscope trigger input with a 50 Ω coaxial cable (Item 9) and a 5X attenuator (Item 8). (The attenuator drops the OIG trigger voltage to the midpoint of the oscilloscope trigger range.)

3. Connect the O/E Converter output to the Sampling Head (Item 2) input using the SMA jumper (Item 4).

The following tests are included in the Impulse Duration and Amplitude tests.

- Low-Energy Impulse Jitter
- High-Energy Impulse Jitter

Low Energy Impulse Jitter

1. Set the OIG **IMPULSE** to **LOW**, the trigger to **1MHz INT**, and the **LASER ENABLE** to **ACTIVE**.

2. Set the oscilloscope trigger to **450 mV** (when using a 5X attenuator), **DC coupled**, and **negative slope**.

3. Obtain a trace of the low energy impulse on the oscilloscope. Center the impulse waveform on the screen and adjust the time base such that the time per division is **20ps/div**. Allow the acquisition to be continuous. Do *not* average the waveform.

4. Enter the measurement menu of the oscilloscope and select the **CROSS** measurement. Exit the measurement menu and touch the **CROSS** measurement to bring up the information window on the crossover measurement. Set **Ref Level** to 50%, **Slope** to +, **Tracking** to **ON**, and **Level Mode** to **Relative**.

5. The standard deviation (**StDev**) in the **CROSS** information window should read less than **5.0 ps**: this is the approximate rms jitter of the **OPTICAL OUTPUT** to the **−PRETRIGGER OUTPUT** for the low impulse energy setting.

High Energy Impulse Jitter

1. Set the OIG **IMPULSE** to **HIGH**, the trigger to **1MHz INT**, and the **LASER ENABLE** to **ACTIVE**.

2. Set the oscilloscope trigger to **900 mV**, **DC coupled**, and **negative slope**.

3. Obtain a trace of the low energy impulse on the oscilloscope. Center the impulse waveform on the screen and adjust the time base such that the time per division is **50 ps/div**. Allow the acquisition to be continuous. Do *not* average the waveform.

4. Enter the measurement menu of the oscilloscope and select the **CROSS** measurement. Exit the measurement menu and touch the **CROSS** measurement to bring up the information window on the crossover measurement. Set **Ref Level** to 50%, **Slope** to +, **Tracking** to **ON**, and **Level Mode** to **Relative**.

5. The standard deviation (**StDev**) in the **CROSS** information window should read less than **5.0 ps**: this is the approximate rms jitter of the **OPTICAL OUTPUT** to the **−PRETRIGGER OUTPUT** for the high impulse energy setting.

WARNING

The following servicing instructions are for use only by qualified personnel. To avoid injury, do not perform any servicing other than that stated in the operating instructions unless you are qualified to do so. Refer to all safety summaries before performing any service.

Maintenance

This chapter describes how to perform routine maintenance on the OIG 501 and OIG 502. There are no user-serviceable parts in the instrument. Should your instrument need service, contact your nearest Tektronix service representative.

The following maintenance procedures are discussed in this chapter.

- Calibration Interval
- Cleaning the Optical Port
- Changing Optical Port Connectors

Calibration Interval

The recommended calibration interval is 12 months. The instrument should be returned to a Tektronix service center for calibration.

Cleaning the Optical Port

If the optical output of the OIG drops below normal, the optical fiber and optical port may be dirty. Clean the fiber connector with a clean cloth. To clean the optical port, perform the following steps:

1. Turn the power supply off or pull the OIG out of the mainframe.
2. Use a Phillips screwdriver to remove the four screws that secure the bulkhead connector to the front panel (see Fig. 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 there is insufficient slack or if you accidently push the disconnected fiber back into the instrument, then perform the following three steps:
   a. Using a flat-blade screwdriver, turn the securing screw on the right-side cover 90° counter-clockwise and remove the side cover (See Fig. 5-1).
   b. You will now have access to the optical fiber. Unscrew it from the bulkhead if necessary or push it back through the front panel.
   c. Reinstall the cover when finished. Turn the securing screw to lock the side cover.
4. Using a soft, lint-free cloth with a high-quality glass cleaner, clean the tip of the fiber cable.

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, on page 5-4, 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.

NOTE

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

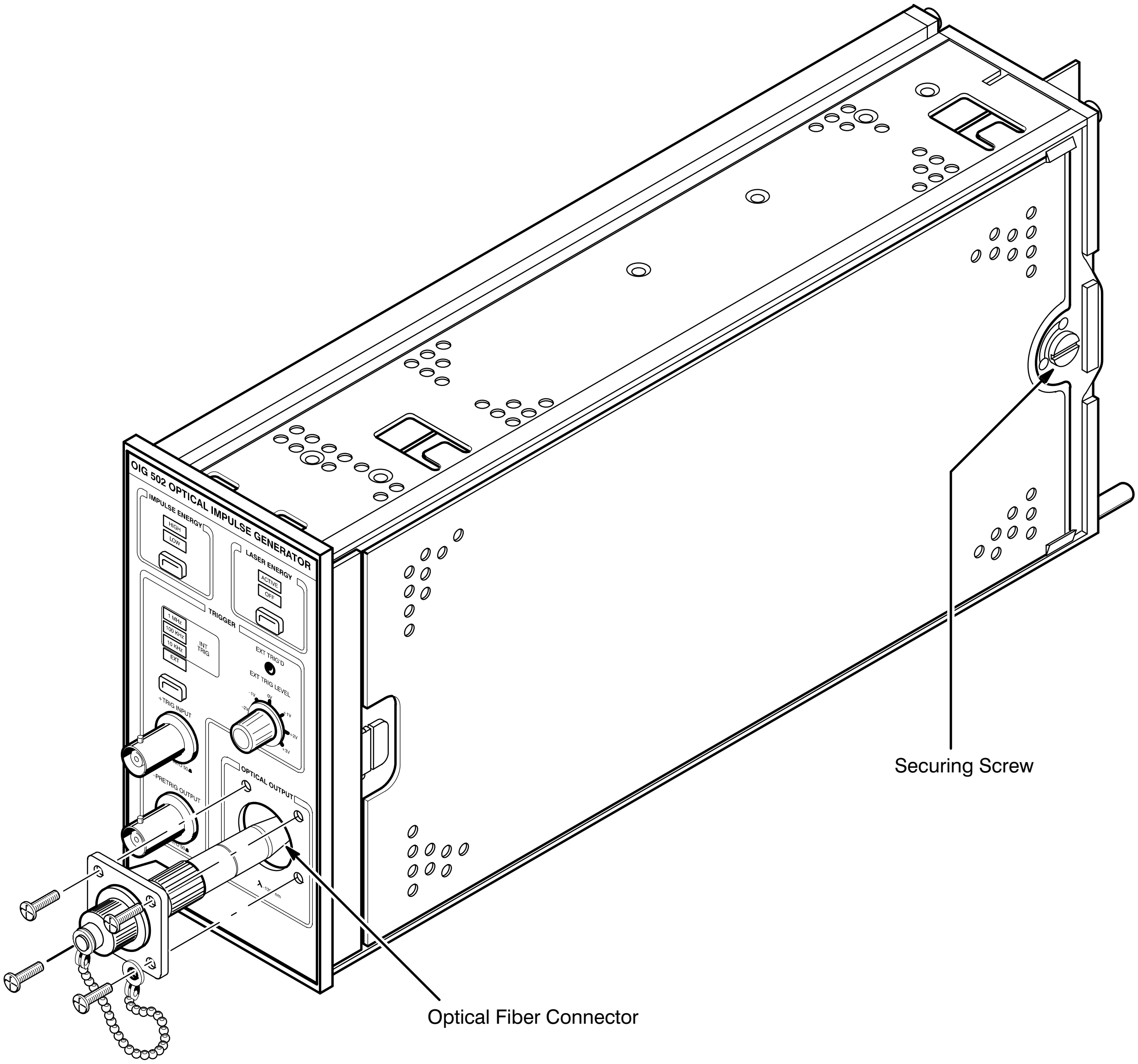

Figure 5-1: Removing the Optical Bulkhead Connector.

Changing the Optical Port Connectors

The OIG is shipped with the FC connector bulkhead and dust cover installed. If you wish to change to the ST or DIN 47256 connectors, perform the following procedure.

1. Turn the power supply off first and then pull the OIG out of the mainframe.
2. Use a Phillips screwdriver to remove the four screws that secure the bulkhead connector to the front panel (see Fig. 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 there is insufficient slack or if you accidently push the disconnected fiber back into the instrument, then perform the following three steps:
   a. Using a flat-blade screwdriver, turn the securing screw on the right-side cover 90° counter-clockwise and remove the side cover (See Fig. 5-1).
   b. You will now have access to the optical fiber. Unscrew it from the bulkhead if necessary or push it back through the front panel.
   c. Reinstall the side cover when finished. Turn the securing screw to lock the side cover.
4. Disassemble the bulkhead as shown in Figures 5-2 through 5-4.

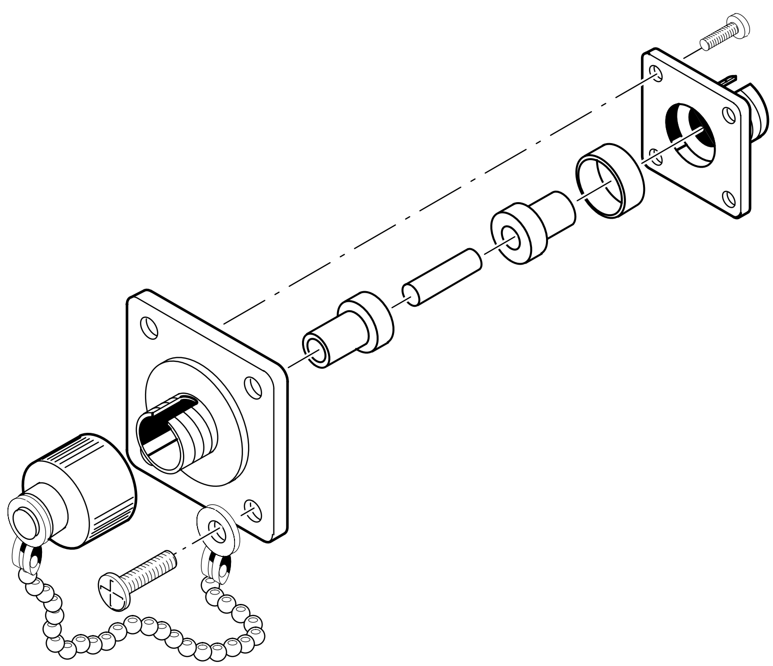

Figure 5-2: FC Optical Bulkhead Assembly.

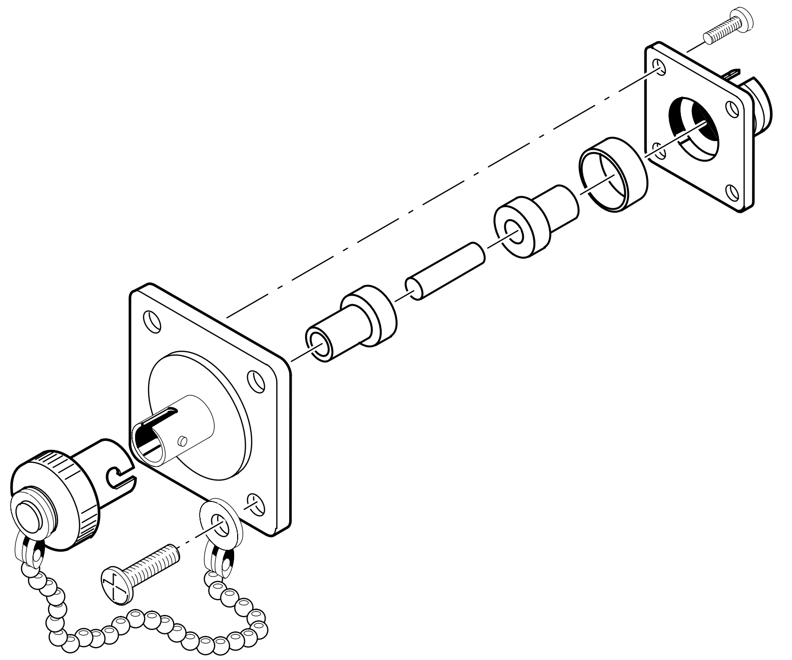

Figure 5-3: ST Optical Bulkhead Assembly.

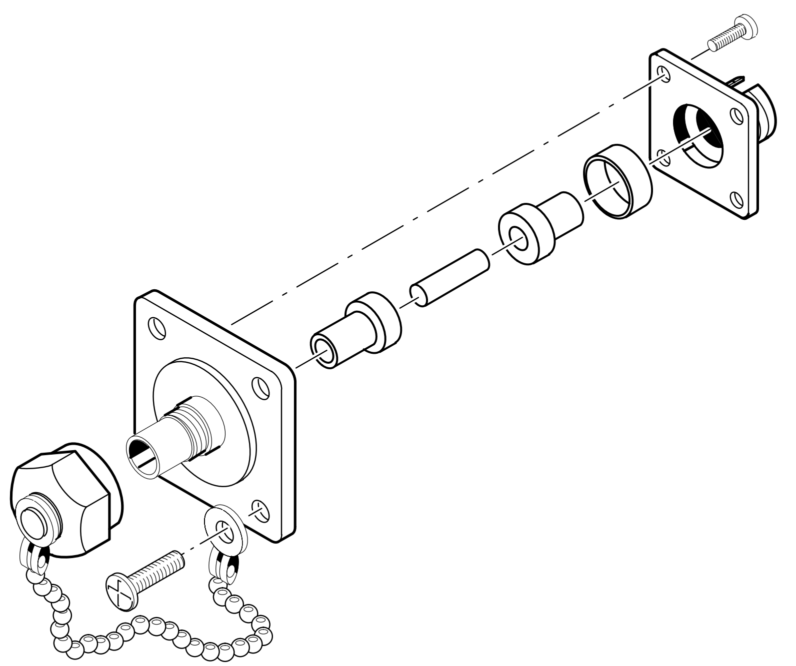

Figure 5-4: DIN 47256 Optical Bulkhead Assembly.

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.

Replaceable Parts

This chapter contains a list of the components that are replaceable for the OIG 501 and OIG 502 Optical Impulse Generators. As described below, use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available from or through your local Tektronix, Inc. service center 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. Therefore, when ordering parts, it is important to include the following information in your order:

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If a part you order has been replaced with a different or improved part, your local Tektronix service center or representative will contact you concerning any change in the part number.

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

Using the Replaceable Parts List

The tabular information in the Replaceable Parts List is arranged for quick retrieval. Understanding the structure and features of the list will help you find the all the information you need for ordering replacement parts.

Item Names

In the Replaceable 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, U.S. Federal Cataloging Handbook H6-1 can be used where possible.

Indentation System

This parts list is indented to show the relationship between items. The following example is 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 at 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 (ANSI) standard Y1.1

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077–0001

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
	—————			1	OIG501 OPTICAL GEN:IMPULSE W/FC ADAPTER		
	—————			1	OIG502 OPTICAL GEN:IMPULSE W/FC ADAPTER		
	366–1146–00			1	.KNOB:GY, 0.127 ID X 0.392 OD X 0.466 H	80009	366–1146–00
	337–3211–00			2	.SHIELD,ELEC:	80009	337–3211–00
					STANDARD ACCESSORIES		
	020–1885–00			1	ACCESSORY PKG:O/E CONVERTER	80009	020–1885–00
	—————			1	.CONN BODY,RCPT:FIBER OPTIC,ST TYPE		
	—————				ADAPTR		
	—————			1	.CONN BODY,RCPT:FIBER OPTIC,FC TYPE		
	—————				ADAPTR		
	—————			1	.CONN BODY,RCPT:FIBER OPTIC,DIN 47256		
	—————				TYPE ADAPTR		
	—————			1	COVER,DUST:W/BEAD CHAIN,FC STYLE		
	—————			1	COVER,DUST:W/BEAD CHAIN,DIN STYLE		
	—————			1	COVER,DUST:W/BEAD CHAIN,ST STYLE		
	070–7818–03			1	MANUAL, TECH:	80009	070–7818–03
					OPTIONAL ACCESSORIES		
	174–1497–00			1	CA ASSY, FBR OPT:SINGLE MODE, 2M L (OIG 502 ONLY)	80009	174–1497–00
	174–1385–00			1	CA ASSY, FBR OPT:SGL MODE, 2M L, FC/PC DIAMOND 3.5 (OIG502 ONLY)	80009	174–1385–00
	174–1386–00			1	CA ASSY, FBR OPT:SINGLE MODE, 2M L,FC/PC-ST (OIG502 ONLY)	80009	174–1386–00
	174–1387–00			1	CA ASSY,FBR OPT:SGL MODE,2M L, FC/PC- FC/PC (OIG502 ONLY)	80009	174–1387–00
	174–1388–00			1	CA ASSY,FBR OPT:SGL MODE,2M L,FC/PC- BICONIC (OIG502 ONLY)	80009	174–1388–00
	174–2322–00			1	CABLE,FIBER OPT:JUMPER,2 METER,62.5 MICRON,FC/PC TO FC/PC (OIG501 ONLY)	80009	174–2322–00
	174–2323–00			1	CABLE,FIBER OPT:JUMPER,2 METER,62.5 MICRON,FC/PC TO BICONIC (OIG501 ONLY)	80009	174–2323–00
	174–2324–00			1	CABLE,FIBER OPT:JUMPER,2 METER,62.5 MICRON,FC/PC TO SMA 906 (OIG501 ONLY)	80009	174–2324–00