Service Manual

Tektronix

TFP2A FiberMaster
Optical Time-Domain Reflectometer

070–9188–03

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 the Safety Summary prior to performing service.

First Printing: April 1997

WARNING

This equipment generates, uses, and can radiate radio-frequency energy, and if not installed and used in accordance with the instructions manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of Part 15 of FCC Rules, which are designated to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference, in which case, the user, at his or her own expense, will be required to take whatever measures may be required to correct the interference.

EC Declaration of Conformity

We

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

declare under sole responsibility that the

TFP2A FiberMaster

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 50081-1 Emissions

EN 55022	Radiated, Class B
IEC 1000-3-2	Mains Current Harmonics

EN 50082-1 Immunity:

IEC 1000-4-2	Electrostatic Discharge
IEC 1000-4-3	RF Radiated
IEC 1000-4-4	Fast Transients
IEC 1000-4-5	Surge
IEC 1000-4-11	Dropout

Contacting Tektronix

Phone	1-800-833-9200*
Address	Tektronix, Inc. Department or name (if known) 14200 SW Karl Braun Drive P.O. Box 500 Beaverton, OR 97077 USA
Web site	www.tektronix.com
Sales support	1-800-833-9200, select option 1*
Service support	1-800-833-9200, select option 2*
Technical support	Email: techsupport@tektronix.com 1-800-833-9200, select option 3* 1-503-627-2400 6:00 a.m. – 5:00 p.m. Pacific time

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

TFP2A FiberMaster Module-Level Service Manual

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Safety Information

The general safety information in these pages is for both operating and servicing personnel. In addition, specific warnings and cautions appear throughout the manual where they apply.

Definition of Terms and Symbols

In this manual, a **CAUTION** flag identifies a potential for equipment or other property damage.

A **WARNING** flag identifies a potential for personal injury or property damage.

A **DANGER** flag identifies an immediate hazard to personal safety or property.

Symbols that may be marked on the equipment indicate the following:

DANGER—High Voltage

ATTENTION—refer to manual

Protective ground (earth) terminal

Power Source

This product is designed to operate from a power source that will not apply more than 250 volts RMS between the supply conductors or between the supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Instrument

The instrument is grounded through the grounding conductor of the power cord. To avoid electric shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals.

Danger Arising from Loss of Ground

If you lose the protective ground connection, all accessible conductive parts (including knobs and controls that appear to be insulating) can render an electric shock.

Use the Proper Power Cord

Use only the power cord and connector specified for your product. Use only a power cord in good condition. Refer cord and connector changes to qualified service personnel.

Use the Proper Fuse

To avoid fire hazard, use only a fuse of the correct type, voltage rating, and current rating as specified in the parts list for your product. Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

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

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the product covers or panels. Do not operate the product without the covers or panel properly installed.

Laser Radiation

Avoid eye exposure to the laser output and open-ended fibers by covering the end or directing the output at a non-reflective surface. FiberMaster has been classified as a Class 1 laser product under the Radiation Control and Health Safety Act of 1968.

Repair

Refer all repair problems to qualified service personnel.

1 Introduction: the FiberMaster OTDR

ATTENTION! *Read the Safety Information section located at the front of this manual before operating or servicing FiberMaster.*

If you have questions about using or servicing FiberMaster, or have special application problems, in the U.S. and Canada call our toll-free help line, ***1-800-835-9433****, or contact your local Tektronix representative.*

Product Description

The TEKTRONIX TFP2A FiberMaster Optical Time-Domain Reflectometer (OTDR) is an optical-fiber test instrument capable of measuring loss characteristics and displaying faults, splices, and other fiber events in singlemode and multimode optical fibers.

FiberMaster applies pulses of light to the fiber under test via the optical output connector. As the pulses travel through the fiber, some light is reflected back to the instrument. These reflections are processed to display a visual representation of the fiber on FiberMaster's cathode ray tube (CRT), where you can make distance and loss measurements on the fiber under test.

The CRT display is a time plot, read from left to right. The trace starts with the outgoing pulse, and the time difference is converted to distance in the measurement process. When you view a typical fiber display, events that are further down the fiber appear to the right (later in time). Loss is measured on the CRT's vertical scale.

NOTE *This manual explains how to maintain the TFP2A FiberMaster product line, which includes mainframe models TFP2A (color monitor) and TFP2AM (monochrome monitor), configured with various options. (Refer to appendix A,* Accessories and Options*.) In this manual, the instrument is referred to generically as "FiberMaster" or "TFP2A," to refer to both the TFP2A and TFP2AM models.*

Modular, Plug-In Laser Sources

- ❏ The FiberMaster OTDR was designed using a modular approach that allows you to choose options that answer your specific test and measurement applications. You can upgrade your instrument configuration as your system requirements change. FiberMaster can accommodate 850-nanometer (nm) multimode, 1300-nm multimode, 1310-nm singlemode, and 1550-nm singlemode laser sources in one or two plug-in modules. The modules can contain either two singlemode or two multimode lasers, or any single laser, allowing the instrument to be configured with one to all four wavelengths.
- ❏ Temperature-controlled laser light sources ensure stable wavelength and optical output for highly accurate measurements.

Accurate, High-Speed Data Acquisition and Measurement

- ❏ The internal 32-bit microprocessor performs up to 16 million high-speed averages per acquisition, maximizing the signal-to-noise ratio, giving a clear display of fiber events.
- ❏ FiberMaster measures a specific fiber feature, with single-keystroke convenience. In addition, manual adjustments provide extended flexibility in interpreting the fiber data.
- ❏ An expand function allows you to magnify any portion or feature on the displayed fiber acquisition.
- ❏ FiberMaster's high-density acquisition capability offers extended expansion capacity and highly accurate measurements.
- ❏ A masking function can be performed automatically, or you can set manual masks to reduce dead zones caused by large Fresnel reflections, improving measurement resolution.

Automatic and Manual Event Marking

- ❏ The instrument's event-marking function automatically locates and measures events on the fiber under test that have splice losses above a user-specified threshold, or you can also mark events manually.
- ❏ An event table is compiled displaying the measurements for each marked event. You can edit and print out this table, plus enter notes and mapping information about each event.

Extended Memory and Storage Capacity

- FiberMaster offers both a current memory, containing the current data acquisition, and a reference memory, for previously acquired fiber waveform data. A dual-trace mode makes it possible to display the contents of both current and reference memory simultaneously, allowing you to compare a current optical-fiber acquisition to historical data.
- Mass-storage devices (the standard floppy-disk drive and optional internal RAM) permit unlimited storage of waveform and settings data on both removable and internal media.

Hardcopy Options

- You can choose the optional high-speed internal thermal printer, or use FiberMaster with either an IEEE 488 general-purpose interface bus (GPIB) external plotter or printer, or an RS232 external plotter or printer. One press of a button on the instrument's front panel provides a 15-second hard copy of the displayed waveform and instrument settings on the internal printer.

Remote Control Capability

- The FiberMaster OTDR can be operated under the remote control of an instrument controller or a computer with a GPIB interface, using an IEEE 488 general-purpose interface bus, or via the RS-232 serial interface.

Additional Features

- An easy-to-use menu system simplifies setting instrument measurement parameters.
- You can upload and download waveform and settings data using the RS232 interface and XModem protocol.
- The 7-inch diagonal, high-resolution color or monochrome CRT provides a comprehensive on-screen readout of waveform and measurement data, and instrument settings.
- Online help displays context-sensitive operator assistance at the press of a button.
- Rugged, portable construction is also lightweight—under 35 pounds (15 kilograms).

Using this Manual

This manual is for servicing the TFP2A FiberMaster OTDR. To prevent injury to yourself or damage to the OTDR, do not attempt service unless:

- ❑ You are a qualified service person,
- ❑ You have read the *Operator and Service Safety Summary* at the beginning of this manual.
- ❑ You have read the *Strategy for Servicing* section in this chapter.

When using this manual for servicing, be sure to observe all warnings, cautions, and notes.

Strategy for Servicing

NOTE *Throughout this manual, any field-replaceable component, assembly, or part of this optical time-domain reflectometer is referred to generically as a module.*

This manual contains all the information needed for periodic maintenance of the FiberMaster OTDR, as well as all information for corrective maintenance down to the module level. This means that the procedures, diagrams, and other troubleshooting aids help isolate failures to a specific module, rather than to components of that module. Once a failure is isolated, replace the module with a new unit obtained from the factory.

All modules are listed in chapter 5, *Replaceable Parts*. To isolate a failure to a module, use the fault isolation procedures given in chapter 4, *Maintenance*. To remove and replace any failed module, follow the instructions in the same chapter.

Manual Structure

The FiberMaster Module-Level Service Manual consists of six chapters and two appendices, containing the following information:

- ❏ Chapter 1, *Introduction*, provides a description of the FiberMaster OTDR, unpacking and repacking instructions, and instrument specifications.
- ❏ Chapter 2, *General Operating Instructions*, describes the functions of each of the front- and rear-panel controls and connectors, at a level appropriate for servicing the instrument. (For complete operating instructions, refer to the *FiberMaster User Manual*.)
- ❏ Chapter 3, *Theory of Operation*, contains a block-level description of the instrument's operation, as well as a block-level diagram.
- ❏ Chapter 4, *Maintenance*, contains the information needed to do periodic and corrective maintenance on the FiberMaster, including inspection and cleaning, performance verification and adjustment, troubleshooting, and module removal and replacement procedures.
- ❏ Chapter 5, *Replaceable Parts*, includes a list of module-level replaceable parts and exploded-view drawings of their locations in the instrument.
- ❏ Chapter 6, *Diagrams*, contains module-level block diagrams.
- ❏ Appendices include data sheets for recording instrument performance information, GPIB and RS232 connection tables, instructions on upgrading firmware, and a listing of error codes.

Manual Conventions

This manual uses certain conventions that you should be familiar with before doing service.

Terminology used in the FiberMaster manuals is in accordance with industry practice. Abbreviations are in accordance with ANSI Y1.1-1972, with exceptions and additions explained in parentheses after the abbreviation. Graphic symbology is based on ANSI Y32.2-1975. Logic symbology is based on ANSI Y32.14-1973 and manufacturers' data books or sheets. A copy of ANSI standards can be obtained from the Institute of Electrical and Electronic Engineers, New York, New York 10017.

Modules

Throughout this manual, any replaceable component, assembly, or part of the FiberMaster OTDR is referred to generically as a module. In general, a module is an assembly, (e.g., a circuit board), rather than a component, (e.g., a resistor or integrated circuit).

Warranty Information

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 or replace 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, the customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. The 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 the customer if the shipment is to a location within the same country as the service center. The customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

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

This warranty is given by Tektronix with respect to this product in lieu of any other warranties, express or implied. Tektronix and its vendors disclaim any implied warranties of merchantability or fitness for use for a particular purpose. Tektronix' responsibility to repair or replace defective products is the sole and exclusive remedy provided to the customer for breach of this warranty. Tektronix and its vendors will not be liable for any direct, special, incidental, or consequential damages irrespective of whether Tektronix or the vendor has advance notice of the possibility of such damages.

Tektronix Service

Tektronix provides service to cover repairs under warranty as well as other services that may provide a cost-effective answer to your service needs. Tektronix service technicians, trained on Tektronix products, are best equipped to service your FiberMaster OTDR. Our technicians are appraised of the latest information on improvements to the product, as well as the latest new options available.

Warranty Service

Tektronix warrants this product for one year from date of purchase. Tektronix technicians provide all warranty service at the factory during this period. Contact your local Tektronix representative for more information.

Self Service

Tektronix supports repair to the module level by providing module exchange and module repair and return services.

NOTE *Module-level service is available only for selected modules, under specific conditions. In the U.S. and Canada call 1-800-835-9433 for assistance with module exchange and repair, or contact your local Tektronix representative.*

Module Exchange—this service reduces downtime for repair by allowing you to exchange most modules for remanufactured ones. Tektronix ships you an updated and tested exchange module from the Redmond, Oregon service center within 24 hours. Each module comes with a 90-day service warranty.

Module Repair and Return—This service returns your module to you within 10 days. The module you send to Tektronix is repaired, tested, and returned to you from the Redmond, Oregon service center. It is not updated to match current modules of the same type. Again, each module comes with a 90-day service warranty.

For More Information

In the U.S. and Canada, call 1-800-835-9433 for more information on warranty and service for the FiberMaster OTDR, or contact your local Tektronix representative.

Specifications

Electrical Characteristics

The following characteristics and features apply to the FiberMaster OTDR mainframe after a warmup period of at least 15 minutes. All loss numbers reflect one-way measurements unless otherwise specified.

Table 1-1. Display Range—Vertical System

Vertical range	1 dB to 50 dB, overview 1 dB to 100 dB, expanded view
Loss measurements Loss readout resolution	0.001 dB to 0.01 dB
Accuracy Two point, splice loss, and LSA fiber loss:	
FM/FS/FG series	±0.05 dB/dB, from 7 dB above the RMS noise floor (SNR = 1) to 30 dB on the screen. Maximum error of ±0.2 dB from +7 dB above the RMS noise floor to top of backscatter.
FL series	±0.02 dB/dB, from 15 dB to 35 dB on the screen.

Table 1-2. Display Range—Horizontal System

Distance range	1 m to 200 km
Distance measurements Cursor resolution (min) FM/FS/FG series: 850 nm MM 1300 nm MM/ 1310 nm SM/ 1550 nm SM FL series: 1310 SM/ 1550 SM Index of refraction range Distance measurement accuracy	 5 cm to 2 m, normal density; 1 cm to 50 cm, high density 20 cm to10 m, normal density; 10 cm to 2 m, high density 2 m to 10 m, normal density; no high density 1.4000 to 1.6000 ±0.001%, ±minimum cursor resolution ±uncertainty in index of refraction
Number of displayed waveform points	>16,000 maximum for each normal and high density

Table 1-3. Display

Size	7 inches (17.5 cm) diagonal
Resolution	640 by 480 pixels
Display type Color Monochrome	 Two-color system giving three colors, with five levels each Five-level gray scale

Table 1-4. Keyboard

Connector	5-pin RJ11
Compatibility	Compatible with IBM AT keyboards (input only), but complete compatibility can be guaranteed only with Tektronix keyboard Option 19

Table 1-5. Hardcopy

Internal printer Resolution Print dimensions	High-speed, high-resolution dot matrix, thermal 150 dots/in vertical and horizontal 4 in by 5 in (10.2 cm by 12.7 cm)
External plotter	HP-GL compatible (Tektronix HC100): GPIB and RS-232 connections
External printer	Epson FX-compatible: RS232 connection Hewlett-Packard ThinkJet-compatible: GPIB and RS-232 connections PostScript-compatible: RS-232 connection

Table 1-6. Mass Storage

Floppy disk drive Size Capacity Format	 3.5 in (8.9 cm) 1.44 Mbyte or 720 Kbyte MS-DOS compatible
Internal RAM Capacity	 1 Mbyte

Operational Characteristics

Table 1-7. Operational Characteristics

Power requirements AC operation (AC only)	 90 - 130 VAC, 47 - 440 Hz 180 - 250 VAC, 47 - 73 Hz (auto select)
AC operation (AC with DC option)	90 - 130 VAC, 47 - 73 Hz
DC operation	11 - 16 VDC
Power supply rating AC operation	 250 watts max. 315 VA max.
DC operation	200 VA max. (watts)
Module capacity	Two dual-wavelength modules maximum, for a total of four wavelengths
Safety	UL 1244, UL 3111-1 CSA: CAN/CSA C22.2 No. 231 CAN/CSA -C22.2 No. 1010.192 IEC 1010-1 EN 61010-1

Physical Characteristics

Table 1-8. Physical Characteristics

Weight	33 lbs (15 kg), mainframe configured with floppy-disk drive, internal printer, and one optical module
Dimensions	Overall dimensions, including front cover, handle, and feet: Length, 25 in (63.7 cm); width, 18 in (46 cm); height, 7 in (18 cm)

Environmental Characteristics

Table 1-9. Environmental Characteristics

Temperature	
Mainframe	Operating: +5° to +50° C Non-operating: -40° to +60° C
With internal printer	Operating: +5° to +40° C Non-operating: -20° to +60° C
Without floppy-disk drive	Operating: -10° to +55° C Non-operating: -40° to +70° C
Humidity (operating)	
Mainframe	8% to 75% (+5%, -0%), noncondensing
With internal printer	35% to 75% (+5%, -0%), noncondensing
Without floppy-disk drive	5% to 90% (+5%, -0%), noncondensing
Altitude (maximum)	
Operating	15,000 ft (4.6 km)
Non-operating	50,000 ft (15.2 km)
	Tek 062-2847-00, Class 3 (exceeds MIL-T-28800E)
Sine vibration	
Operating	Frequency sweep: 10 to 55 Hz Loading: 0.5G, maximum
Disk drive non-operating	Frequency sweep: 10 to 55 Hz Loading: 2.0G, maximum
Shock (maximum)	
Operating	5G
Disk drive non-operating	30G
Bench handling	MIL-T-28800E
Transit drop	MIL-T-28800E
Water resistance	Drip proof, tested with front cover on
Fungus resistance	Enclosure and electronics are fungus inert by design

Table 1-9. Environmental Characteristics, cont.

Electromagnetic compatibility	EC Council Directive 89/336/EEC
Emissions:	EN 50081-1
Radiated emissions	FCC Part 15, Subpart J, Class A EN55022, Class B
Mains Current Harmonics	IEC 1000-3-2
Conducted emissions	FCC Part 15, Subpart J, Class A EN55022, Class B EN60555-2
Magnetic emissions	Vfg 243, Class B
Immunity:	EN 50082-1
RF radiated	IEC 1000-4-3
Electrostatic discharge	IEC 1000-4-2
Fast transients	IEC 1000-4-4
Surge	IEC 1000-4-5
Dropout	IEC 1000-4-11

FS1300 Singlemode Optical Module

Table 1-10. FS1300 Singlemode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
10 µs/1000 m	29.5	38.0	1080	1050
4000 ns/400 m	27.5	38.0	480	420
2000 ns/200 m	23.5	38.0	240	220
1000 ns/100 m	22.0	38.0	140	110
500 ns/50 m	20.5	38.0	70	55
200 ns/20 m	18.5	38.0	40	25
100 ns/10 m	17.0	38.0	25	12
50 ns/5 m	15.5	38.0	20	7
50 ns/5 m HR	12.0	34.0	15	7
20 ns/2 m HR	10.5	34.0	NA	5
10 ns/1 m HR	9.0	34.0	NA	3

Operating wavelength: 1310 nm ± 20 nm

Masking: menu selectable

- ❏ Auto-QuickMask
- ❏ Auto-AccuMask
- ❏ Manual-QuickMask
- ❏ Manual-AccuMask

Full-screen display range: 50 m to 200 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times range from 30 seconds to three minutes, depending on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FS1500 Singlemode Optical Module

Table 1-11. FS1500 Singlemode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
10 µs/1000 m	26.5	36.0	1080	1050
4000 ns/400 m	24.5	36.0	480	420
2000 ns/200 m	20.5	36.0	240	220
1000 ns/100 m	19.0	36.0	140	110
500 ns/50 m	17.5	36.0	70	55
200 ns/20 m	15.5	36.0	40	25
100 ns/10 m	14.0	36.0	25	12
50 ns/5 m	12.5	36.0	20	7
50 ns/5 m HR	9.0	33.0	18	7
20 ns/2 m HR	7.5	33.0	NA	5
10 ns/1 m HR	5.0	33.0	NA	3

Operating wavelength: 1550 nm ± 20 nm

Masking: menu selectable

- ❏ Auto-QuickMask
- ❏ Auto-AccuMask
- ❏ Manual-QuickMask
- ❏ Manual-AccuMask

Full-screen display range: 50 m to 200 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FS1315 Singlemode Optical Module

Table 1-12. FS1315 Singlemode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
10 µs/1000 m	29.5/26.5	38.0/36.0	1080	1050
4000 ns/400 m	27.5/24.5	38.0/36.0	480	420
2000 ns/200 m	23.5/20.5	38.0/36.0	240	220
1000 ns/100 m	22.0/19.0	38.0/36.0	140	110
500 ns/50 m	20.5/17.5	38.0/36.0	70	55
200 ns/20 m	18.5/15.5	38.0/36.0	40	25
100 ns/10 m	17.0/14.0	38.0/36.0	25	12
50 ns/5 m	15.5/12.5	38.0/36.0	20	7
50 ns/5 m HR	12.0/9.0	34.0/33.0	15/18	7
20 ns/2 m HR	10.5/7.5	34.0/33.0	NA	5
10 ns/1 m HR	9.0/5.0	34.0/33.0	NA	3

Operating wavelengths: 1310/1550 nm ± 20 nm

Masking: menu selectable

- ❏ Auto-QuickMask
- ❏ Auto-AccuMask
- ❏ Manual-QuickMask
- ❏ Manual-AccuMask

Full-screen display range: 50 m to 200 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FG1300 Singlemode Optical Module

Table 1-13. FG1300 Singlemode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
10 µs/1000 m	31.0	38.0	1150	1150
4000 ns/400 m	28.5	38.0	550	475
2000 ns/200 m	25.5	38.0	250	225
1000 ns/100 m	24.0	38.0	150	110
500 ns/50 m	21.5	38.0	80	55
200 ns/20 m	19.5	38.0	55	25
100 ns/10 m	18.0	38.0	50	12
50 ns/5 m	16.5	38.0	45	10
50 ns/5 m HR	13.5	34.0	30	7
20 ns/2 m HR	11.5	34.0	25	5
10 ns/1 m HR	9.5	34.0	N/A	4

Operating wavelength: 1310 nm ± 20 nm

Masking: not applicable

Full-screen display range: 50 m to 200 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -30˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter. Specifications are based on reflections not to exceed a return loss of 40 dB.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

Performance specifications are at 25˚ C.

FG1315 Singlemode Optical Module

Table 1-14. FG1315 Singlemode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
10 µs/1000 m	31.0/29.0	38.0/36.0	1150	1150
4000 ns/400 m	28.5/26.5	38.0/36.0	550	475
2000 ns/200 m	25.5/23.5	38.0/36.0	250	225
1000 ns/100 m	24.0/22.0	38.0/36.0	150	110
500 ns/50 m	21.5/19.5	38.0/36.0	80/85	55
200 ns/20 m	19.5/17.5	38.0/36.0	55/60	25
100 ns/10 m	18.0/16.0	38.0/36.0	50/55	12
50 ns/5 m	16.5/14.5	38.0/36.0	45/50	10
50 ns/5 m HR	13.5/11.5	34.0/33.0	30/35	7
20 ns/2 m HR	11.5/9.5	34.0/33.0	25/30	5
10 ns/1 m HR	9.5/7.5	34.0/33.0	N/A	4

Operating wavelengths: 1310/1550 nm ± 20 nm

Masking: not applicable

Full-screen display range: 50 m to 200 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -30˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter. Specifications are based on reflections not to exceed a return loss of 40 dB.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

Performance specifications are at 25˚ C.

FL1300 Singlemode Optical Module

Table 1-15. FL1300 Singlemode Optical Module

Pulse	Dynamic Range[1]		Dead Zone	
	SNR = 1 (dB)[2]	End Detect (dB)[3]	Meas. (m)[4]	Event (m)[5]
20 µs/2000 m	37.5	46.0	2375	2100
10 µs/1000 m	36.0	46.0	1270	1050
4000 ns/400 m	33.5	45.5	670	440
2000 ns/200 m	31.0	44.5	395	220
1000 ns/100 m	29.5	44.5	280	120
500 ns/50 m	27.5	44.0	150	60
200 ns/20 m	25.5	44.0	125	35
100 ns/10 m	24.0	44.0	125	25

Operating wavelength: 1310 nm ± 20 nm

Masking: not applicable

Full-screen display range: 50 m to 320 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 262,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FL1500 Singlemode Optical Module

Table 1-16. FL1500 Singlemode Optical Module

Pulse	Dynamic Range[1]		Dead Zone	
	SNR = 1 (dB)[2]	End Detect (dB)[3]	Meas. (m)[4]	Event (m)[5]
20 µs/2000 m	37.0	46.5	2375	2100
10 µs/1000 m	35.0	46.0	1270	1050
4000 ns/400 m	33.0	46.0	670	440
2000 ns/200 m	30.5	45.0	395	220
1000 ns/100 m	29.0	45.0	280	120
500 ns/50 m	27.0	44.5	150	60
200 ns/20 m	25.0	44.5	195	35
100 ns/10 m	23.0	44.0	170	25

Operating wavelength: 1550 nm ± 20 nm

Masking: not applicable

Full-screen display range: 50 m to 320 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 262,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FL1315 Singlemode Optical Module

Table 1-17. FL1315 Singlemode Optical Module

Pulse	Dynamic Range[1]		Dead Zone	
	SNR = 1 (dB)[2]	End Detect (dB)[3]	Meas. (m)[4]	Event (m)[5]
20 µs/2000 m	37.5/37.0	46.0/46.5	2375	2100
10 µs/1000 m	36.0/35.0	46.0/46.0	1270	1050
4000 ns/400 m	33.5/33.0	45.5/46.0	670	440
2000 ns/200 m	31.0/30.5	44.5/45.0	395	220
1000 ns/100 m	29.5/29.0	44.5/45.0	280	120
500 ns/50 m	27.5/27.0	44.0/44.5	150	60
200 ns/20 m	25.5/25.0	44.0/44.5	125/195	35
100 ns/10 m	24.0/23.0	44.0/44.0	125/170	25

Operating wavelength: 1310/1550 nm ± 20 nm

Masking: not applicable

Full-screen display range: 50 m to 320 km

Laser safety: Class 1, 21 CFR 1040

Temperature: -10˚ to +55˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 262,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FM8500 Multimode Optical Module

Table 1-18. FM8500 Multimode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
100 ns/10 m	27.0	36.0	13.0	10.5
50 ns/5 m	25.5	36.0	8.5	5.5
20 ns/2 m	23.5	36.0	6.0	3.0
8 ns/80 cm	20.5	36.0	4.5	1.0
3 ns/30 cm	16.5	35.0	3.5	0.5
1 ns/10 cm	14.0	35.0	2.5	0.2

Operating wavelength: 850 nm ± 25 nm

Masking: not applicable

Full-screen display range: 5 m to 20 km

Laser safety: Class 1, 21 CFR 1040

Temperature: 0˚ to +50˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FM1300 Multimode Optical Module

Table 1-19. FM1300 Multimode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
1000 ns/100 m	26.5	38.0	125	110
500 ns/50 m	23.5	38.0	65	55
200 ns/20 m	21.5	38.0	35	25
100 ns/10 m	20.0	38.0	30	12
50 ns/5 m	18.5	38.0	25	7
50 ns/5 m HR	15.0	35.0	20	7
20 ns/2 m HR	13.0	35.0	18	5
10 ns/1 m HR	15.0	35.0	14	3

Operating wavelength: 1300 nm ± 30 nm

Masking: not applicable

Full-screen display range: 50 m to 100 km

Laser safety: Class 1, 21 CFR 1040

Temperature: 0˚ to +50˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

1 Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

2 Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

3 Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

4 Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

5 Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

FM8513 Multimode Optical Module

Table 1-20. FM8513 Multimode Optical Module

Pulse Width	Dynamic Range[1] SNR = 1 (dB)[2]	Dynamic Range[1] End Detect. (dB)[3]	Dead Zone Loss Meas. (m)[4]	Dead Zone Event (m)[5]
850 nm:				
100 ns/10 m	27.0	36.0	13.0	10.5
50 ns/5 m	25.5	36.0	8.5	5.5
20 ns/2 m	23.5	36.0	6.0	3.0
8 ns/80 cm	20.5	36.0	4.5	1.0
3 ns/30 cm	16.5	35.0	3.5	0.5
1 ns/10 cm	14.0	35.0	2.5	0.2
1300 nm:				
1000 ns/100 m	26.5	38.0	125	110
500 ns/50 m	23.5	38.0	65	55
200 ns/20 m	21.5	38.0	35	25
100 ns/10 m	20.0	38.0	30	12
50 ns/5 m	18.5	38.0	25	7
50 ns/5 m HR	15.0	35.0	20	7
20 ns/2 m HR	13.0	35.0	18	5
10 ns/1 m HR	15.0	35.0	14	3

Operating wavelengths: 850 nm ± 25 nm, 1300 nm ± 30 nm

Masking: not applicable

Full-screen display range: 850 nm—5 m to 20 km; 1300 nm—50 m to 100 km

Laser safety: Class 1, 21 CFR 1040

Temperature: 0˚ to +50˚ C operating; -40˚ to +70˚ C non-operating

Humidity: Up to 90% relative humidity (+5, -0%)

Weight: 4.4 lbs (<2 kg)

Dimensions: 1.75 in (4.5 cm) by 5.5 in (14.0 cm) by 17.5 in (44.5 cm)

[1] Dynamic range specifications are based on 32,000 averages. Actual averaging times depend on instrument settings. For 3 Sigma values, subtract 2.4 dB from SNR=1 values.

[2] Dynamic range, SNR = 1 is the one-way difference between the extrapolated backscatter level at the start of the fiber and the RMS noise level.

[3] Dynamic range, end detection is the one-way difference between the top of a 4% Fresnel reflection at the start of the fiber and the 3 Sigma (99.5%) level of the noise.

[4] Dead zone, loss measurement is the minimum distance after any reflective event on the display to measure loss to within 0.5 dB of backscatter.

[5] Dead zone, event (two-point spatial resolution) is the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

Accessories and Options

The following paragraphs list the standard accessories, optional accessories, options, and option accessories that may be shipped with your FiberMaster OTDR.

Mainframes

Table 1-21. Mainframe Options

Mainframe #	Description
TFP2A	Mainframe with color monitor
TFP2AM	Mainframe with monochrome monitor
1T	Hard case option
1R	19-inch rackmount option
L1	French language option
L3	German language option
L4	Spanish language option
1S	Mainframe with FMTAP

Accessories

Table 1-22. Standard ccessories

Description	Part Number	Quantity
Power cord, standard	161-0104-00	1
User manual	070-9189-XX	1
Quick-reference card	063-2292-XX	1
Soft case	016-1037-01	1
Front-panel cover	200-3566-00	1
Option-port cover	333-3572-00	1
Plug-in spacer	386-5950-00	1
Rackmount instruction sheet	063-1691-XX	

Table 1-23. Optional Accessories

Nomenclature	Part or Option Number
Jumpers (all combinations)	
Keyboard adapter cable	174-2356-01
External plotter	HC100 or HC100 Option 03
RS232C cable	012-1384-00
GPIB cable (2 meter)	012-0991-00
Hard-shell transit case	016-1036-00
Module-level service manual	070-9188-XX
FiberMaster Trace Analysis Pkg.	FMTAP
FiberMaster utilities disk	063-1493-XX
Keyboard	118-7637-00
TOP130 LED source 850/1300 nm w/ ST connector	2T
TOP140 laser source 1550 nm w/ FC connector	3T

Table 1-24. Optional Accessories (Con't)

Nomenclature	Part or Option Number
TOP150 laser source 1550 nm w/ FC connector	4T
TOP200 optical power meter 850/1300/1550 nm w/ ST connector	5T
TOP300 visual fault finder 635 nm w/ FC connector	6T
TOP160 laser source 1310/1550 nm w/ FC connector	7T
French User Manual	070-9428-XX
German User Manual	070-9429-XX
Spanish User Manual	070-9430-XX
French Quick Reference Card	063-1844-XX
German Quick Reference Card	063-1982-XX
Spanish Quick Reference Card	063-1983-XX

Options

Table 1-25. System Options

Opt. #	Description
14	1 Mbyte nonvolatile RAM
16	Internal printer assembly
17	DC power option
19	Keyboard and adapter cable (USA format)
A1	Universal European, 220VAC/16A, 50 Hz
A2	United Kingdom, UK, 240VAC/13A, 50 Hz
A3	Australian, 240VAC/10A, 50 Hz
A4	North American, 240VAC/12A, 60 Hz
A5	Swiss, 250VAC/6A, 50Hz

Table 1-26. System Multimode Options

Opt. #	Description	Order #
01	850 nm MM acquisition module	FM8500*
02	1300 nm MM acquisition module	FM1300*
03	850/1300 nm MM acquisition module	FM8513*
20	Biconic connector, MM, 62.5 µm	119-4515-00
21	FC/PC connector, MM, 62.5 µm	119-4516-00
22	D4/PC connector, MM, 62.5 µm	119-4514-00
23	SMA 905/906 connector, MM, 62.5 µm	119-4557-00
24	ST/PC connector, MM, 62.5 µm	119-4513-00
25	DIN/PC 47256 connector, MM, 62.5 µm	119-4546-00
26	Diamond 3.5 connector, MM, 62.5 µm	119-4558-00
27	Diamond 2.5 connector, MM, 62.5 µm	119-4556-00
28	SC/PC connector, MM, 62.5 µm	119-4518-00
29	SMA 2.5 connector, MM, 62.5 µm	119-4517-00

*Use when ordering optical module for a previously purchased mainframe, and when ordering connector options for a previously purchased optical module.

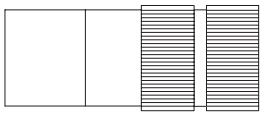
Table 1-27. System Singlemode Options

Opt. #	Description	Order #
04	1310 nm SM acquisition module	FS1300*
05	1550 nm SM acquisition module	FS1500*
06	1310/1550 SM acquisition module	FS1315*
07	1310 nm SM long-range acquisition module	FL1300*
08	1310/1550 nm SM long-range acquisition module	FL1315*
09	1550 nm SM long-range acquisition module	FL1500*
10	1310 nm SM general-purpose acquisition module	FG1300*
11	1310/1550 SM general-purpose acquisition module	FG1315*
30	Biconic connector, SM	119-4515-00
31	FC/PC connector, SM	119-4516-00
32	D4/PC connector, SM	119-4514-00
33	SMA 905/906 connector, SM	119-4557-00
34	ST/PC connector, SM	119-4513-00
35	DIN/PC 47256 connector, SM	119-4546-00
36	Diamond 3.5 connector, SM	119-4558-00
37	Diamond 2.5 connector, SM	119-4556-00
38	SC connector, SM	119-4518-00
39	SMA 2.5 connector, SM	119-4517-00
41	FC/APC connector, SM**	119-5115-00
42	SC/APC connector, SM**	119-5116-00

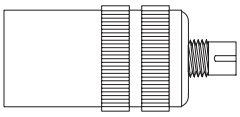
*Use when ordering optical module for a previously purchased mainframe, and when ordering connector options for a previously purchased optical module.
** Angle polish connectors (options 41 and 42) cannot be interchanged with any of the option 2x or 3x adapters.

Table 1-28. Option Accessories

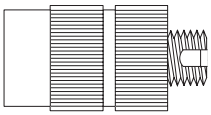
Description	Part Number	Quantity
Thermal print paper	006-7682-00	1
Thermal print paper, case	006-7682-20	50
Paper holders	386-5947-01	2
3-1/2" diskette, 1.44 MB	119-3910-00	1
Power cord, option A1	161-0104-06	1
Power cord, option A2	161-0104-07	1
Power cord, option A3	161-0104-05	1
Power cord, option A4	161-0134-00	1
Power cord, option A5	161-0167-00	1
Power cord, option 17	161-0280-01	1



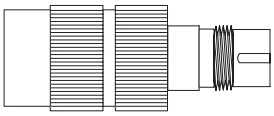
Opt. 20 Multimode
Opt. 30 Singlemode



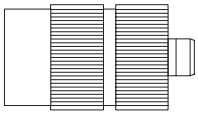
Opt. 25 Multimode
Opt. 35 Singlemode



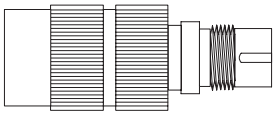
Opt. 21 Multimode
Opt. 31 Singlemode
Opt. 41 Singlemode



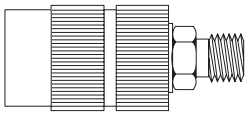
Opt. 26 Multimode
Opt. 36 Singlemode



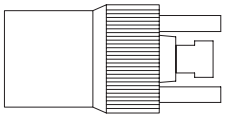
Opt. 22 Multimode
Opt. 32 Singlemode



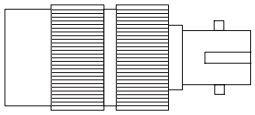
Opt. 27 Multimode
Opt. 37 Singlemode



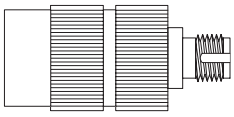
Opt. 23 Multimode
Opt. 33 Singlemode



Opt. 28 Multimode
Opt. 38 Singlemode
Opt. 42 Singlemode



Opt. 24 Multimode
Opt. 34 Singlemode



Opt. 29 Multimode
Opt. 39 Singlemode

Figure 1-1. Connector Options

Unpacking and Preparation for Use

Before unpacking FiberMaster from its shipping container or carton, inspect for signs of external damage. If the carton is damaged, notify the carrier. The shipping carton contains the instrument and its standard and optional accessories.

If the contents of the shipping container are incomplete, if there is mechanical damage or defects, or if the instrument does not meet operational check requirements, contact your local Tektronix Field Office or representative. If the shipping container is damaged, notify the carrier as well as Tektronix.

The instrument was inspected both mechanically and electrically before shipment. It should be free of mechanical damage and meet or exceed all electrical specifications. Functional and operational self tests are performed at power-on. If your instrument fails to perform satisfactorily, contact your Tektronix representative immediately, or in the U.S. and Canada, telephone toll free **1-800-835-9433**.

Preparation for Use

Use FiberMaster's front cover to protect the front panel when storing and transporting the instrument. Remove the cover by pulling out on the sides and lifting off. Replace the cover by pressing it over the front panel until the cover snaps in place. The instrument's accessories are stored in the soft carrying case.

You can position FiberMaster's handle to serve as a tilt stand, or you can move it to the front of the instrument, so the instrument can be stacked or carried. To position the handle, press in at both pivot points and rotate to the desired position.

Power Source and Power Requirements

FiberMaster is intended to be operated from a power source that does not apply more than 250V RMS between the supply conductors, or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

The AC power connector is a three-wide, polarized plug with the ground (earth) lead connected directly to the instrument frame to provide electrical shock protection. If the unit is connected to any other power source, the unit frame must be connected to an earth ground.

CAUTION *To avoid electric shock, the power cord protective grounding conductor must be connected to ground.*

Power and voltage requirements are printed on the back panel. With the DC power option (option 17), FiberMaster can be operated from 11 to 16 VDC, or from 90 to 250 VAC nominal line voltage at 47 to 73 Hz. AC-only instruments can be operated from 90 to 250 VAC, 47 to 73 Hz; or from 90 to 130 VAC, 47 to 440 Hz. In AC-only instruments, power source selection is made automatically when the unit is plugged in.

Installing the Optical Module(s)

Your TFP2A mainframe may be shipped with optical module(s) installed. If you order modules separately, you may have to install them at your site. Install one or two optical modules into the mainframe as follows:

1. Detach the left-hand side of the mainframe back panel by unscrewing four black quick-release screws in each corner of the back-panel assembly (see figure 1-2). Pull the back-panel assembly off the mainframe using the handle provided, disconnecting the control and module support boards from the interconnect board, which is attached to the inside of the back panel.

2. Plug one module into the bottom set of module connectors on the interconnect board, inserting the module's screwholes through the back-panel assembly. (See figure 1-3.)

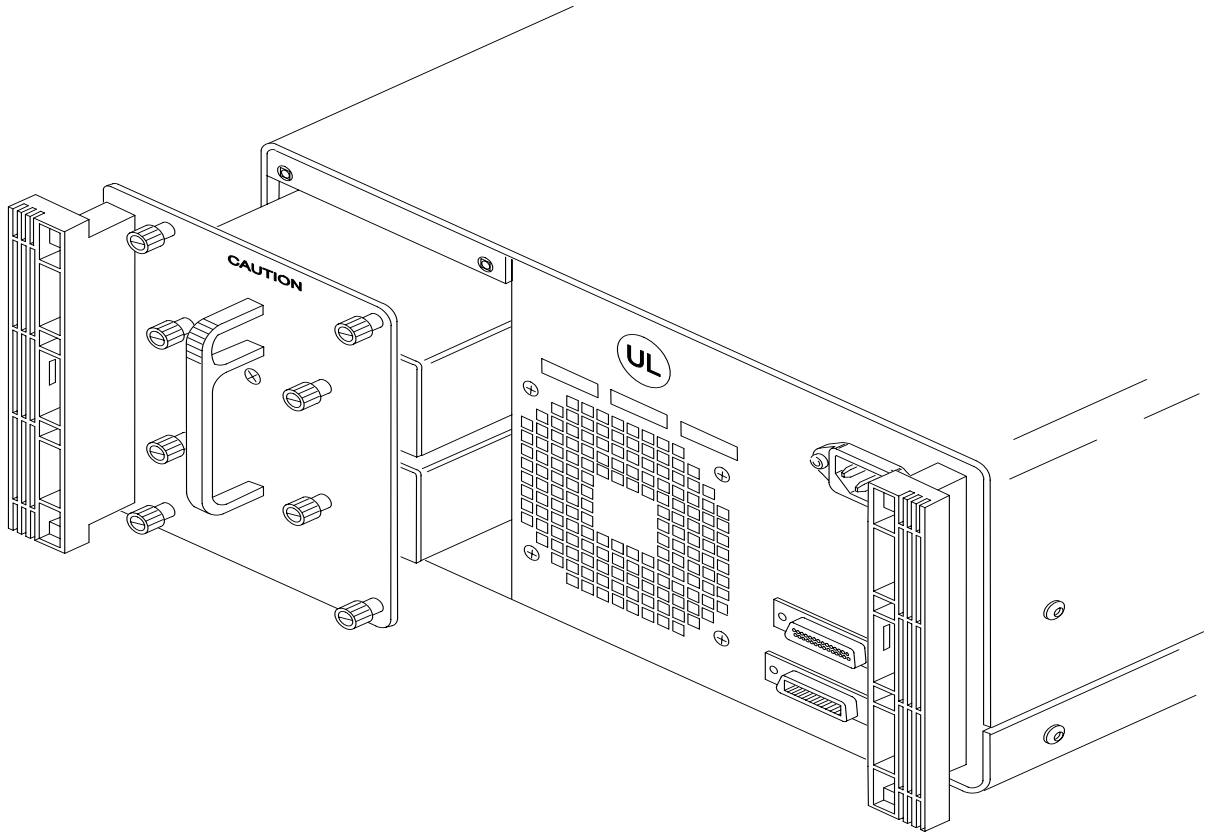


Figure 1-2. Installing Optical Modules

3. Secure the module to the back-panel assembly by tightening the two back-panel quick-release screws into the module's screwholes.

4. If you have a second module, plug it into the top set of module connectors on the interconnect board.

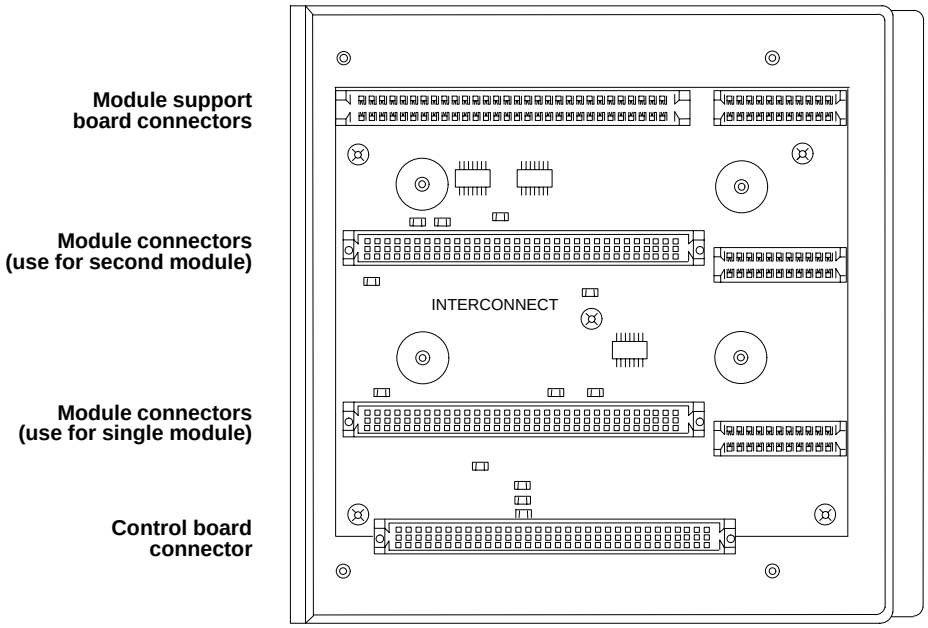


Figure 1-3. Interconnect Circuit Board Connectors

5. Secure the second module to the back-panel assembly by tightening the two quick-release screws into the module's screwholes.

6. If you are installing two modules, snap the plastic spacer between the modules as shown in figure 1-4, into the holes provided.

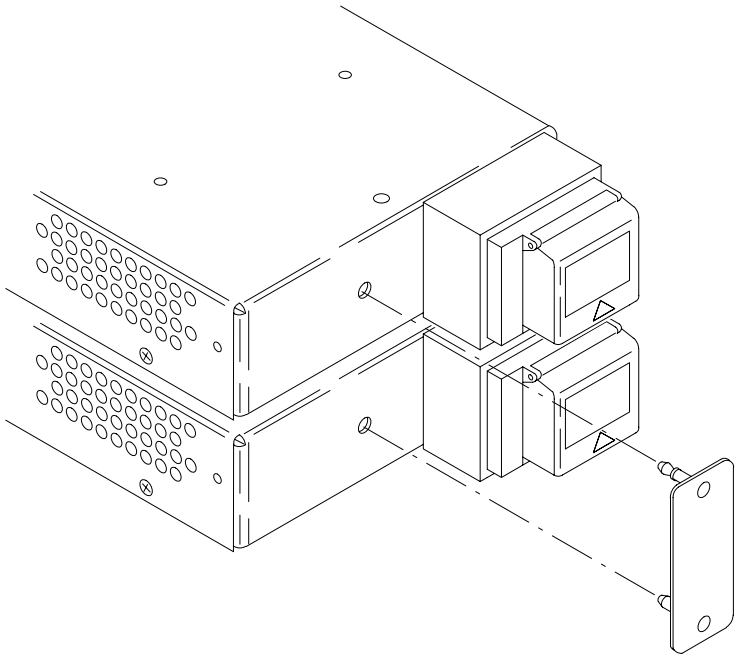


Figure 1-4. Installing the Module Spacer: Two-Module Configuration

7. Place the modules inside the mainframe, lining up the fiber connectors with the openings in the front panel, and reconnecting the control and module support boards to the interconnect board.

NOTE *Align the connectors on the interconnect board correctly to ensure complete connections with the module support board, optical module(s), and control board. If connections are not made properly, the instrument will not work.*

8. Reattach the back-panel assembly to the mainframe by tightening the four black quick-release screws. All the screws in the back-panel assembly can be tightened further using a screwdriver, if necessary.

To take the modules out of the TFP2A mainframe, reverse this procedure.

Front-Panel Covers

If your instrument includes one optical module, the top module slot on the front panel is unused. If your instrument is not configured with a floppy-disk drive, the drive slot is unused. Unused option slots are covered before the instrument is shipped from the factory. If you change your instrument's configuration, however, you may need to remove or install these covers, as shown in figure 1-5.

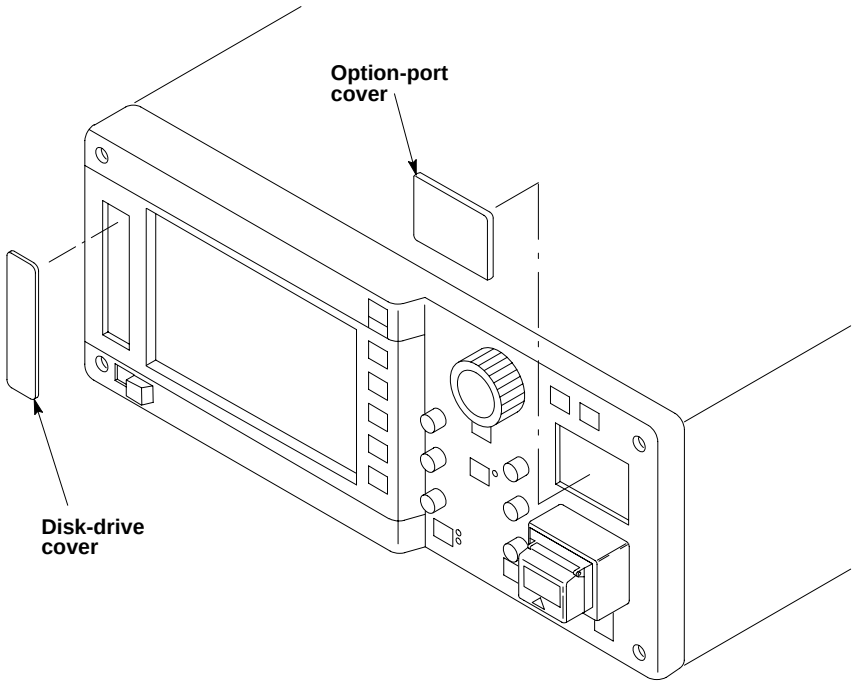


Figure 1-5. Front-Panel Option Covers

Loading Paper into the Internal Printer

To load paper into the internal thermal printer, follow these steps:

1. Slide the printer cover back.
2. Lift out the old paper roll and remove the black disks from either end.
3. Insert the disks into the ends of the new paper roll.
4. Place the new roll into the printer, with the end of the paper coming out from under the roll towards the front of the instrument.
5. Push the paper tension lever down, and hold it down for step 6.
6. Feed the paper into the slot in the paper guide, until it comes out in front of the aluminum paper guide. See figure 1-6. The arrows indicate the direction in which to feed the paper.
7. Release the tension lever.

When the printer is in use, slide the printer cover closed until it reaches the stops provided for the paper opening. Use the serrated edge of the cover as a guide to tear the paper off. After printing, tear off any remaining paper and slide the cover completely closed over the printer.

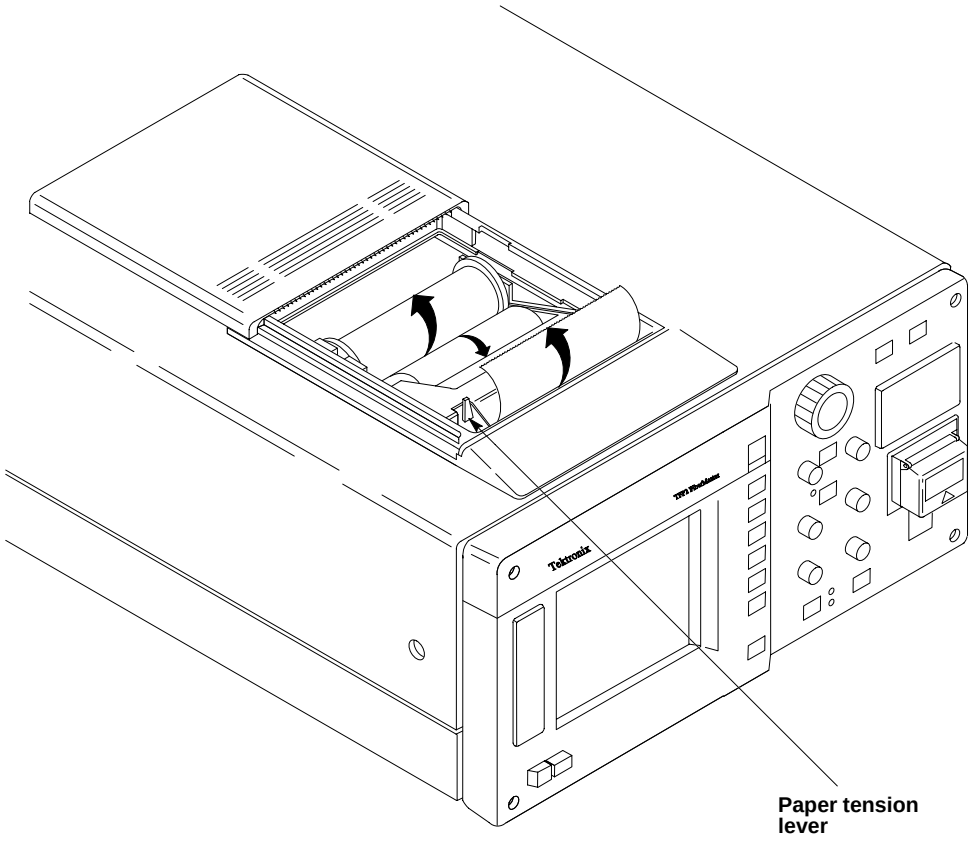


Figure 1-6. Loading Paper into the Internal Printer

Laser Output

FiberMaster is equipped with low-energy lasers and does not output continuous laser light unless you have started data acquisition by pressing the **START/STOP** button. The LED next to the currently selected laser source flickers to indicate the laser is firing.

WARNING *The TFP2A FiberMaster has been classified as a Class 1 laser product under the Radiation Control and Health Safety Act of 1968.*

Although output from a Class 1 laser is not considered hazardous, it is good practice not to allow eye exposure from direct or reflected laser light. This can be avoided by covering the end of the fiber or directing the output at a non-reflective surface.

It is important to set up and operate the instrument as instructed in this manual. Use of controls or adjustments for performance of procedures other than those specified herein may result in hazardous radiation exposure.

Storage

Both short-term and long-term storage conditions must meet the enviromental specifications given for the FiberMaster earlier in this chapter.

Repacking for Shipment

When packing an instrument for shipping to a Tektronix Service Center for service or repair, attach a tag showing the name and address of the owner, name of the individual at your firm to contact, complete serial number, and a description of the service required. If the original packaging is not available, repackage the instrument as follows:

1. Install the front cover on the OTDR.
2. Position the handle over the front cover, and wrap the instrument in polyethylene sheeting to protect the finish.
3. Cushion the instrument on all sides with packing material or urethane foam between the carton and the sides of the instrument.
4. Seal the carton using shipping tape.

No special handling is required to prepare the floppy-disk drive for shipping.

A shipping carton and packing material can be obtained through your local Tektronix field office or representative, if necessary.

If you have any questions, contact your local Tektronix field office or representative or in the U.S. and Canada call toll free **1-800-835-9433**.

Recalibration

Tektronix recommends that the TFP2A be sent to the factory or a qualified Tektronix service center for recalibration every 12 months. To arrange for recalibration, contact any Tektronix service center or call **1-800-835-9433**.

2 General Operating Instructions

Before servicing FiberMaster, read the following operating instructions. These instructions are at the level appropriate for servicing the OTDR. Refer to the *FiberMaster User Manual* for complete operating instructions.

Additional instructions are integrated into the service procedures given in following chapters. For example, the procedure in the Performance Check and Adjustment section contain instructions for making the front-panel settings required to check each instrument characteristic included there. Also, the instructions for operating FiberMaster's internal diagnostic routines are given in chapter 5, *Maintenance*. You may also find the product description in chapter 1 useful for understanding how the instrument functions.

Overview of FiberMaster Operation

Start data acquisition on a fiber-optic cable under test by simply connecting the cable to the appropriate front-panel connector, and pressing the **START/STOP** button. An averaged waveform appears on the screen, and you can make measurements immediately.

The FiberMaster OTDR provides five measurement modes for viewing faults and measuring transmission loss, fusion-splice loss, connection loss, return loss, and other characteristics of fiber-optic cable. These are Preview, Two Point, Splice Loss, and two Return Loss modes.

- ❏ Preview mode gives a clear overview of the fiber. Scan fiber features and measure distances in Preview mode.
- ❏ Two Point mode allows you to measure loss between any two points on the fiber.
- ❏ Splice Loss mode gives loss measurements at splice points along the fiber.
- ❏ Link Return Loss mode lets you measure the return loss of a fiber link.
- ❏ Event Return Loss shows the return loss for a particular event on the fiber.

Enter each measurement mode by pressing a front-panel softkey. Two-point, splice-loss, and return-loss measurements can be made automatically. Front-panel controls permit manual adjustment to automatic measurements.

Automatic and manual event-marking modes locate and perform measurements on all events on the fiber under test. An online table is compiled that contains two-point, splice-loss, return-loss, and distance measurements for each event. You can adjust measurement values on the table, and enter and edit notes for each event.

A general-purpose interface bus (GPIB) and the RS-232 serial interface allow remote control of the instrument.

Advanced Functions

FiberMaster's automatic measurements provide adequate data for many applications. If you require more in-depth fiber analysis, however, the instrument's advanced functions offer extended flexibility in acquiring and interpreting fiber data. These functions include:

- ❏ High-density data acquisition
- ❏ A dual-waveform display, for comparing two waveforms
- ❏ Manipulation of the expansion window
- ❏ Real-time acquisition
- ❏ Manual-masking capabilities

Instrument Configuration

Instrument configuration and measurement settings are set through a menu system, accessed by pressing a front-panel softkey. You can set parameters using various front-panel controls to enter the data, or you can connect an optional IBM-AT-compatible keyboard to FiberMaster for data entry.

Mass Storage

The mass-storage system is also entered through a front-panel softkey, for storing waveform and settings data on floppy disks or an optional internal RAM. Data is saved in MS-DOS-compatible files.

The Acquisition Screen

The acquisition screen displays fiber test data and measurement information, and is used for all fiber-evaluation activity. Other than instrument setup, event marking, and mass-storage operations, most of your work with FiberMaster will be on the acquisition screen.

The acquisition screen displays either data acquisition in progress or a completed acquisition, including all measurements on the fiber under test. Distance and loss cursors display on this screen, depending on the measurement mode, and can be manipulated to perform manual measurements on the fiber.

The acquisition screen includes:

- ❏ A horizontal distance scale and a vertical loss scale.
- ❏ One or two distance cursors, and one or two loss cursors, depending on the measurement mode.

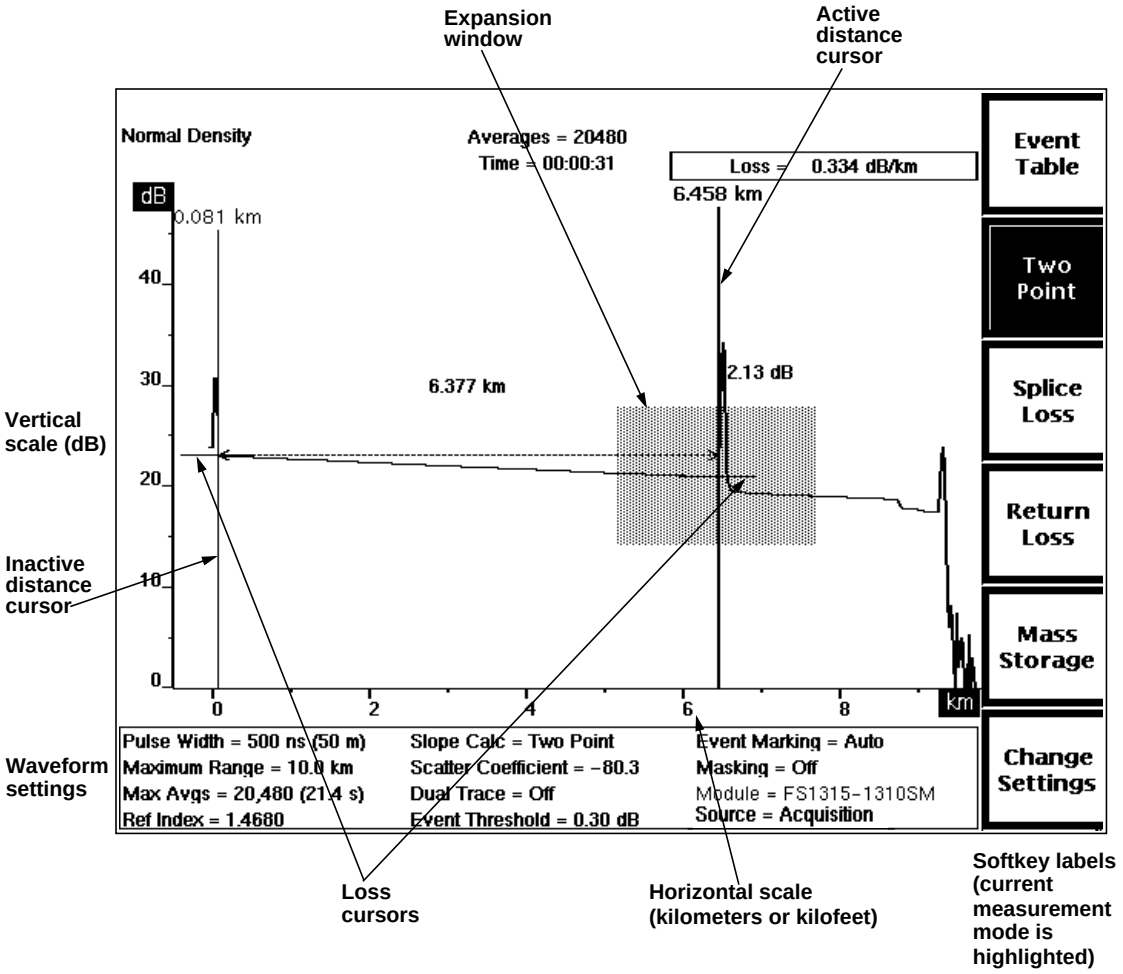


Figure 2-1. Features on the Acquisition Screen

- An expansion window. Pressing the **EXPAND** button on the front panel switches between expanded view and overview. In expanded view, the area within the expansion window is magnified to fill the display, allowing closer examination of the fiber. See figure 2-2.

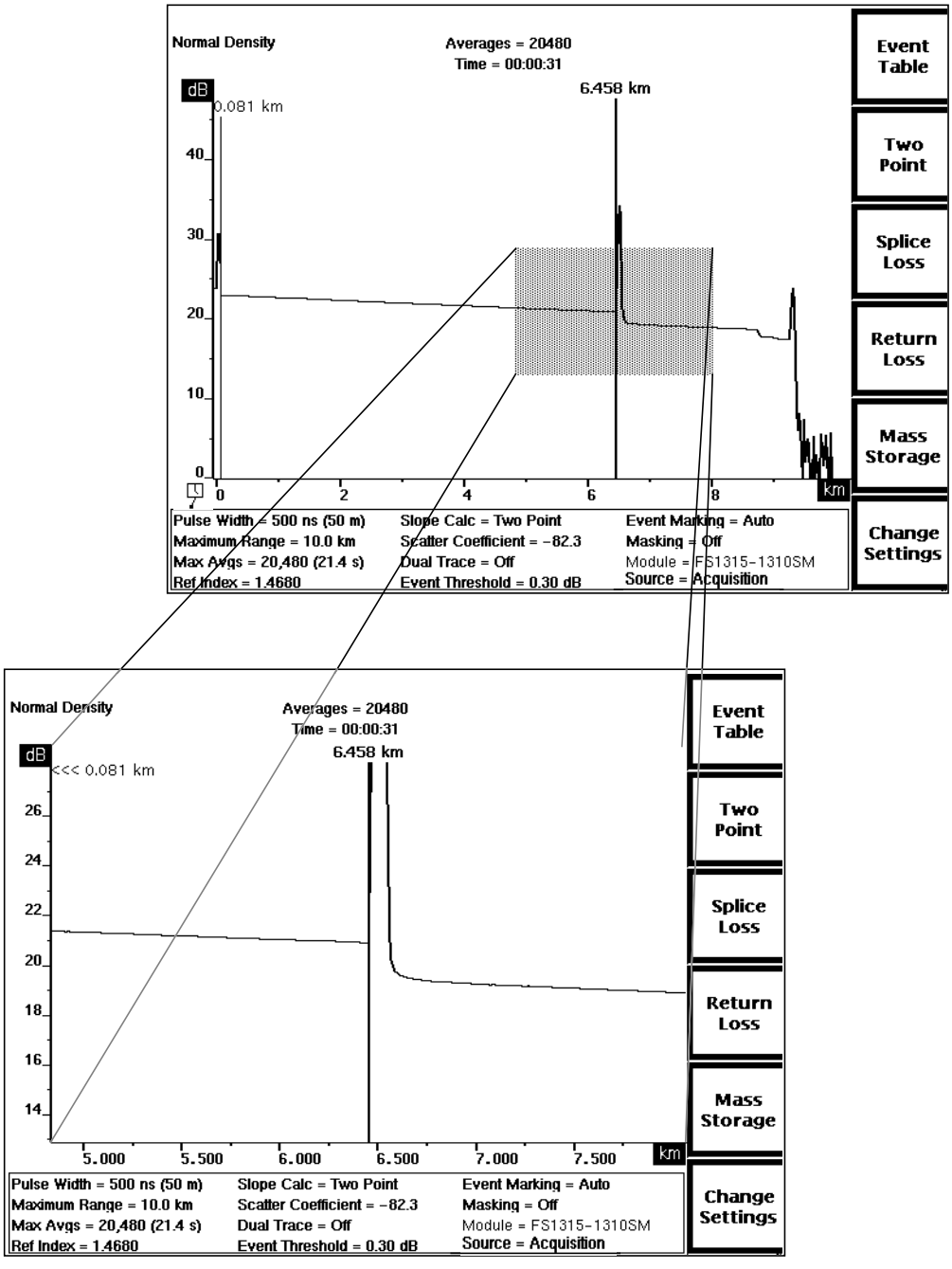


Figure 2-2. Acquisition Screen Expansion—Overview (top), and Expanded View (bottom)

- Waveform and measurement data. Distance and loss measurements are displayed on the screen near the waveform. In Two Point mode and both return-loss modes, the slope calculation and return loss, respectively, appears in the upper right-hand corner of the screen. The message **User Adjusted Measurement** displays in the upper left-hand corner of the screen for all manually adjusted measurements. The actual number of averages that were performed on the waveform, and the actual elapsed averaging time are shown in the upper center screen. If an acquisition is in progress, the number of averages and the time elapsed are seen increasing.

  During an acquisition, the display also contains an acquisition-active indicator in the lower-left corner of the waveform area. This indicator provides a quick way to check whether an acquisition is still in progress. When data acquisition is complete, and calculations are still in progress, the indicator changes to show a clock with a swinging pendulum.

  When event-marking mode is turned on, events on the fiber are marked and numbered at the bottom of the acquisition screen. In addition, when the active distance cursor is on an event marker, a field below the horizontal distance scale displays measurements for that event.

- On color monitors, the waveform area of the acquisition screen is color coded for easier interpretation of data and measurements. Waveform data, including the active waveform (except for high-density data), the number of averages, elapsed time, and the **Normal Density** or **High Density** message, is green. The user-adjustable elements—distance and loss cursors, and the **User Adjusted Measurement** message—are displayed in red. Measurement values such as the two-point distance and loss, splice loss, fiber loss, and return loss figures are shown in yellow. Event markers are also displayed in yellow.

- All waveform settings used for the acquisition are displayed at the bottom of the screen. These user-defined settings are selected on the Waveform Settings menu, reached by pressing the **Change Settings** softkey on the acquisition screen. Refer to the *FiberMaster User Manual*, for details on configuring your instrument and setting parameters.

  A **Module** parameter in the list of settings indicates which laser source is currently selected. The type of module is shown, plus the currently selected wavelength. For example, **FS1315-1310SM** indicates that the 1310-nm wavelength of a dual-wavelength singlemode FS-type optical module is currently selected. If the active module is different from the one that was used to acquire the current waveform, the module parameter is highlighted.

  The module parameter may include alphabetical characters to indicate the modification level of the module, and whether the module has an internal fiber with a non-standard core diameter. This information is appended to the wavelength. Lower-case letters indicate the modification level of the module, and upper-case letters stand for a non-standard core diameter. For example:

  FS1315-1310SM — standard module with standard core diameter
  FS1315-1310SMaA — modified module with non-standard core diameter
  FS1315-1310SMA — standard module with non-standard core diameter
  FS1315-1310SMa — modified module with standard core diameter

  For more information on module modifications and internal fiber core diameters, in the U.S. and Canada, call 1-800-835-9433, or contact your local Tektronix representative.

  The **Source** parameter shows where the current waveform data originated. The data could be the result of an acquisition, a data transfer, or from a mass-storage file. For an acquisition, the parameter displays as **Source = Acquisition**. If the waveform was loaded from mass storage, the parameter reads **File = <FILE_NAME>** where **<FILE_NAME>** is the name of the mass-storage file. If the waveform data was received via an XModem data transfer, the parameter reads **Source = XModem**.

- Softkey labels display along the right-hand edge of the screen. On the acquisition screen, the softkeys allow you to switch measurement modes, view the event table, enter the menu system, and access mass-storage functions.

Basic Operating Procedures

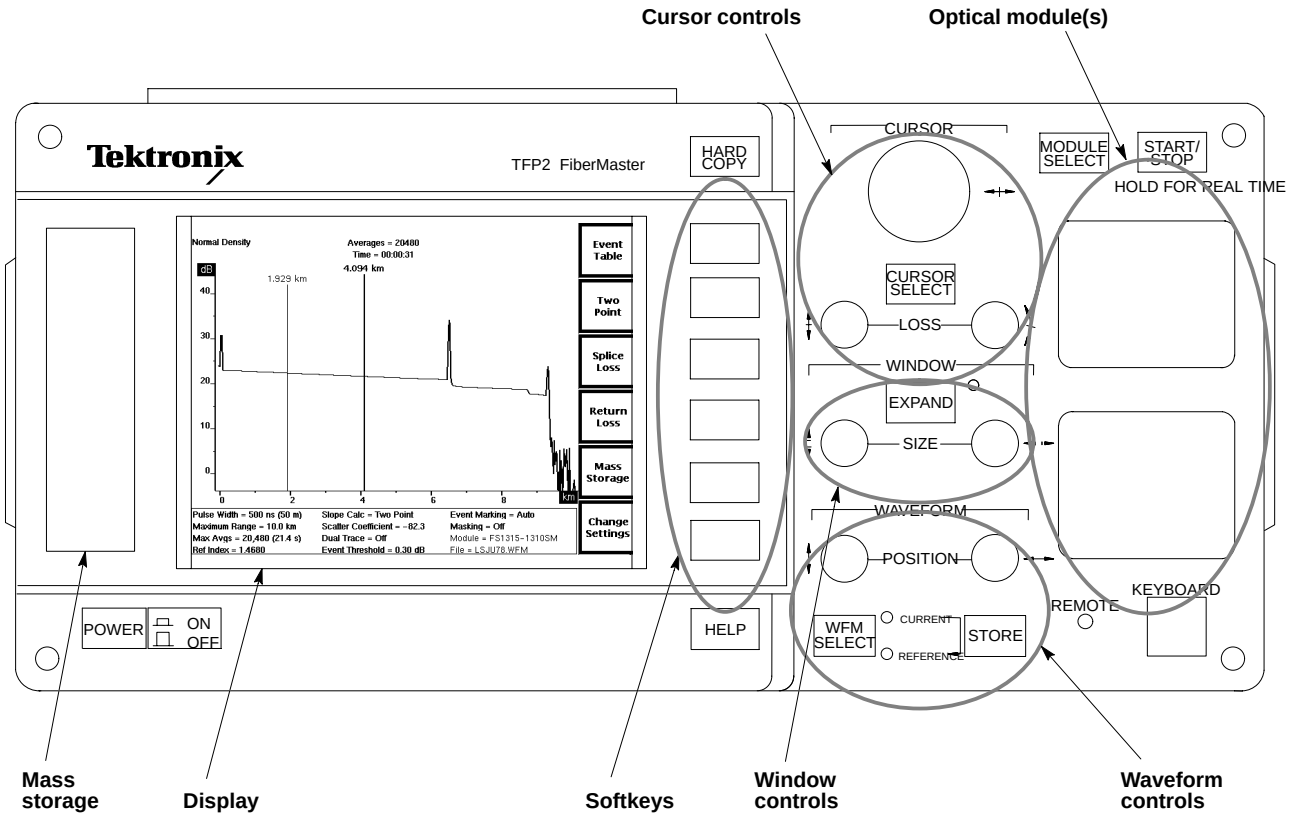


Figure 2-3. Front Panel Overview

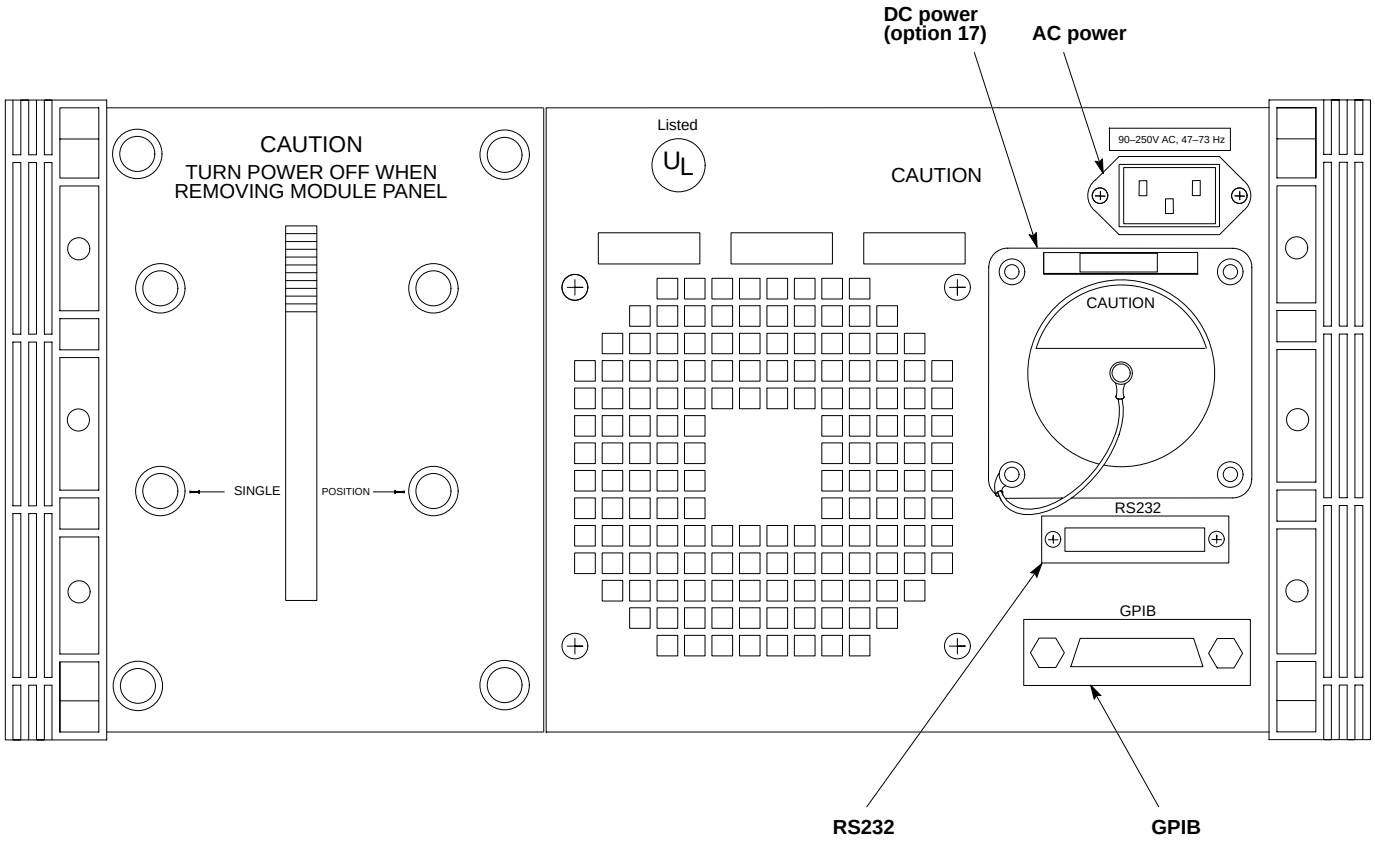


Figure 2-4. Back Panel

Power on

POWER

To turn on FiberMaster and start the power-on sequence of self tests, press the **POWER** button. Pressing the **POWER** button a second time turns off the instrument.

To quick-start the instrument, push the **POWER** button while holding down the **START/STOP** button. Release the **START/STOP** button after you see the message **Starting operating system...** on the instrument screen. Quick-start makes the instrument bypass the power-on diagnostics, causing the start-up screen to appear faster.

Do not quick-start your instrument every time it is powered on. Allow the instrument to run the power-on diagnostics periodically to detect any malfunctions that might have occurred.

Read help

HELP

Push the **HELP** button to read help information on the current operation. For example, if the instrument is in Splice Loss mode, pressing the **HELP** button lets you read explanations on splice-loss measurement and the functions of the front-panel controls in Splice Loss mode. In the menu system, pressing the **HELP** button displays information about the currently selected setting.

Select a wavelength

MODULE SELECT

Push the **MODULE SELECT** button to cycle through the available laser sources. The corresponding indicator next to each module lights up to show which wavelength is currently selected. After making your selection, press **START/STOP** to start a new acquisition using the selected wavelength.

The module parameter in the list of settings at the bottom of the acquisition screen shows which laser source is selected. The type of module is shown, plus the current wavelength. For example, **FS1315-1310SM** indicates that the 1310-nm wavelength of a dual-wavelength singlemode FS-type optical module is currently selected. If the active module is different from the one used to acquire the current waveform, the module parameter is highlighted until you start a new acquisition.

Set up the system

Change Settings

Enter the menu system by pressing the **Change Settings** softkey. Using the menus, you can select waveform, operator, and system settings, set user power-on defaults, and perform remote data transfers. Refer to the *FiberMaster User Manual* for details on selecting instrument settings.

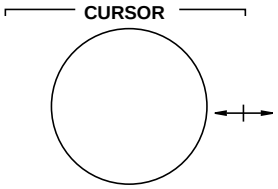
Start an acquisition

START/ STOP

Press the **START/STOP** button once to start an averaged waveform acquisition based on the current instrument settings. Pressing **START/STOP** again before an averaged acquisition is complete stops the acquisition.

Pressing and holding the **START/STOP** button starts a real-time acquisition, useful for adjusting fiber connections and making splices. In real-time mode, data is averaged minimally, and new acquisitions are displayed continually. To stop a real-time acquisition, press **START/STOP** again.

Move the distance cursor



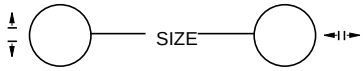
Turn the **CURSOR** knob to move the active distance cursor along the waveform. The distance from the instrument's front panel to the cursor position is displayed at the top of the cursor. In the menu system, use the **CURSOR** knob to select instrument parameter settings.

Expand the view

EXPAND

Press the **EXPAND** button to switch between overview and expanded view. The degree of expansion is controlled by the size of the expansion window.

Size the expansion window



Change the size of the expansion window using the vertical and horizontal **SIZE** knobs. In expanded view, these controls expand and contract the waveform itself, instead of the expansion window.

Switch active cursors

CURSOR SELECT

In Preview, Two Point, and Link Return Loss modes, which have two distance cursors, press the **CURSOR SELECT** button to pick which distance cursor is controlled by the **CURSOR** knob. In Splice Loss and Event Return Loss modes, which have one distance cursor and two loss cursors, press **CURSOR SELECT** to pick which loss cursor is controlled by the **LOSS** knobs.

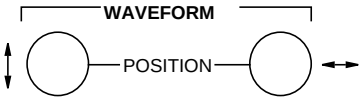
The active cursors are shown at higher intensity to differentiate them from the inactive cursors.

Join cursors: Press and hold the **CURSOR SELECT** button to join cursors. In Preview, Two Point, and Link Return Loss modes, the inactive distance cursor is moved to the same location as the active cursor. In Splice Loss and Event Return Loss modes, the inactive loss cursor is moved to the same amplitude and slope as the active cursor.

Adjust loss cursors

Use the **LOSS** knobs to make manual adjustments to automatic measurements in Two Point, Splice Loss, Link Return Loss, and Event Return Loss modes. The vertical **LOSS** knob moves the active loss cursor up and down. The slope **LOSS** knob rotates the active loss cursor around the point where it intersects the distance cursor.

Move the waveform



Move the active waveform up and down and from side to side on the display using the vertical and horizontal **POSITION** knobs.

Select a waveform

WFM SELECT

Pressing the **WFM SELECT** button alternately selects the current and the reference waveform as the active waveform. One of the indicators next to the **WFM SELECT** button lights to show which waveform is active.

When dual-trace mode is on, both the current and reference waveforms are displayed, with the active waveform at higher intensity. When dual trace is not on, only the active waveform is displayed. (Turn on dual-trace mode through the menu system.)

Press and hold the **WFM SELECT** button to zero the waveform's position. It is moved so that the amplitude and distance axes meet at 0 dB and 0 km. In dual-trace mode, pressing and holding **WFM SELECT** moves the inactive waveform to the same dB scale as the active waveform.

Store a waveform

STORE

Press the **STORE** button to store the current waveform and associated settings into reference memory. The previous contents of reference memory are overwritten.

Event Table

Event Table

Press this softkey to display the Event Table screen. The event table shows distance and loss measurements for events marked on the fiber. The Event Table screen allows access to additional screens where you can read and enter notes and mapping information about each event.

On the acquisition screen, pressing and holding the **Event Table** softkey for two seconds turns event markers on and off.

You can set FiberMaster to locate and mark events automatically or you can mark events manually. The Event Marking parameter on the Waveform Settings menu (accessible from the acquisition screen by pressing **Change Settings**) lets you choose automatic or manual event marking, and gives access to an additional screen for placing markers manually.

Two-Point Mode

Two Point

Press this softkey to enter Two Point mode. Use Two Point mode to make measurements between two points on a fiber, including end-to-end distance and loss measurements and fiber-loss measurements. Two distance and two loss cursors define two-point measurements. Loss between the two distance cursor positions is calculated and displayed in the upper-right corner of the screen.

To turn off Two Point mode and enter Preview mode, press and hold the **Two Point** softkey.

This softkey is available only when return loss is off.

Splice Loss Mode

Splice Loss

Press this softkey to enter Splice Loss mode. Use Splice Loss mode to measure loss caused by a particular fiber feature, for example a connector or splice. There are one distance cursor and two loss cursors in Splice Loss mode. The loss at the distance cursor is calculated and displayed.

To turn off Splice Loss mode and enter Preview mode, press and hold the **Splice Loss** softkey.

This softkey is available only when return loss is off.

Return Loss/Exit Return Loss

Return Loss **Exit Return Loss**

Use these softkeys to turn the return-loss measurement modes on and off. When return loss is on, the **Two Point** softkey is replaced by the **Link Return Loss** softkey, the **Splice Loss** softkey is replaced by the **Event Return Loss** softkey, and **Return Loss** changes to **Exit Return Loss**. When return loss is off, the softkeys revert to **Two Point**, **Splice Loss**, and **Return Loss**.

Link Return Loss

Link Return Loss

Press this softkey to enter Link Return Loss mode. Use Link Return Loss mode to measure the transmission energy lost due to the total light reflected by a link. Two distance cursors are used to define the link to be measured, and one loss cursor establishes the backscatter level before the link. Link return loss between the two distance cursor positions is calculated and displayed in the upper-right corner of the screen.

To turn off Link Return Loss mode and enter Preview mode, press and hold the **Link Return Loss** softkey.

This softkey is available only when return loss is on.

Event Return Loss

Event Return Loss

Press this softkey to enter Event Return Loss mode. Use Event Return Loss mode to measure the transmission energy lost due to the total light reflected by a particular reflective fiber feature, such as a connector or splice. A single distance cursor is used to indicate the reflection to be measured. One loss cursor establishes the backscatter level before the event, and a second loss cursor marks the top of the reflection. Event return loss is calculated and displayed in the upper-right corner of the screen.

To turn off Event Return Loss mode and enter Preview mode, press and hold the **Event Return Loss** softkey.

This softkey is available only when return loss is on.

Print

HARD COPY

Print a hard copy of the screen. If an external plotter is selected as the hardcopy device, only the acquisition screen can be hard copied. The internal printer or any external printer can print hard copies of menus, help screens, and event tables as well.

Mass Storage

Mass Storage

Enter the mass-storage menu system by pressing the **Mass Storage** softkey. Use this system to load waveform and settings data from mass storage to the instrument, save data from the instrument to mass storage, format mass-storage media, and delete and copy files.

3 Theory of Operation

A1 - Control

Host Processor

The host processor has a 68020 microprocessor core, which contains the 68020, system ROM, system RAM, and interfaces for the display processor and peripherals. The host processor has direct control over the mass-storage, hardcopy, external I/O, front-panel, and acquisition systems. Indirect control is exercised over the display system, a secondary processor that performs the required data manipulation under the host processor's control.

The host processor has three main functions:

1. **Instrument Control**. At power-on, control software from each plug-in optical module is uploaded to the host processor. Instrument operation is controlled by this software and the operating-system kernel resident in the mainframe. Front-panel controls are monitored, and information from the panel is used by the host processor.

   Instrument control also includes control of the mass-storage device(s), the hardcopy device, and external communications.

2. **Data Acquisition**. The host processor computes the data-acquisition parameters for the timebase and the signal averager from the current instrument state and loads the command data into the front end. Masking requirements and plug-in setup are sent to the selected optical plug-in module and module support.

3. **Data Manipulation**. Data is accumulated in the signal-averager memory. The host processor converts raw measurement data to data that is meaningful to the user.

Display Processor

The display processor has a 34010 graphics processor core that contains the 34010 microprocessor, ROM, RAM, video frame buffer and interfaces to the host processor system and video display.The display processor has two main functions:

1. **Waveform Post-Processing**. Corrected waveform data and front-panel switch settings are received by the display processor from the host processor. Waveform data is scaled and formatted to reflect the front-panel switch settings. The newly formatted waveform and its associated measurement text are then placed into the frame buffer to be displayed on the video display.

2. **Automatic Display Refresh**. The display processor generates the synchronization and blanking signals required to drive the video display and liquid-crystal shutter. The display processor is programmed to support a 640-by-480 screen resolution in a non-interlaced video mode.

Timebase

The data-acquisition system uses a combination of high-speed (10 Msamples/sec) and sequential sampling techniques. The timebase provides the signals necessary to control the acquisition. The timebase consists of a sampler control/address generator and a pulse generator.

The sampler control/address generator controls sample density, time positioning of the data acquisition window relative to the pulse, and the averaging system.

The pulse generator produces the triggers that control the laser pulse generators in the optical modules. In those applications using optical masking, the pulse generator allows time positioning of the mask relative to the pulse.

Signal Averager

The signal averager and its primary memory constitute the core of the high-speed digital data-acquisition system. The signal averager is controlled by the sampler control/address generator to maintain a 10Msample/second throughput as it accumulates and averages input data. The averager receives its input directly from the optical plug-in modules on the HSD bus.

Once the acquisition cycle has concluded, the memory performs a DMA dump to the signal-averager buffer memory where the host processor may access it as desired. This transfer, like the acquisition, is controlled by the sampler control/address generator in both control signals and addressing.

A2 - Front Panel

Front Panel

The front panel provides the interface between the host processor and the operator. This human interface consists of the following:

- Seven quadrature shaft encoders
- Fourteen push-buttons and softkeys
- Four LEDs
- IBM-AT-compatible keyboard interface

All front-panel control logic has been incorporated into a single front-panel controller.

A3 - Power Supply

Instrument power is provided by a switching type power supply. The power supply has an auto-ranging input system that allows it to function on both 110 VAC and 220 VAC. A DC option allows operation from 11 to 16 VDC.

A4 - Interconnect

Interconnect

The interconnect board connects the control board with the two plug-ins and the optical-module support board. The interconnect board provides power and control for operating the plug-ins, as well as for handling the digital data flow from the front end.

A5 - Module Support

Digital Interface and Cooler Power Supplies

The backplane interface connections are made through the two edge-card connectors that contain four basic areas of connections: cooler sense and power, sample-strobe signals, CPU bus signals, and mask-control signals.

Up to four lasers may be controlled by the laser-cooler power supply. Each of the lasers is packaged with a thermoelectric cooler and a 10KΩ thermistor. The lasers are stabilized at a temperature between 15 and 35 degrees Celsius, determined during the plug-in calibration. The temperature is selected to optimize power and wavelength.

The detector cooler power supplies are a simplified version of the laser cooler power supplies. All detectors are set to operate at -10 degrees Celsius. Up to two detector thermoelectric coolers can be controlled by the detector cooler power supplies.

Mask Generator

The mask generator converts parallel mask pattern bits provided by the mask RAM into a serial bit pattern to drive the optical masking circuitry. Timing control for this operation is driven by a 160MHz clock, which is derived from a 40MHz clock. This 40MHz clock is synchronous with the pulse system.

Strobe Continuation

In order to minimize the transients caused by starting and stopping the sampling system, dummy fill strobes are generated and supplied to the sampler when no data is to be taken. A shift register is used to produce the fill strobe with the proper timing relationship. This register is clocked by a 40MHz signal that is synchronous with the sampling system.

A6 - Printer Assembly

Printer-Power Distribution

The printer-power distribution board is used for cable management and +24V power-supply control.

A7 - Display Assembly

Display

The display is a 7-inch-diagonal, 480-line-by-640-pixel raster CRT display monitor. To obtain a three-color system, a liquid-crystal shutter is placed in front of the monochrome CRT. By driving the shutter at 60 Hz, and the CRT display monitor's Z axis at a high (two times normal) dot rate, the red, green, and yellow combination color scheme is produced. The display monitor is broken into four major blocks. These blocks include CRT monitor, deflection and high-voltage circuitry, cell driver, and liquid-crystal shutter.

A20/A30 - Optical Plug-in

The optical plug-in can contain up to two optical modules to support measurements of different fiber types and different wavelengths. The optical plug-in provides the laser sources, optical receiver, and digitizer to supply measurement data to the TFP2A mainframe for making accurate distance and loss measurements on optical fiber. An optical switch supports a variety of masking modes for improved accuracy and resolution of singlemode and 1300nm multimode measurements.

‘

4 Maintenance

This chapter contains the information you need to do periodic and corrective maintenance on the FiberMaster OTDR. The following topics are covered:

- ❏ Inspection and cleaning
- ❏ Functional tests
- ❏ Performance verification
- ❏ Adjustments
- ❏ Troubleshooting and diagnostics
- ❏ Removal and installation procedures

If your instrument does not function properly, take corrective measures immediately; otherwise additional problems may develop within the instrument.

Product Service

To assure prompt product service and maintenance for our instruments, Tektronix has established field offices and service centers throughout the United States and outside the U.S. in countries where our products are sold. Contact your local service center, representative, or sales engineer for details regarding warranty, calibration, emergency repair, repair parts, scheduled maintenance, maintenance agreements, pick-up and delivery, and other services available through these centers. Or in the U.S. and Canada, telephone toll free **1-800-835-9433**.

An emergency repair service is available to provide immediate attention if your instrument malfunctions in an emergency situation. To receive this service, contact any Tektronix service center or call **1-800-835-9433**.

Recalibration

Tektronix recommends that the TFP2A be sent to the factory or a qualified Tektronix service center for recalibration every 12 months. To arrange for recalibration, contact any Tektronix service center or call **1-800-835-9433**.

Static-Sensitive Components

CAUTION *Static discharge can damage any semiconductor component in this instrument.*

When performing any service that requires internal access to the instrument, take the following precautions to avoid damaging internal modules and their components with electrostatic discharge (ESD).

1. Minimize handling of static-sensitive modules.
2. Transport and store static-sensitive modules in their static-protected containers or on a metal rail. Label any package that contains static-sensitive modules.
3. Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules. Service the modules only at a static-free workstation.
4. Do not allow anything capable of generating or holding a static charge on the workstation surface.
5. Handle circuit boards by the edges whenever possible.
6. Do not slide the modules over any surface.
7. Avoid handling the modules in areas that have carpeted floors or work surfaces capable of generating static charges.

Inspection and Cleaning Procedures

FiberMaster's cabinet minimizes dust accumulation inside the instrument. Never operate the OTDR without the cabinet installed. When storing or transporting the instrument, make sure the front cover is on to protect the front panel and display from dust and damage.

Inspect and clean your FiberMaster OTDR as often as operating conditions require. For example, under average conditions (laboratory use), inspect and clean your instrument after every 1000 hours of operation. When using FiberMaster extensively in the field, inspect and clean it after every 500 hours of operation. Dirt acts as a thermal insulator and can cause overheating and component breakdown. It also provides an electrical conduction path that could cause instrument failure, especially under high-humidity conditions.

Exterior Inspection

Inspect the outside of the OTDR for damage, wear, and missing parts, using table 4-1 as a guide. OTDRs that appear to have been dropped or otherwise abused should be checked thoroughly to verify correct operation and performance.

Table 4-1. External Inspection Checklist

Item	Inspect For	Repair Action
Cabinet, front panel cover, handle	Cracks, scratches, deformations, damaged hardware or gaskets, proper operation of handle	Replace defective module.
Front-panel knobs	Missing, damaged, or loose knobs	Repair or replace missing or damaged knobs.
Connectors	Broken shells, cracked insulation, deformed contacts. Dirt in connectors.	Replace defective modules. Clear or wash out dirt.
Accessories	Missing items or parts of items, bent pins, broken or frayed cables, and damaged connectors.	Replace damaged or missing items, frayed cables, and defective modules.

Exterior Cleaning

CAUTION *To prevent getting moisture inside the OTDR during external cleaning, use only enough liquid to dampen the cloth or applicator.*

1. Remove dust from the outside of the instrument by wiping with a lint-free cloth or brushing the surface with a small brush. Use the brush to remove dust from around the front-panel controls.
2. Clean remaining dirt with a lint-free cloth dampened in a general-purpose detergent-and-water solution. Do not use abrasive cleaners.
3. Clean the monitor screen with a lint-free cloth dampened with isopropyl alcohol.

Optical-Fiber Cleaning

As a rule, clean any fiber before connecting it to FiberMaster's front panel, or at any time you think it may be contaminated. Clean the connector using electronics-grade isopropyl alcohol on a lint-free swab, then blow dry with clean, canned air. If you know the connector is clean, blowing with air should be sufficient.

CAUTION *Never use any abrasive material to clean the fiber. Damage to the fiber results in deteriorated performance.*

Cleaning and Changing the Front-Panel Connector

Newer FiberMaster optical modules have cleanable, universal front-panel connectors, while older modules do not. The universal connector system is identified by the nomenclature FREE and LOCK printed on the adapter plate inside the door of the optical connector assembly. Clean both types of connectors before connecting a fiber, and when changing connector adapters on the universal connectors.

Clean FiberMaster's old-style front-panel connector with electronics-grade isopropyl alcohol and a small lint-free swab. Insert the end of the swab into the connector, roll it gently, then blow dry using canned air.

Clean or change the universal connector system following the steps below. The tools you will need are:

- ❏ Flat-blade screwdriver
- ❏ Lint-free swab
- ❏ Pipe cleaner
- ❏ Electronics-grade isopropyl alcohol
- ❏ Optical-grade canned air

1. Lift the door of the optical connector assembly.
2. Using the flat-blade screwdriver, rotate the FREE-LOCK screw in either direction until it is aligned vertically with the FREE position, then rotate it back to the LOCK position. This releases the connector from the universal interface assembly.

3. Unscrew the connector by holding it around the connector knurling and turning it counterclockwise until it rotates freely. Remove the connector.
4. Dampen the pipe cleaner with alcohol and draw it through the connector barrel.
5. Dampen a lint-free swab with alcohol and swab the ferrule. The ferrule must be clean, otherwise it can deposit dirt into the optical connector.
6. Blow dry the connector barrel and the ferrule with canned air.
7. Dampen a second lint-free swab with alcohol and gently roll it over the end of the fiber. Do not scrub; this can scratch the polished end.
8. Gently blow dry the fiber end with canned air.
9. Replace the connector over the universal interface. Applying light pressure, rotate the connector barrel (the end of the connector) until it locks in the keyed position.
10. Screw the connector back in by holding it around the connector knurling and turning it clockwise until finger tight.
11. Using the screwdriver, turn the FREE-LOCK screw to align it vertically with the FREE position.
12. Push the connector assembly into the module until it stops. While holding the connector in, rotate the FREE-LOCK screw back to the LOCK position. Release the connector.

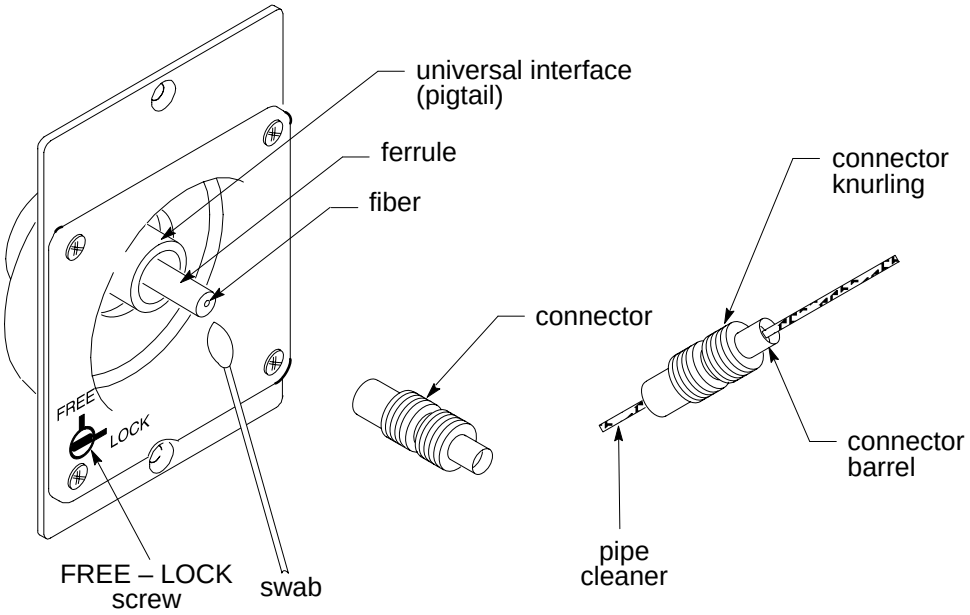


Figure 4-1. Cleaning and Changing the Universal Connector

Interior Inspection

To gain access to the inside of the OTDR for inspection and cleaning, refer to the removal and replacement procedures given later in this chapter.

Inspect the internal portion of your FiberMaster OTDR for damage and wear, using table 4-2 as a guide. Repair any deficiencies found immediately.

CAUTION *To prevent damage from electrical arcing, make sure that circuit boards and components are dry before applying power to the OTDR.*

Table 4-2. Internal Inspection Checklist

Item	Inspect For	Repair Action
Circuit boards	Loose, broken, or corroded solder connections. Burned circuit board. Burned, broken, or cracked circuit-run plating.	Remove failed module and replace with a new module
Resistors	Burned, cracked, broken, or blistered	Remove failed module and replace with a new module.
Solder connections	Cold solder or rosin joints	Resolder joint and clean with isopropyl alcohol.
Capacitors	Damaged or leaking cases. Corroded solder on leads or terminals.	Remove damaged module and replace with a new module.
Semiconductors	Loosely inserted in sockets. Distorted pins.	Firmly seat loose semiconductors. Remove devices with distorted pins, carefully straighten pins, (as required to fit socket) using long-nose pliers, and reinsert firmly. Ensure that straightening action does not cause pins to crack or break off.
Wiring and cables	Loose plugs or connectors. Burned, broken, or frayed wiring.	Firmly seat connectors. Repair or replace modules that have defective wiring or cables.
Chassis	Dents, deformation, and damaged hardware	Straighten, repair, or replace defective hardware.

Interior Cleaning

NOTE *If a module is clean upon inspection after steps 1 and 2, skip the remaining steps.*

1. Blow dust out of interior using dry, low-pressure, deionized air (approximately 9 psi).
2. Remove any remaining dust with a lint-free cloth dampened in a 75% isopropyl alcohol solution, and rinse with warm deionized water. Lint-free swabs are useful for cleaning in narrow spaces and on circuit boards.
3. If steps 1 and 2 do not remove all the dust or dirt, you can spray wash the OTDR using a solution of 75% isopropyl alcohol as described in steps 4 through 8.
4. Expose the parts to be cleaned by removing easily accessible shields and panels (refer to the removal and replacement procedures given later in this chapter).
5. Spray wash dirty parts with the isopropyl alcohol solution and wait 60 seconds for the majority of the alcohol to evaporate.
6. Thoroughly rinse the parts using hot (120 to 140 degrees F) deionized water.
7. Dry all parts with low-pressure, deionized air.
8. Dry all components and assemblies in an oven or drying compartment with low-temperature (125 to 150 degrees F) circulating air.

Lubrication

Components in the FiberMaster OTDR do not require lubrication.

Terminal Interface

Some of the functional tests and performance verification procedures described in the following pages use FiberMaster's terminal interface. Access to this interface requires that you connect the OTDR to a VT-100-compatible dumb terminal, using a serial cable configured with a special connector to achieve the proper pin connections. You can make the connector yourself, using the following parts and tools:

- ❏ 25-pin DSUB male connector, solder cup, Tek part number 131-0570-00 (manufacturer: Cannon, part number DB-25P)
- ❏ 25-pin DSUB female connector, wirewrap, Tek part number 131-1437-00 (manufacturers: Cannon, part number DB25S-F179; or Souriau Inc., part number DB25S-631)
- ❏ Fine-tip soldering iron
- ❏ Wire cutters

1. Cut wirewrap pins 14 and 16 from the female connector.
2. Solder pin 2 on the female connector to pin 14 on the male connector
3. Solder pin 3 on the female connector to pin 16 on the male connector.

4. Solder pin 1, pins 4 through 13, pin 15, and pins 17 through 25 on the female connector straight across to the corresponding pins on the male connector, as shown in figure 4-2,

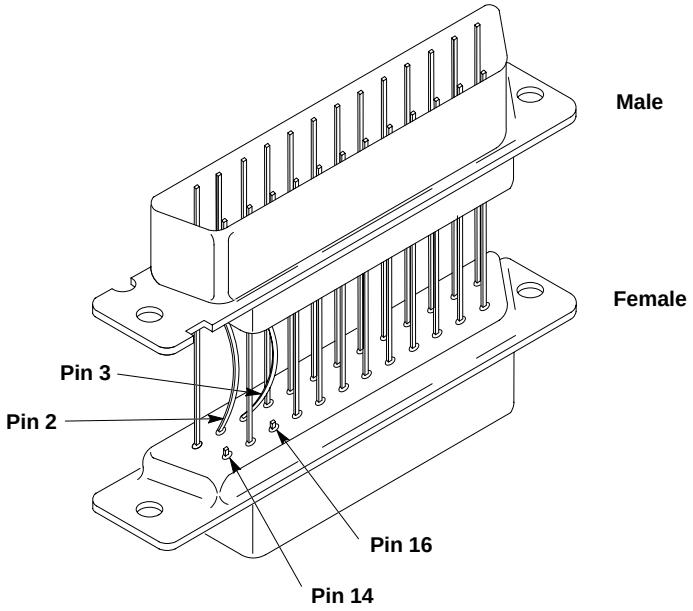


Figure 4-2. Terminal Interface Connector

Connect FiberMaster to the terminal by plugging the terminal interface connector into the RS-232 port on FiberMaster's back panel. Then plug an RS-232 cable into the connector and into the RS-232 connector on the terminal. The main menu of FiberMaster's terminal interface displays on the terminal screen.

CAUTION *When using the TFP2A terminal interface to perform functional tests and perfomance verification, restrict menu use only to those procedures given in this manual. Most of the terminal interface menus are intended for factory use only, and some of the functions can damage the instrument if used improperly.*

Functional Tests

The purpose of these procedures is to confirm that Fibermaster is functioning properly. These tests verify that the OTDR and its options are functioning. They do not verify that they operate within specified limits. Instrument operation within limits is checked in the *Performance Verification* section, which follows this section.

Mainframe Checks

Equipment required:

- ❏ External AT-compatible keyboard
- ❏ VT-100-compatible dumb terminal
- ❏ RS-232 cable with terminal interface connector
- ❏ CRT template (The template is located on a mylar sheet at the back of this manual. To use, cut out the template along its outer edge.)
- ❏ Five-kilometer multimode or singlemode test fiber

1. Connect the FiberMaster's RS-232 port to the terminal's R-S232 port.
2. Plug the external keyboard into the keyboard connector on FiberMaster's front panel.
3. Press the **POWER** button on the FiberMaster. After power-up diagnostics are complete, the start-up screen displays.

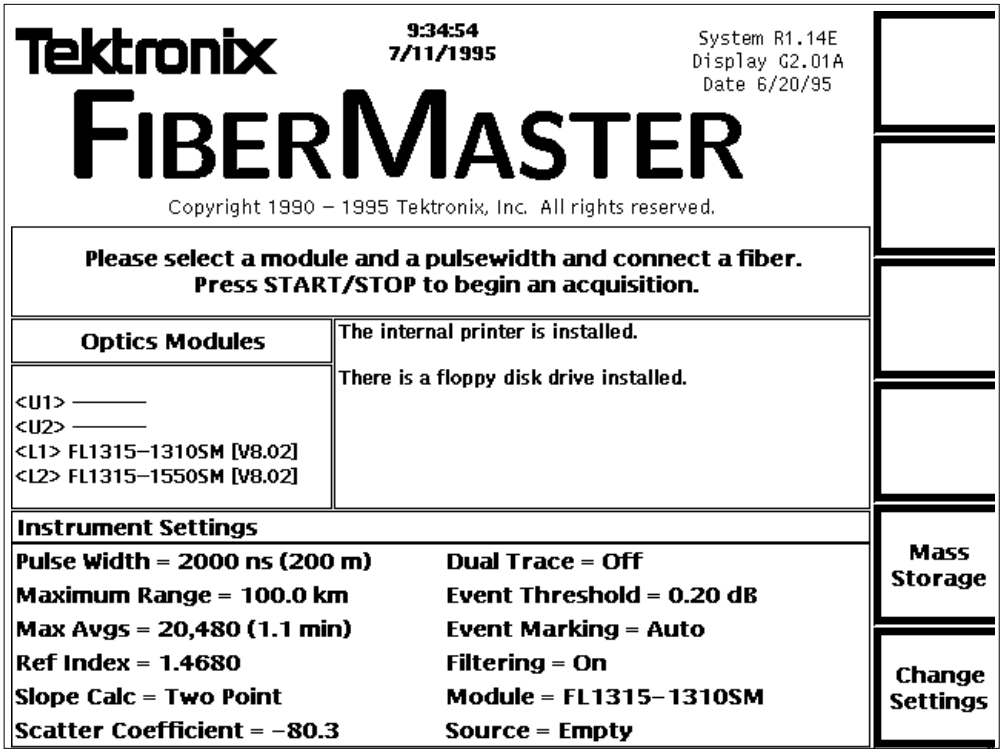


Figure 4-3. The Start-Up Screen

4. Verify the software version numbers are correct.
5. Verify that the date and time are correct.
6. Check that the display characteristics (focus, color, size, etc.) are normal. The corners of the display may be slightly out of focus, but must be legible.
7. Set the serial-port baud rates on the OTDR and the terminal to 9600 baud. Set the FiberMaster's baud rate as follows:
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Menu** softkey twice to go to the System Settings menu.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the RS-232 Baud Rate parameter is highlighted.
   - ✔ Turn the **CURSOR** knob to highlight the 9600 baud rate selection.
   - ✔ Press the **Exit** softkey to return to the start-up screen.
8. Enter the Run Diagnostics menu by pressing the **Help** and **Change Settings** softkeys simultaneously, then rotating the **CURSOR** knob.
9. Verify that there were no diagnostics failures during the power-on testing. If a failure occurred during power-on, a **Self Test** softkey displays on the start-up screen, allowing direct entry to the Run Diagnostics menu. The failed test is noted on the Run Diagnostics menu screen.
10. Turn the **CURSOR** knob until the front-panel test is highlighted on the Run Diagnostics menu. Press the **Select Test** softkey.
11. Press the **Start Test** softkey. Verify operation of all front-panel controls and keyboard. After testing the front-panel controls, press softkey 1 then softkey 3 to exit the test.
12. Display CRT alignment pattern:
    - ✔ At the terminal, the Main Menu of the terminal interface should be displayed. Type **3** on the terminal keyboard to select item 3 on the menu, **Diagnostics Menu**.
    - ✔ On the Diagnostics Menu, select item 3, **Select Display Tests**.
    - ✔ On the Display Tests menu, select item 1, **Display Hold Time**. Enter the number of seconds to display the test pattern that you will use to align the display. For example, to display the test pattern for two minutes, enter 120.
    - ✔ Select item 5, **Alignment Pattern**, and the alignment pattern displays on the CRT.
13. Place the CRT template over the display.
14. Verify that the alignment pattern closely matches the template (horizontal and vertical lines only).
15. On the FiberMaster, press the **Exit** softkey to return to the start-up screen.

16. Press the **Change Settings** softkey. The instrument enters the Waveform Settings menu.
17. Press the **Next Menu** softkey. The Operator Settings menu displays. Press **Next Param** or **Prev Param** softkey until the Fiber ID window is displayed on the screen.
18. Type in 12 to 15 characters from the external keyboard connected to the FiberMaster, and check that the same characters are displayed in the Fiber ID window.
19. Press the **Exit** softkey to return to the start-up screen.
20. Select a wavelength by pressing the **MODULE SELECT** button until the LED next to your selected optical module lights up.
21. Connect the test fiber to the connector on the selected optical module.
22. Press the **START/STOP** button to start data acquisition. The optical module LED flickers to indicate that the laser is firing, and the acquisition screen displays.
23. Check that a waveform is acquired and displayed on the acquisition screen.

Internal RAM (if installed)

1. Connect the FiberMaster's RS-232 port to the terminal's RS-232 port, using the specified cable.
2. Set the serial-port baud rates on the OTDR and the terminal to 9600 baud. Set the FiberMaster's baud rate as follows:
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Menu** softkey twice to go to the System Settings menu.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the RS-232 Baud Rate parameter is highlighted.
   - ✔ Turn the **CURSOR** knob to highlight the 9600 baud rate selection.
   - ✔ Press the **Exit** softkey to return to the start-up screen.
3. On the terminal keyboard, type **3** to select the **Diagnostics Menu** item on the Main Menu.
4. On the Diagnostics Menu, select item 4, **Select Disk Tests**.
5. Press **4** on the terminal keyboard to change the **Toggle Active Drive** selection to the fixed drive.
6. Press **A** on the terminal keyboard to select the **Data Test** option. The test stores a hex value into all the RAM memory, then reads it back and compares it to the original value. Any addresses not matching are displayed on the screen. Successful completion of the test causes the message **Data Test Passed** to be reported.
7. On the terminal keyboard, type **0** twice to return to the Main Menu.
8. On FiberMaster, press the **Mass Storage** softkey.
9. Press the **Next Menu** softkey twice to go to the Format menu.
10. Press the **Format Fixed** softkey. A prompt displays on the screen to inform you that if you format the fixed drive, all information on the drive is lost. Press the **Yes** softkey to begin formatting.
11. When formatting is complete, press **Exit** to go to the acquisition screen.

Internal Printer Test (if installed)

1. If the start-up screen or the Run Diagnostics menu is not currently displayed, cycle power to FiberMaster to display the start-up screen.
2. Press the **HELP** button and **Change Settings** softkey simultaneously to go to the Run Diagnostics menu.
3. Turn the **CURSOR** knob to highlight the Printer test.
4. Press the **Select Test** softkey.
5. Press the **START TEST** softkey.
6. The printer prints a test pattern. Check for even intensity across the full width of the print.
7. Press **Exit** to return to the start-up screen.
8. Check that the printer cover closes completely.

External Printer Test (if used)

1. From the start-up screen, press the **Change Settings** softkey.
2. Press the **Next Menu** softkey twice to go to the System Settings menu.
3. Press the **Next Param** softkey until the Hard Copy parameter is highlighted.
4. Turn the **CURSOR** knob to change the hardcopy device to the type of printer you use.
5. Press the **Exit** softkey.
6. Connect the printer cable to the appropriate connector on the back of the FiberMaster (RS-232 or GPIB).
7. Press the **HARD COPY** button and check that the external printer prints a copy of the display.

Disk Drive Test (if installed)

1. Insert a blank, unformatted floppy disk into the disk drive.
2. From the start-up screen, press the **Mass Storage** softkey.
3. Press the **Next Menu** softkey twice to go to the Format menu.
4. Press the **Format** softkey to format the floppy disk. (Note that if internal RAM is installed in your instrument you must press the **Format Removable** softkey to format the floppy disk.)
5. A prompt displays, asking you to confirm the format operation. Press the **Yes** softkey.
6. After the format is complete, remove the disk from the drive and insert it into the floppy disk drive of an IBM PC or compatible.
7. At the PC, type the following command:

   dir <drive designator>:

   In place of **<drive designator>**, type the letter designator of the floppy disk drive, usually **a** or **b**.
8. Verify that the response on the PC screen reads:

   Volume in drive <drive designator>: is FIBERMASTER

   If the PC does not display the statement above, there is a formatting problem with FiberMaster's disk drive.
9. Remove the disk from the PC drive and return it to the TFP2A.
10. Return to the FiberMaster start-up screen by cycling power to the OTDR.
11. Enter the Run Diagnostics menu by pressing the **Change Setting**s softkey and the **HELP** button simultaneously.
12. Select the mass storage tests by turning the **CURSOR** knob until the test is highlighted. Then press the **Select Test** softkey.
13. Run the mass storage tests by pressing the **START TEST** softkey.
14. Verify successful completion of the mass storage tests by pressing the **More Info** softkey.
15. Press the **OK** softkey to return to the Run Diagnostics menu, then **Exit** to return to the start-up screen.

Performance Verification

The following performance checks describe procedures to verify that FiberMaster is performing properly and meets the specifications listed in chapter 1. Optical plug-in module(s) must be installed in the TFP2A mainframe, with all covers in place, and warmed up for a minimum of 20 minutes before starting the performance verification.

Equipment Required

- ❏ 3/32 Allen wrench
- ❏ Two-kilometer singlemode or multimode test fiber
- ❏ Four-kilometer multimode test fiber
- ❏ 25-kilometer singlemode test fiber
- ❏ Jumper cables
- ❏ Tektronix DC508 (or equivalent) frequency counter
- ❏ Tektronix OA5002 (or equivalent) optical attenuator
- ❏ Tektronix OA5022 (or equivalent) optical attenuator
- ❏ Tektronix TFC200 power meter with 20-dB attenuator (FL module only)
- ❏ VT-100-compatible dumb terminal
- ❏ RS-232 cable with terminal interface connector (described in the previous *Functional Tests* section)
- ❏ Data sheets (provided in appendix A)

Clock Frequency

Equipment required:

- ❏ 3/32 Allen wrench
- ❏ Tektronix DC508 (or equivalent) frequency counter

1. Press **POWER** to turn off power to the TFP2A.
2. Remove the bottom case half from the TFP2A mainframe by removing four Allen-head screws, two on each side.
3. Press **POWER** to turn on the TFP2A.
4. Connect the DC508 frequency counter to the S40 test point located near the rear corner of the control board.
5. Verify that the frequency is 40 MHz ± 400 Hz.
6. Turn off power to the TFP2A and re-install the bottom cover of the TFP2A.

Verify Clock Phase

Equipment required:

- ❏ 3/32 Allen wrench
- ❏ 2465B oscilloscope

1. Connect the positive lead of a DMM to the VCO test point and the negative lead ground.
2. Verify the DMM read 4.0 volts (+/-.25). The VCO adjust (C40320) may be adjusted if required.
3. Connect channel A input of the 2465 oscilloscope to the PLOCK test point.
4. Connect channel B input of the 2465 oscilloscope to the SLOCK test point.
5. Set the 2465 horizontal time/div to 100 nsec/div. Set the 2465 vertical to 5 volts/div on both channels.
6. Set the 2465 triggering to channel 1. Adjust the triggering to display the pulses from the SLOCK and PLOCK test points.
7. Verify the rising edges of these pulses are less than 5 nsec apart. If greater than 5 nsec, replace the control board
8. Remove all test leads from the TFP2A.
   .

Front-Panel Loss

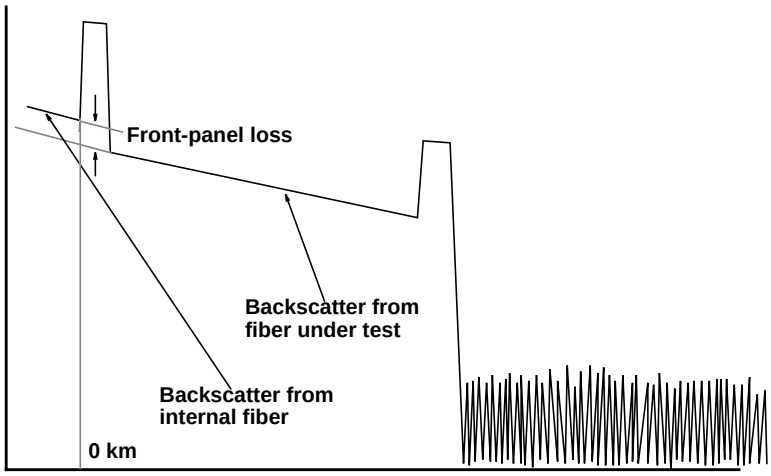


Figure 4-4. Front-Panel Loss

Equipment required:

- ❏ Two-kilometer or longer singlemode or multimode test fiber
- ❏ One-meter jumper
- ❏ Data sheet (provided in appendix A)

All dynamic range specifications assume a loss of one dB or less at the front panel. To check the front-panel loss, follow these steps:

1. Connect a four-kilometer test fiber to the FiberMaster using a one-meter test jumper.
2. Turn on power to the instrument by pressing the **POWER** button.
3. Press the **MODULE SELECT** button to choose the laser source.
4. Set the pulse width to 20 meters (2 meters for 850 nm) and the range to 50 kilometers as follows:
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
   - ✔ Turn the **CURSOR** knob to highlight the 20-meter pulse-width selection (2 meters for 850 nm).
   - ✔ Press **Next Param** to highlight the Maximum Range setting.
   - ✔ Turn the **CURSOR** knob to select the 50-km range selection.
   - ✔ Press the **Exit** softkey to return to the start-up screen.
5. Start an acquisition by pressing the **START/STOP** button.

6. Press the **Splice Loss** softkey to enter Splice Loss mode.
7. Move the distance cursor to the front-panel reflection at 0 kilometers. Expand the view if necessary for precise cursor placement by pressing the **EXPAND** button.
8. If manual adjustments to the loss cursors are necessary, use the vertical and slope **LOSS** knobs to adjust the left loss cursor to the internal fiber backscatter, and the right loss cursor to the backscatter of the fiber under test. Press the **CURSOR SELECT** button to switch between the distance cursors.
9. Note the splice loss for the front-panel reflection and record on the data sheet.
10. If the front-panel loss exceeds one dB, check the connection at the front panel and clean the connectors, or try a different jumper cable.

Dynamic Range

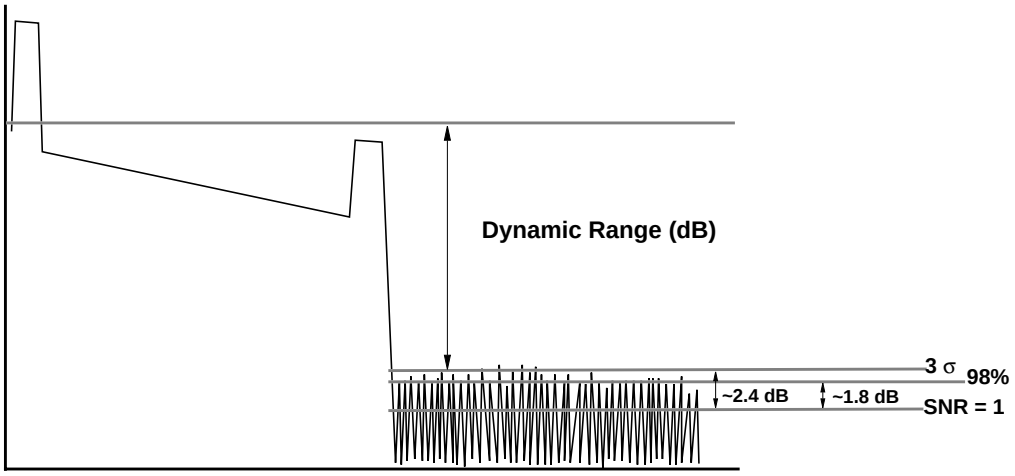


Figure 4-5. Dynamic Range Measurements

Dynamic range is defined as the difference between the backscatter level at the start of the fiber (extrapolated through the front-panel reflection to the front panel) and the noise level, as follows:

- ❏ Dynamic range, SNR = 1, measures the difference between the backscatter and the RMS noise level. This is at about the 68.3% level of the noise.
- ❏ Dynamic range, SNR = 3 sigma, measures the difference between the backscatter and the 99.5% of the noise level (i.e., one or two noise peaks may exceed this level when measuring 1000 data points of noise).
- ❏ Dynamic range, 98%, measures the difference between the backscatter and the 98% level of the noise.

There are two methods of measuring dynamic range given in the following pages. Method 1 involves an automatic calculation of the noise floor, measured via FiberMaster's terminal interface. This method requires a VT-100-compatible terminal and a special cable connection (described earlier in this chapter), and accurately establishes the noise floor. Method 2 does not need special equipment, but requires you to estimate the 98% level of the noise and can yield less precise results.

NOTE *Dynamic Range Method 1, which provides an automatic calculation of the noise floor, varies slightly when testing an FL-series optical module (vs. an FS-, FG-, or FM-type module). Therefore, two versions of method 1 for testing dynamic range are given. The first one applies to the FS-, FG-, and FM-series modules, and the second applies to the FL series.*

FS/FG/FM-Series Dynamic Range Measurement—Method 1

Equipment required:

- ❏ VT-100-compatible dumb terminal
- ❏ RS-232 cable with terminal interface connector (described in the previous *Functional Tests* section)
- ❏ Two-kilometer or longer singlemode or multimode test fiber
- ❏ Data sheet (provided in appendix A)

1. Connect the FiberMaster's RS-232 port to the terminal's RS-232 port, using the specified cable.
2. Set the serial-port baud rates on the OTDR and the terminal to 9600 baud. Set the FiberMaster's baud rate as follows:
   - ✔ Turn power on to the instrument by pressing the **POWER** button.
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Menu** softkey twice to go to the System Settings menu.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the RS-232 Baud Rate parameter is highlighted.
   - ✔ Turn the **CURSOR** knob to highlight the 9600 baud rate selection.
   - ✔ Press the **Exit** softkey to return to the start-up screen.
3. Connect the test fiber to the instrument using a one-meter jumper.
4. Select a wavelength by pressing the **MODULE SELECT** button until you reach the desired wavelength.
5. Select pulse width and maximum range settings.
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
   - ✔ Turn the **CURSOR** knob to select the pulse width.
   - ✔ Press **Next Param** to highlight the Maximum Range menu.
   - ✔ Turn the **CURSOR** knob to select the range.
   - ✔ Press the **Exit** softkey to return to the start-up screen.
6. At the terminal, the Main Menu is displayed. Type **1** on the terminal keyboard to select item 1 on the Main Menu, **RMS Settings Menu**. The Waveform RMS Settings Menu is displayed.
7. Type **2** on the terminal keyboard to turn on **Two-Point RMS**.

8. Make sure item 4 is set to **RMS Reported Average (waveform baseline)**. If the RMS Reported Average item is set to linear average, press 4 to switch to waveform baseline.
9. Type **0** to return to the Main Menu.
10. On the Main Menu, select item 2, **Acquisition Diagnostics Menu**.
11. On the Acquisition Menu, select item D, **MISC ACQUISITION ON/OFF MENU 2**.
12. On the MISC ACQUISITION ON/OFF MENU 2, select item 1 to turn on the **Use opposite laser plugin selection in acq** option. This option causes the opposite laser source to the one selected (the laser source in the non-active plug-in module) to be used in the next acquisition. The active laser source then detects only noise, allowing the instrument to calculate the noise level for that wavelength.
13. Set the number of averages to 32,768.
    - ✔ Press the **Change Settings** softkey.
    - ✔ Press the **Next Param** or **Prev Param** softkey until the Maximum Averages menu is highlighted.
    - ✔ Turn the **CURSOR** knob clockwise to increase the number of averages to 32,768.
    - ✔ Press the **Exit** softkey to return to the start-up screen.
14. Start an acquisition on the FiberMaster by pressing the **START/STOP** button.
15. Press the **Two Point** softkey to enter Two Point mode.
16. Set the distance cursors at approximately one kilometer in from the ends of the displayed range. For example, if the maximum range is set to 25 kilometers, place the distance cursors at about 1 and 24 kilometers.
17. The FiberMaster calculates the RMS noise level and displays it in the upper right-hand corner of the screen. The data might look like this:

    RMS = 2352 [4.1] (-88 [-0.2])

    The RMS (1 Sigma) noise level is given in dB in the first bracketed number; in this example, it is 4.1. Record the RMS noise level on the data sheet.
18. Repeat steps 5 and 14 through 17 for each pulse width and range as required.
19. On the terminal, the MISC ACQUISITION ON/OFF MENU 2 is still displayed. Type **1** on the terminal keyboard to turn off the **Use opposite laser plugin selection in acq** option.
20. Type **0** to go back to the Acquisition Menu, then **0** again to go to the Main Menu.
21. Type **1** to go to the Waveform RMS Settings Menu.
22. On the Waveform RMS Settings Menu, type **2** to turn off the **Two Point RMS** option, then type **0** to return to the Main Menu.

23. On the FiberMaster, set the maximum number of averages back to 1024.
    - ✔ Press the **Change Settings** softkey.
    - ✔ Press the **Next Param** or **Prev Param** softkey until the Maximum Averages menu is highlighted.
    - ✔ Turn the **CURSOR** knob counterclockwise to decrease the number of averages to 1024.
    - ✔ Press the **Exit** softkey to return to the acquisition screen.
24. Press the **CURSOR SELECT** button (if necessary) to select the right-hand distance cursor.
25. Set the active loss cursor to a straight horizontal line at 0 dB, using the **LOSS** knobs.
26. Press the **CURSOR SELECT** button to activate the left-hand distance cursor. Turn the **CURSOR** knob to move this cursor to 0 kilometers.
27. Use the **LOSS** knobs to align the active loss cursor with the backscatter.
28. Record the two-point loss figure on the data sheet. (The two-point loss is shown in dB near the active distance cursor.)
29. Calculate the dynamic range by subtracting the 1 Sigma noise level recorded in step 17 from the two-point loss recorded in step 28. Record the result on the data sheet.
30. Reset instrument settings and start a new acquisition for each pulse width and range combination on the data sheet. Repeat steps 27 through 29 each time. You do not need to reset the 0 dB level at the right-hand loss cursor for each new acquisition.
31. Repeat steps 4 through 30 for each wavelength.

FL-Series Dynamic Range Measurement—Method 1

Equipment required:

- ❏ VT-100-compatible dumb terminal
- ❏ RS-232 cable with terminal interface connector (described in the previous *Terminal Interface* section in this chapter)
- ❏ Two-kilometer or longer singlemode test fiber
- ❏ Data sheet (provided in appendix A)

1. Connect the FiberMaster's RS-232 port to the terminal's RS-232 port, using the specified cable.
2. Set the serial-port baud rates on the OTDR and the terminal to 9600 baud. Set the FiberMaster's baud rate as follows:
   - ✔ Turn power on to the instrument by pressing the **POWER** button.
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Menu** softkey twice to go to the System Settings menu.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the RS-232 Baud Rate parameter is highlighted.
   - ✔ Turn the **CURSOR** knob to highlight the 9600 baud rate selection.
   - ✔ Press the **Exit** softkey to return to the start-up screen.
3. Connect the test fiber to the instrument using a one-meter jumper.
4. Select a wavelength by pressing the **MODULE SELECT** button until you reach the desired wavelength.
5. Select pulse width and maximum range settings.
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
   - ✔ Turn the **CURSOR** knob to select the pulse width.
   - ✔ Press **Next Param** to highlight the Maximum Range menu.
   - ✔ Turn the **CURSOR** knob to select the range.
   - ✔ Press the **Exit** softkey to return to the start-up screen.
6. At the terminal, the Main Menu is displayed. Type **1** on the terminal keyboard to select item 1 on the Main Menu, **RMS Settings Menu**. The Waveform RMS Settings Menu is displayed.
7. Type **2** on the terminal keyboard to turn on **Two-Point RMS**.
8. Make sure item 4 is set to **RMS Reported Average (waveform baseline)**. If RMS Reported Average is set to linear average, press 4 to switch to waveform baseline.

9. Type **0** to return to the Main Menu.
10. On the Main Menu, select item H, **FL Module Diagnostics Menu**.
11. On the FL Module Diagnostics Menu, select item 6, **MISC ACQUISITION ON/OFF MENU**.
12. On the MISC ACQUISITION ON/OFF MENU, select item 1 to turn on the **Use opposite laser plugin selection in acq (on)** option. This option causes the opposite laser source to the one selected (the laser source in the non-active plug-in module) to be used in the next acquisition. The active laser source then detects only noise, allowing the instrument to calculate the noise level for that wavelength.
13. Set the number of averages to 262,144.
    - ✔ Press the **Change Settings** softkey.
    - ✔ Press the **Next Param** or **Prev Param** softkey until the Maximum Averages menu is highlighted.
    - ✔ Turn the **CURSOR** knob clockwise to increase the number of averages to 262,144.
    - ✔ Press the **Exit** softkey to return to the start-up screen.
14. Start an acquisition on the FiberMaster by pressing the **START/STOP** button.
15. Press the **Two Point** softkey to enter Two Point mode.
16. Set the distance cursors at approximately one kilometer in from the ends of the displayed range. For example, if the maximum range is set to 25 kilometers, place the distance cursors at about 1 and 24 kilometers.
17. The FiberMaster calculates the RMS noise level and displays it in the upper right-hand corner of the screen. The data might look like this:

    RMS = 2352 [4.1] (-88 [-0.2])

    The RMS (1 Sigma) noise level is given in dB in the first bracketed number; in this example, it is 4.1. The mean noise level appears in the second bracketed number; in the example it is -0.2. Record the RMS noise level and the mean noise level on the data sheet.
18. Repeat steps 5 and 14 through 17 for each pulse width and range as required.
19. On the terminal, the MISC ACQUISITION ON/OFF MENU is still displayed. Type **1** on the terminal keyboard to turn off the **Use opposite laser plugin selection in acq (on)** option.
20. Type **0** to go back to the FL Module Diagnostics Menu, then **0** again to go to the Main Menu.
21. Type **1** to go to the Waveform RMS Settings Menu.
22. On the Waveform RMS Settings Menu, type **2** to turn off the **Two Point RMS** option, then type **0** to return to the Main Menu.

23. On the FiberMaster, set the maximum number of averages back to 1024.
    - ✔ Press the **Change Settings** softkey.
    - ✔ Press the **Next Param** or **Prev Param** softkey until the Maximum Averages menu is highlighted.
    - ✔ Turn the **CURSOR** knob counterclockwise to decrease the number of averages to 1024.
    - ✔ Press the **Exit** softkey to return to the acquisition screen.
24. Note the baseline difference numbers reported on the VT100 terminal. These are used to adjust the baseline value to account for calibration offset.
25. Press the **CURSOR SELECT** button (if necessary) to select the right-hand distance cursor.
26. Set the active loss cursor to a straight horizontal line at 0 dB, using the **LOSS** knobs.
27. Press the **CURSOR SELECT** button to activate the left-hand distance cursor. Turn the **CURSOR** knob to move this cursor to 0 kilometers.
28. Use the **LOSS** knobs to align the active loss cursor with the backscatter.
29. Record the two-point loss figure on the data sheet. (The two-point loss is shown in dB near the active distance cursor.)
30. Calculate the dynamic range by the following formula: scattering level + front-panel loss - mean noise level - RMS noise level - baseline difference - 0.5. Record the result on the data sheet.
31. Reset instrument settings and start a new acquisition for each pulse width and range combination on the data sheet. Repeat steps 27 through 29 each time. You do not need to reset the 0 dB level at the right-hand loss cursor for each new acquisition.
32. Repeat steps 4 through 31 for each wavelength.

Dynamic Range Measurement—Method 2

Equipment required:

- ❑ FS/FG/FM series: two-kilometer or longer singlemode or multimode test fiber
- ❑ FL series: 25-kilometer singlemode test fiber
- ❑ Jumper cable
- ❑ Data sheet (provided in appendix A)

1. Turn on power to the FiberMaster by pressing the **POWER** button.
2. Connect a test fiber to the instrument using a jumper cable.
3. Select a wavelength by pressing the **MODULE SELECT** button until you reach the desired wavelength.
4. Select pulse width and maximum range settings.
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
   - ✔ Turn the **CURSOR** knob to select the pulse width.
   - ✔ Press **Next Param** to highlight the Maximum Range menu.
   - ✔ Turn the **CURSOR** knob to select the range.
5. Set the number of averages to 1024.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the Maximum Averages menu is highlighted.
   - ✔ Turn the **CURSOR** knob clockwise to increase the number of averages to 1024.
   - ✔ Press the **Exit** softkey to return to the start-up screen.
6. Press the **START/STOP** button to start an acquisition.

7. Measure the backscatter level of the fiber.

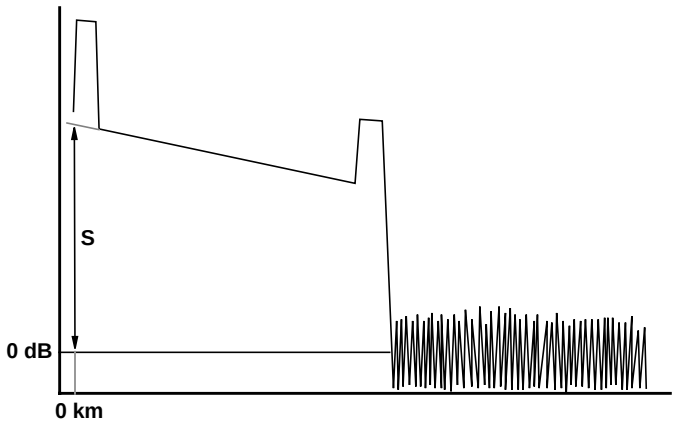


Figure 4-6. Measuring the Backscatter

   - ✔ Press the **Two Point** softkey to enter Two Point mode.
   - ✔ Move the active cursor to 0 on the distance scale.
   - ✔ Press and hold **CURSOR SELECT** to move the inactive cursor to the same position as the active cursor.
   - ✔ Press **EXPAND** to expand the view of the front-panel events and the start of the backscatter of the fiber under test.
   - ✔ Use the **LOSS** knobs to match the active loss cursor to the backscatter of the fiber under test.
   - ✔ Press **CURSOR SELECT** to switch active cursors.
   - ✔ Use the **LOSS** knobs to move the second loss cursor to a horizontal position lined up with the 0 dB level.
   - ✔ Note the two-point loss shown on the screen. This is value S, used to calculate the dynamic range.

8. Remove the fiber and jumper cable from the instrument.
9. Set the number of averages to 32,768 (FM/FG/FS) or 262,144 (FL).
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the Maximum Averages menu is highlighted.
   - ✔ Turn the **CURSOR** knob clockwise to increase the number of averages to 32,768 (FM/FG/FS) or 262,144 (FL).
   - ✔ Press the **Exit** softkey to return to the start-up screen.
10. Press **START/STOP** to start an acquisition.

11. The instrument should still be in Two Point mode. If it is not, press the **Two Point** softkey.
12. Measure the noise floor (N) as follows:

    ✔ Move the active distance cursor towards the end of the noise. Leave the cursor at a convenient location to mark the start of a section of noise that will be used to determine the 98% level of the noise.

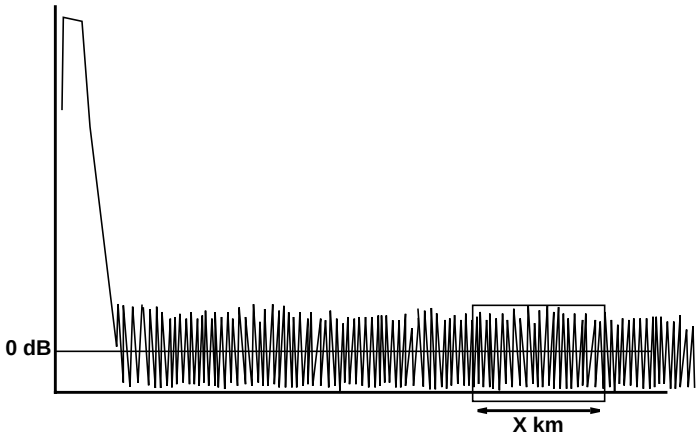


Figure 4-7. Noise Acquisition

    ✔ Press **EXPAND** to expand the view.

    ✔ Press and hold **CURSOR SELECT** to move the inactive distance cursor to the same location as the active cursor.

    ✔ Turn the horizontal **POSITION** knob to position the waveform so the cursor location is at the left edge of the screen.

✔ Turn the horizontal **SIZE** knob until the distance span (X) shown on the screen matches the appropriate value in the list below. The distance span used in this measurement depends on the wavelength and pulse width, as follows:

Table 4-3. Dynamic Range Pulse Width and Distance Span

Optical Module	Pulse Width	Distance Span
FL series	10 m	1000 m
	20 m to 50 m	2500 m
	100 m to 2000 m	5000 m
FS/FG series	5 mHR	500 m
	20 m	2500 m
	100 m to 2000 m	5000 m
FM series, 850 nm	80 cm	100 m
	10 m	1000 m
FM series, 1300 nm	5 mHR	500 m
	20 m to 100 m	2500 m

✔ Turn the vertical **SIZE** knob to expand the noise peaks.

✔ Use the **LOSS** knobs to move the active loss cursor to a horizontal position so that ten noise spikes are above the cursor as shown in figure 4-8.

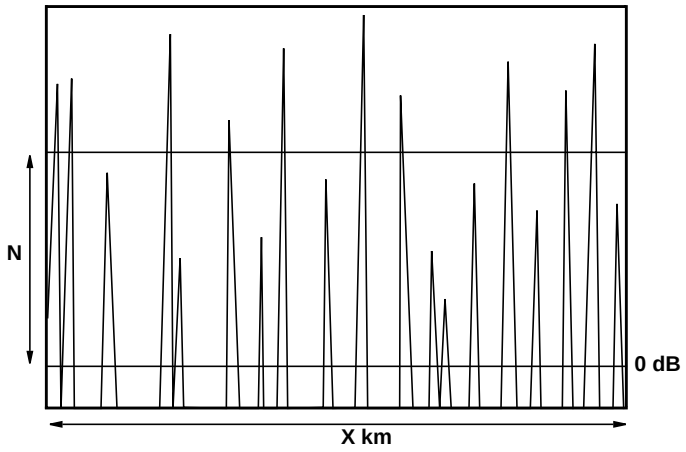


Figure 4-8. Measuring the Noise Floor

✔ Press **CURSOR SELECT** to switch active cursors.

✔ Use the **LOSS** knobs to move the second loss cursor to a horizontal position lined up with the 0 dB level.

✔ Note the two-point loss shown on the screen. This is value N, used to calculate the dynamic range.

13. Calculate the dynamic range (SNR=1) using the following equation:

    DR (SNR=1) = S - N + front-panel loss - 0.5 + 1.8

    Record the result on the data sheet.

14. Repeat steps 2 through 13 for each wavelength and pulse width/range combination.

Dead Zone (Attenuation)

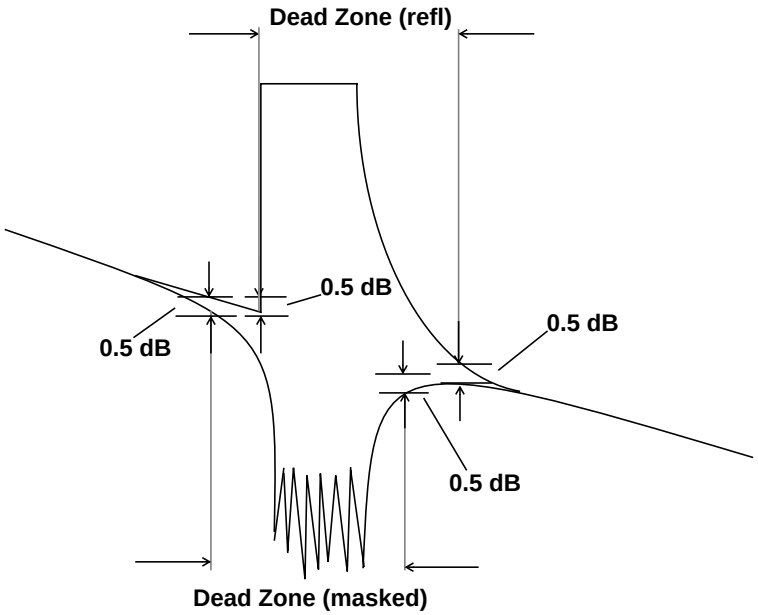


Figure 4-9. Dead Zone (Attenuation) Measurement

Dead zone, attenuation, is defined as the distance between the initial and final points where the backscatter level is disrupted more than 0.5 dB due to a single reflective event.

NOTE *To insure accurate measurements, the backscatter level should be at least 7 dB above the noise floor.*

Equipment required:

- ❏ Singlemode or multimode test fiber. The front-panel reflection must not exceed a return loss of 30 dB.
- ❏ Data sheet (provided in appendix A)

1. Connect the test fiber to the instrument.
2. Turn power on to the FiberMaster by pressing the **POWER** button.
3. Select a wavelength by pressing the **MODULE SELECT** button until you reach the desired wavelength.

4. Select pulse width and maximum range settings.
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
   - ✔ Turn the **CURSOR** knob to select the pulse width.
   - ✔ Press **Next Param** to highlight the Maximum Range menu.
   - ✔ Turn the **CURSOR** knob to select the range.
   - ✔ Press the **Exit** softkey.
5. Press the **START/STOP** button to start an acquisition.
6. Press the **Two Point** softkey to enter Two Point mode.
7. Use the waveform **POSITION** knobs to adjust the waveform position to place the front-panel Fresnel reflection at center screen.
8. Turn the **CURSOR** knob to place the active distance cursor at the point where the waveform first deviates by 0.5 dB from the backscatter level prior to the reflection.
9. Press the **CURSOR SELECT** button to switch active cursors, and move the new active distance cursor to the point where the waveform first returns to within 0.5 dB of the backscatter level after the reflection.
10. Read and record the two-point distance value. This is the attenuation dead zone for the current instrument settings.
11. Repeat steps 2 through 10 for each wavelength and pulse width necessary.

NOTE *For FS-series optical modules, masking may be required to obtain the specified dead zones. For detailed instructions on how to use FiberMaster's masking function, refer to the* FiberMaster User Manual*.*

Dead Zone (Event)

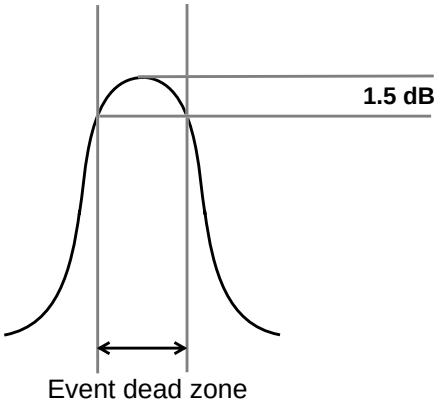


Figure 4-10. Dead Zone (Event) Measurement

Dead zone, event (two-point spatial resolution), is defined as the minimum distance after any reflection necessary to determine accurately the distance to another event (based on a minimum recover of 1.5 dB down from the top of the first reflection).

Equipment required:

- ❑ Singlemode or multimode test fiber
- ❑ Data sheet (provided in appendix A)

1. Connect the test fiber to the instrument.
2. Turn power on to the FiberMaster by pressing the **POWER** button.
3. Select a wavelength by pressing the **MODULE SELECT** button until you reach the desired wavelength.
4. Select pulse width and maximum range settings.
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
   - ✔ Turn the **CURSOR** knob to select the pulse width.
   - ✔ Press **Next Param** to highlight the Maximum Range menu.
   - ✔ Turn the **CURSOR** knob to select the range.
   - ✔ Press the **Exit** softkey.
5. Press the **START/STOP** button to start an acquisition.
6. Press the **Two Point** softkey to enter Two Point mode.

7. Turn the **CURSOR** knob to position the active distance cursor at the center of the Fresnel reflection of the front-panel connector (0 meters).
8. Press and hold the **CURSOR SELECT** button to move the other distance cursor to the same position as the active cursor.
9. Use the **LOSS** knobs to position the loss cursor on the active distance cursor horizontally, 1.5 dB down from the peak level of the reflection.
10. Press **CURSOR SELECT** to activate the other distance cursor, and use the **LOSS** knobs to position the loss cursor at the new active distance cursor on the same horizontal line, 1.5 dB down from the top of the reflection.
11. Turn the **CURSOR** knob to move the active distance cursor to the point on the leading edge of the pulse where the 1.5 dB loss marker intersects the leading edge.
12. Press **CURSOR SELECT** to switch active distance cursors and turn the **CURSOR** knob to position the new active cursor to the point on the trailing edge of the pulse where the 1.5 dB loss marker intersects the trailing edge.

NOTE *With FM-, FS-, and FG-series modules, for some pulse widths, it may be necessary to expand the window and acquire high-density data to obtain accurate measurements.*

13. Read the two-point distance. This is the event dead zone for the current instrument settings. Record on the data sheet.
14. Repeat steps 3 through 13 for each wavelength and pulse width/range combination listed on the data sheet.

Displayed Noise <0.030 dB (FS/FG series only)

Equipment required:

❑ 25-km singlemode test fiber

1. Connect a 25-km singlemode fiber to the optical module under test.
2. Press the **MODULE SELECT** button to select the optical module and wavelength.
3. Select pulse width and maximum averages settings.
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
   - ✔ Turn the **CURSOR** knob to select the 20-meter pulse width.
   - ✔ Press **Next Param** twice to display the Maximum Averages menu.
   - ✔ Turn the **CURSOR** knob to set the number of averages to 32,768.
   - ✔ Press the **Exit** softkey.
4. Press the **Two Point** softkey to enter Two Point mode.
5. Press **START/STOP** to start a new acquisition.
6. With the distance cursor positioned on a section of backscatter 4 to 8 km from the front panel, turn the window **SIZE** knobs to decrease the expansion window to the smallest possible size.
7. Press **EXPAND**.
8. Adjust the horizontal **SIZE** knob so approximately 2 km of backscatter is displayed.
9. Turn the **LOSS** knobs to align the active loss cursor with the displayed backscatter signal.
10. Press and hold the **CURSOR SELECT** button to join the loss cursors.

11. Use the vertical **LOSS** knob to position the loss cursors to measure the difference between the top and bottom variations in the backscatter. Note the two-point loss measurement. See figure 4-11.

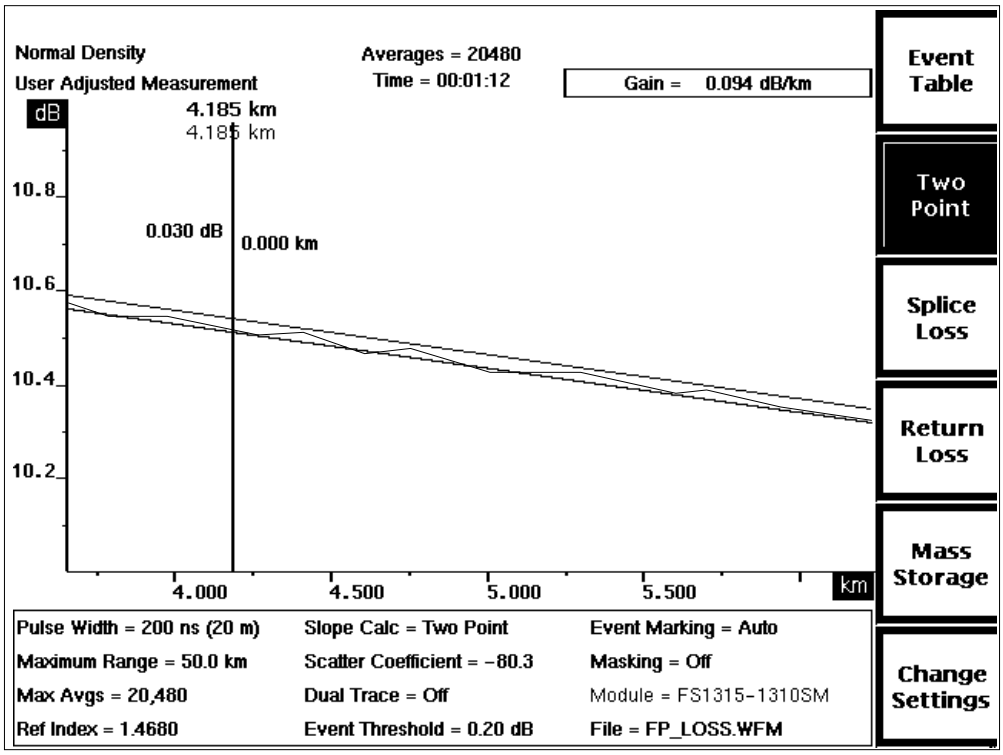


Figure 4-11. Loss Cursors Measuring Noise

NOTE *Ignore noise spikes and measure only the peak-to-peak value of the cyclic portion of the signal.*

12. This peak-to-peak noise must be 0.030 dB or less. If it is greater than 0.030 dB, verify that the signal being measured is greater than 20 dB, and that masking is off. It may be necessary to move closer to the beginning of the waveform to perform this test.

13. Repeat steps 1 through 12 for each FS- and FG-type singlemode wavelength installed.

Zero Distance Accuracy

Accurate distance measurements between two points are based upon the accuracy of the internal timebase in the TFP2A mainframe. The accurate placement of the range zero is critical to making absolute distance measurements. Each bandwidth of the receiver section of the optical module has different risetime characteristics, so each bandwidth must be verified on each wavelength. Pulse widths and performance requirements are given in the following table.

Table 4-4. Distance Accuracy Tolerance

	Tolerance	
FG & FS 1310/1550 distance accuracy tolerance *use 50k max range or less unless noted otherwise)		
2HR	+/- 1m	
5m	+/- 1m	
100	+/- 2m	(use 100km range)
400	+/- 8m	(use 100km range)
FM 850 distance accuracy tolerance (use 10k max range)		
30cm	+/- 1m	
80cm	+/- 1m	
2m	+/- 2m	
FM 1300 distance accuracy tolerance (use 50k max range)		
2HR	+/- 1m	
5m	+/- 1m	
100	+/- 4m	
FL 1310 & 1550 distance accuracy tolerance (use 200k max range)		
10m	+/- 2m	
100	+/- 10m	
400	+/- 10m	
2000m	+/- 10m	

1. Select the pulse width shown in Table 4-4 for the module under test.

   ✔ Press the **Change Settings** softkey.

   ✔ Press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.

   ✔ Turn the **CURSOR** knob to select the pulse width.

   ✔ Press the **Exit** softkey.

2. Connect a 2km (4km for the FL series) of the appropriate type (singlemode or multimode) to the front panel.
3. Press the **START/STOP** button to start an acquisition.
4. When the acquisition is displayed on screen, position the active cursor near the end reflection of the 2km (4km) fiber. Press **CURSOR** to select the other cursor and position it at **ZERO** meters and press **EXPAND**.
5. Rotate the Horizontal **SIZE** knob until the message **Press START/STOP to Acquire High Density Data** appears on screen. Press **START/STOP**. Verify the **ZERO** point is within specifications as shown in Figure 4-12.
6. Press the **CURSOR** button to select the other cursor. If high density data is not displayed, press **START/STOP** to acquire high density data. Position this cursor at the point where the rising edge of the fiber end reflection just begins to rise from the scattering signal (at the knee). Note the distance reading at the top of the cursor (absolute distance).
7. Select the desired pulse width to be tested. Press **START/STOP**. When the acquisition is displayed, expand the display until **Press START/STOP to Acquire High Density Data** appears. Press **START/STOP**.
8. When high density data is displayed, position this cursor where the rising edge of the fiber end reflection just begins to rise from the scattering signal (at the knee). Verify this distance is the same as the distance noted in step 6 above (+/- the tolerance shown in Table 4-4).
9. Repeat steps 1 through 8 for each pulse width listed in Table 4-4..

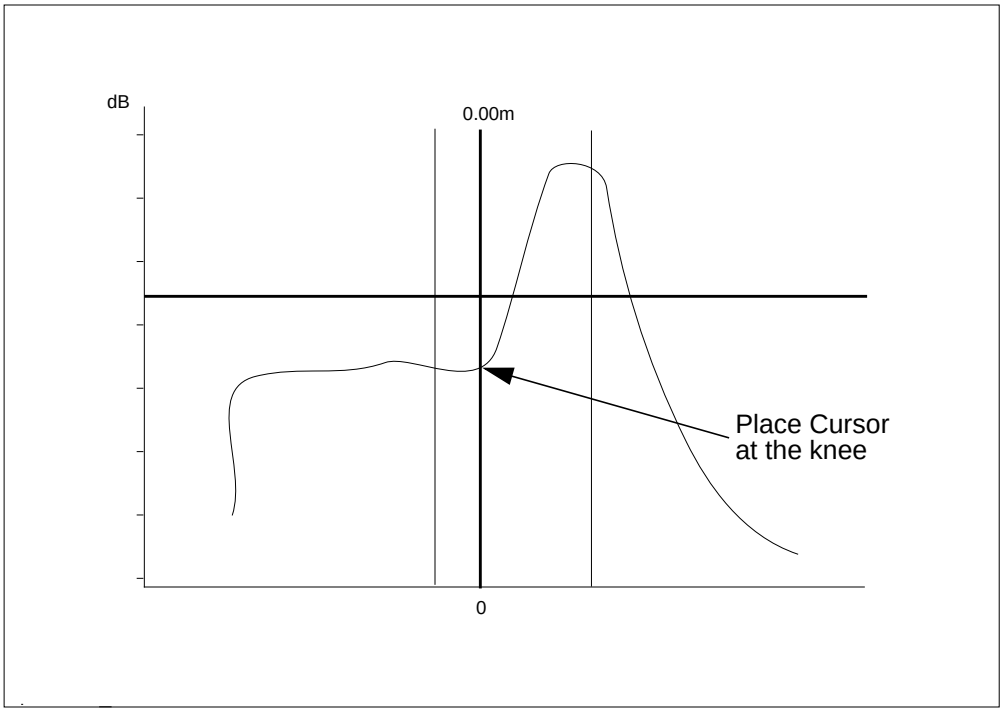


Figure 4-12. Zero Distance Measurement

Vertical System Linearity

Vertical system linearity is verified using two different techniques. One is used to establish traceability to a traceable standard, and the other is used to verify that there are no small non-linearities in the system that may not be exhibited when performing the loss measurement accuracy tests.

Both techniques use a spool of optical fiber and an optical attenuator. The optical fiber should have a constant loss throughout its length, with no events or localized variations in loss.

If you must use a fiber without a constant loss or with localized variations, take extra care to ensure these loss variations are not interpreted as system non-linearities. You can identify loss variations associated with the fiber by comparing the displayed backscatter at a given pulse width with the displayed backscatter at a different pulse width. Loss variations attributable to the fiber remain at a fixed distance, while those attributable to the vertical system remain at a fixed vertical level and the distance to them changes with the pulse width.

The following paragraphs describe (1) how to distinguish fiber-loss variations from vertical-system variations, (2) how to measure system non-linearities, (3) how to verify that there are no small non-linearities in the vertical system, and (4) how to verify loss measurement accuracy.

Distinguishing between Fiber Loss Variations and Vertical System Variations

Equipment required:

❑ 25-km singlemode or 4-km multimode test fiber

1. Turn on power to the TFP2A by pressing the **POWER** button. Allow the instrument a 20-minute warm-up period.
2. Connect the test fiber to the appropriate front-panel connector, and press **START/STOP** to acquire a waveform.
3. Store the displayed backscatter signal in memory by pressing the **STORE** button.
4. Select a new pulse width and turn on dual-trace mode.
   - ✔ Press the **Change Settings** softkey.
   - ✔ The Pulse Width parameter on the Waveform Settings menu should be the first one displayed. If not, press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
   - ✔ The currently selected pulse width is highlighted on the Pulse Width pop-up window. Turn the **CURSOR** knob to select the next longer pulse width.
   - ✔ Press the **Next Param** softkey until the Dual-Trace pop-up window appears.
   - ✔ Turn the **CURSOR** knob to turn dual-trace mode on.
   - ✔ Press the **Exit** softkey to return to the acquisition screen.

5. Press **START/STOP** to begin a new acquisition. The new acquisition is displayed concurrently with the stored waveform.

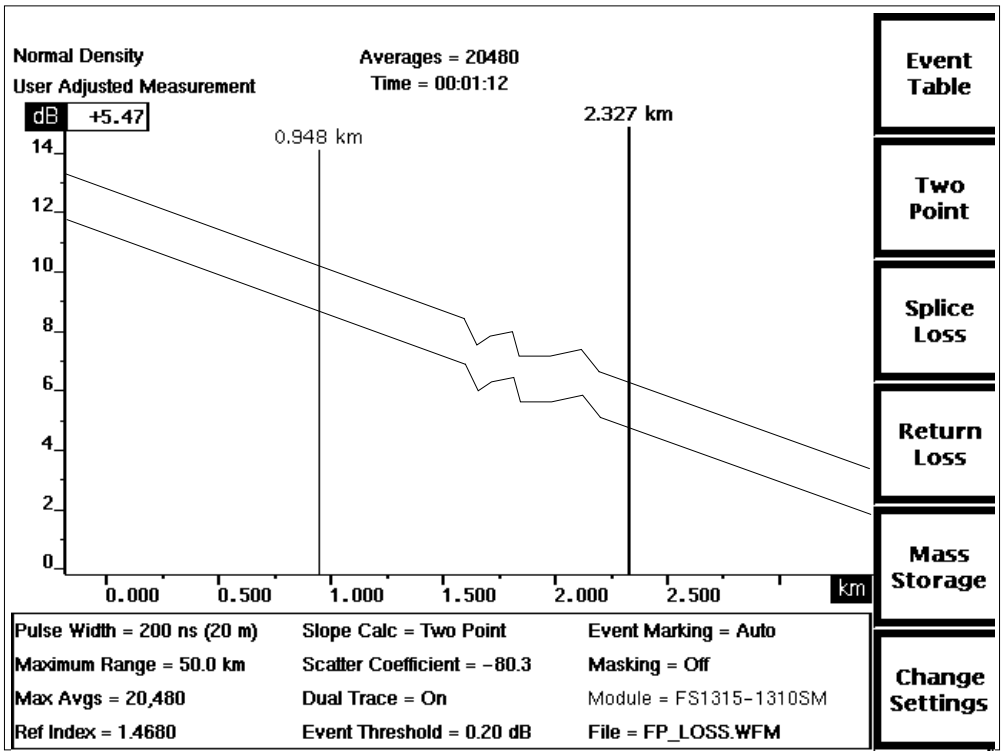


Figure 4-13. Two Acquisitions with Loss Variations

6. When the acquisition is complete, position the new waveform over the previous acquisition, using the vertical **POSITION** knob.

7. If the loss variation appears on both waveforms at the same distance, the loss variation is a result of a variation in the fiber.

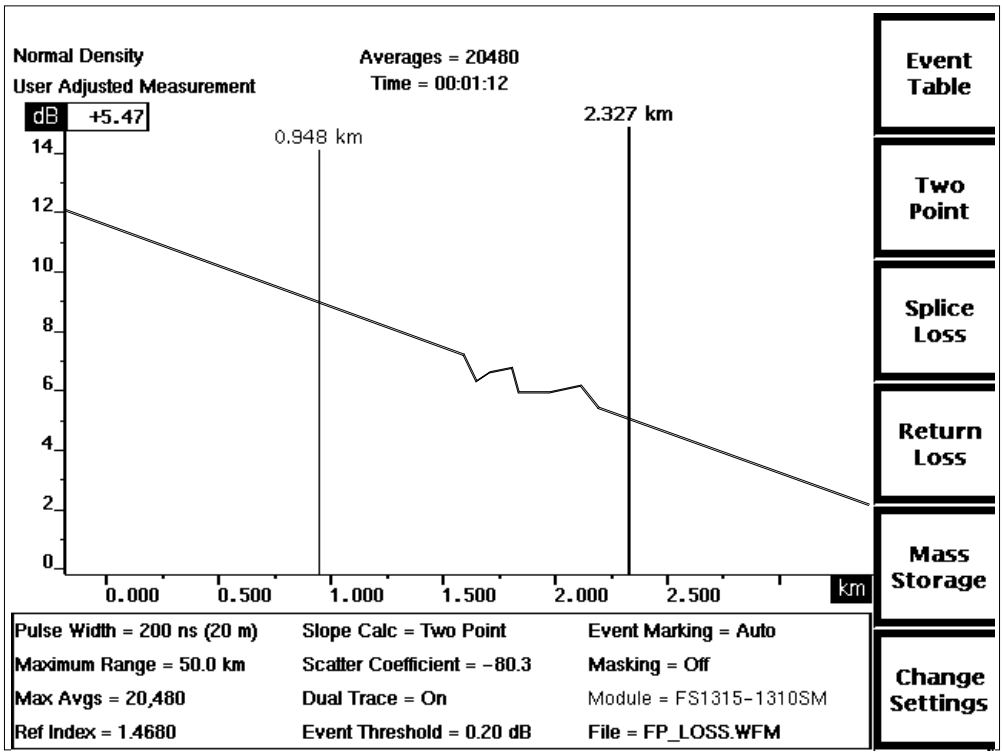


Figure 4-14. Waveforms Superimposed: Variation in Fiber

8. If the loss variation has moved to a different distance, the variation is attributable to the vertical system. In this case, the amount of variation must be measured to ensure that vertical system linearity is within specification.

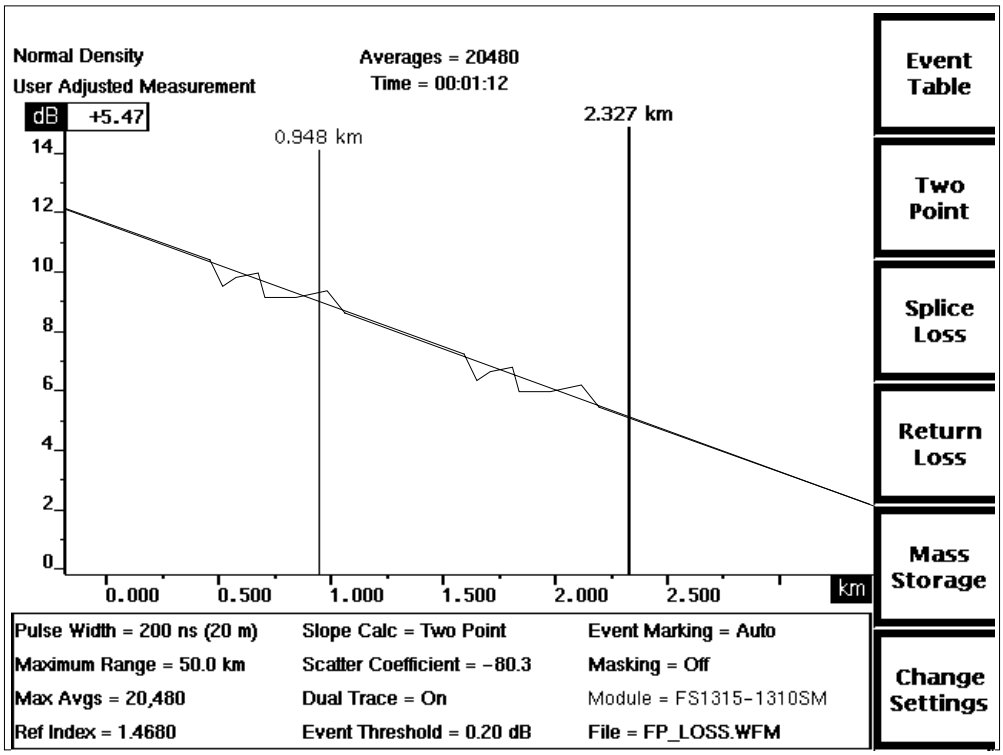


Figure 4-15. Waveforms Superimposed: Variation in Vertical System

Measurement of Vertical System Linearity

Equipment required:

❑ 25-km singlemode or 4-km multimode test fiber

1. After verifying the displayed loss variation is due to a vertical system non-linearity, and not a variation in the fiber, store the acquisition with the variation by pressing the **STORE** button.

2. Select another pulse width, and change the number of averages used for an acquisition.

   ✔ Press the **Change Settings** softkey.

   ✔ Press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.

   ✔ The currently selected pulse width is highlighted on the Pulse Width pop-up window. Turn the **CURSOR** knob to select the next longer pulse width.

   ✔ Press **Next Param** until the Max Averages menu is highlighted. Turn the

CURSOR knob to set the number of averages to 4096.

✔ Press the **Exit** softkey to return to the acquisition screen.

3. Press **START/STOP** to start a new acquisition.
4. When the acquisition is complete, position the latest acquisition over the stored waveform, using the vertical **POSITION** knob. The variation should now be superimposed over a linear section of the new acquisition (or vice versa).
5. Turn the **CURSOR** knob to position the active distance cursor near the loss variation to be measured. Turn the window **SIZE** knobs to adjust the expansion window to cover a distance of about three to four kilometers on each side of the variation (horizontally), and to include all the displayed waveform within the selected distance (vertically).
6. Press the **EXPAND** button. Make sure the waveforms are positioned approximately in the center of the screen, and superimposed over each other.

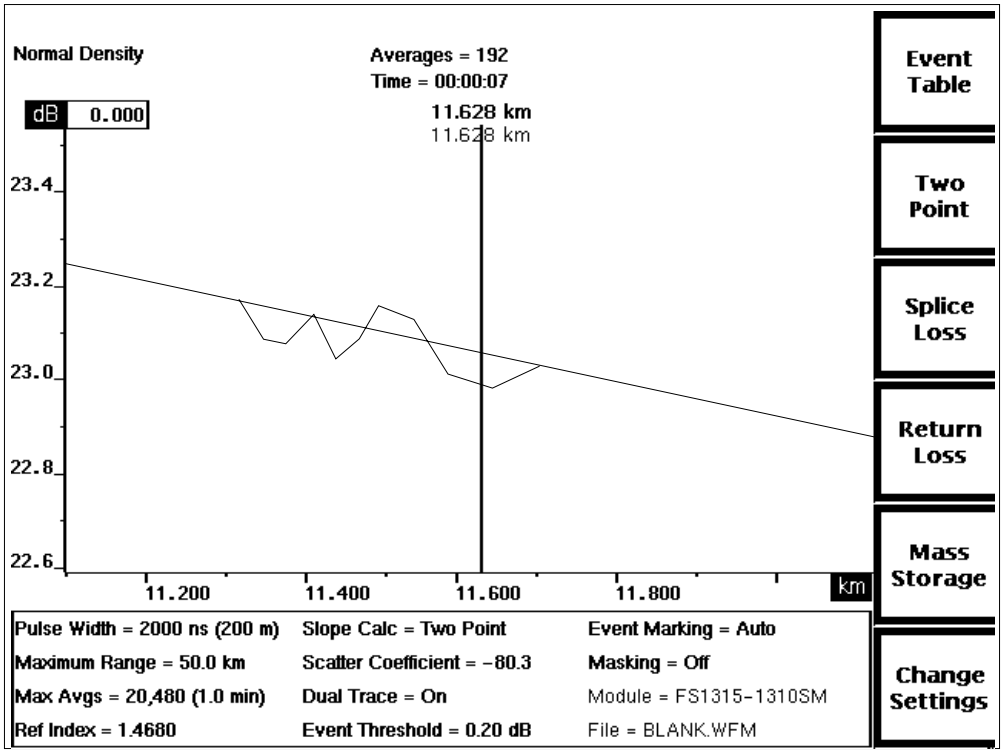


Figure 4-16. Variation Superimposed on Linear Backscatter

7. Press the **Two Point** softkey.
8. Turn the **CURSOR** knob to position the active distance cursor near the center of the variation. Press and hold the **CURSOR SELECT** button to move the inactive distance cursor to the same position as the active cursor.

9. Turn the slope **LOSS** and vertical **LOSS** knobs to position the active loss cursor parallel to the displayed acquisitions. Press and hold **CURSOR SELECT** to join the loss cursors.

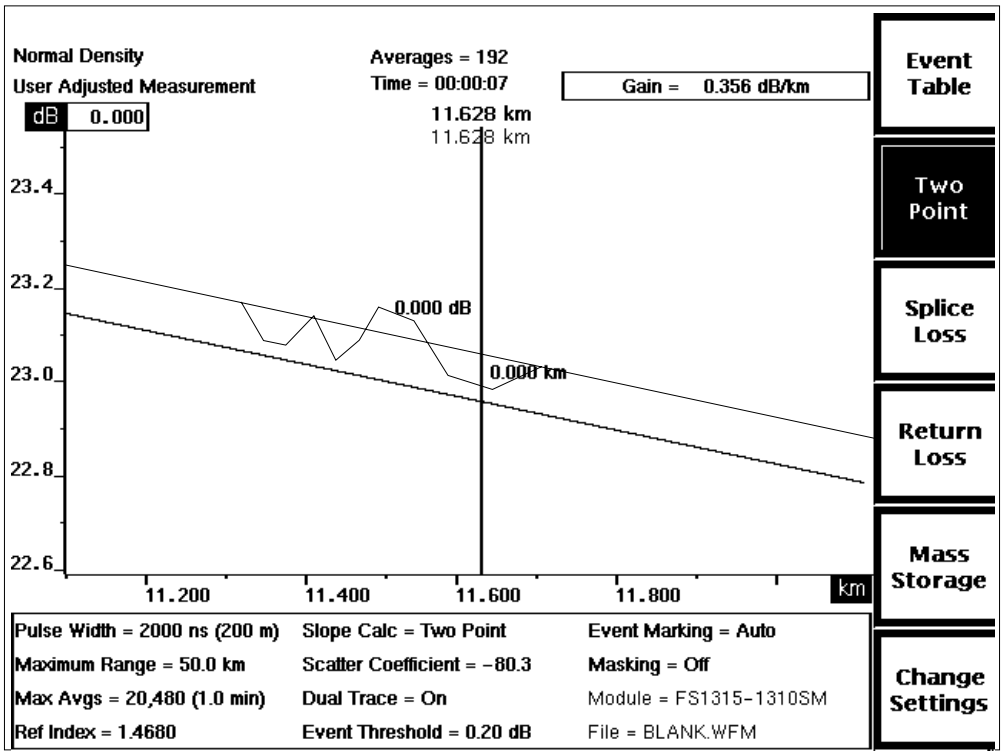


Figure 4-17. Two-Point Cursors Parallel to Waveforms

10. Use the vertical **LOSS** knob to move the active loss cursor even with the most positive going portion of the loss variation.

11. Press **CURSOR SELECT** to switch cursors, then use the vertical **LOSS** knob to position the second loss cursor directly over the reference waveform (the waveform without loss variation).

12. To measure the positive going non-linearity, read the two-point loss measurement displayed on the screen.

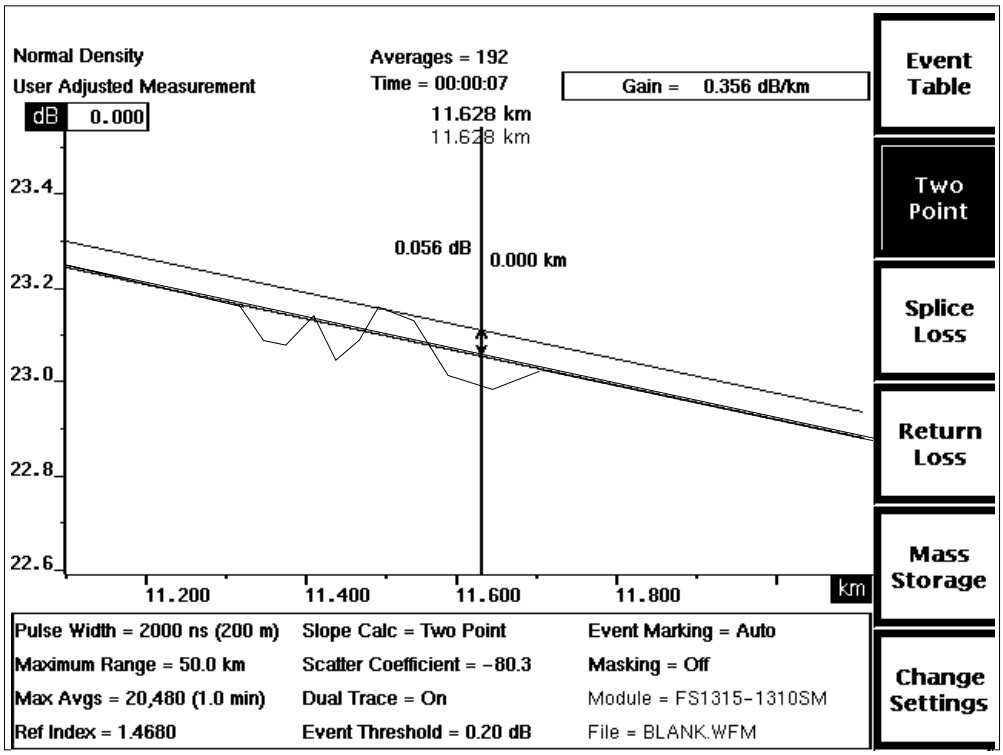


Figure 4-18. Measuring Positive Non-Linearity

13. Press **CURSOR SELECT** to switch cursors again, then use the vertical **LOSS** knob to position the loss cursor even with the most negative going portion of the variation.

14. To measure the negative going non-linearity, read the two-point loss measurement displayed on the screen.

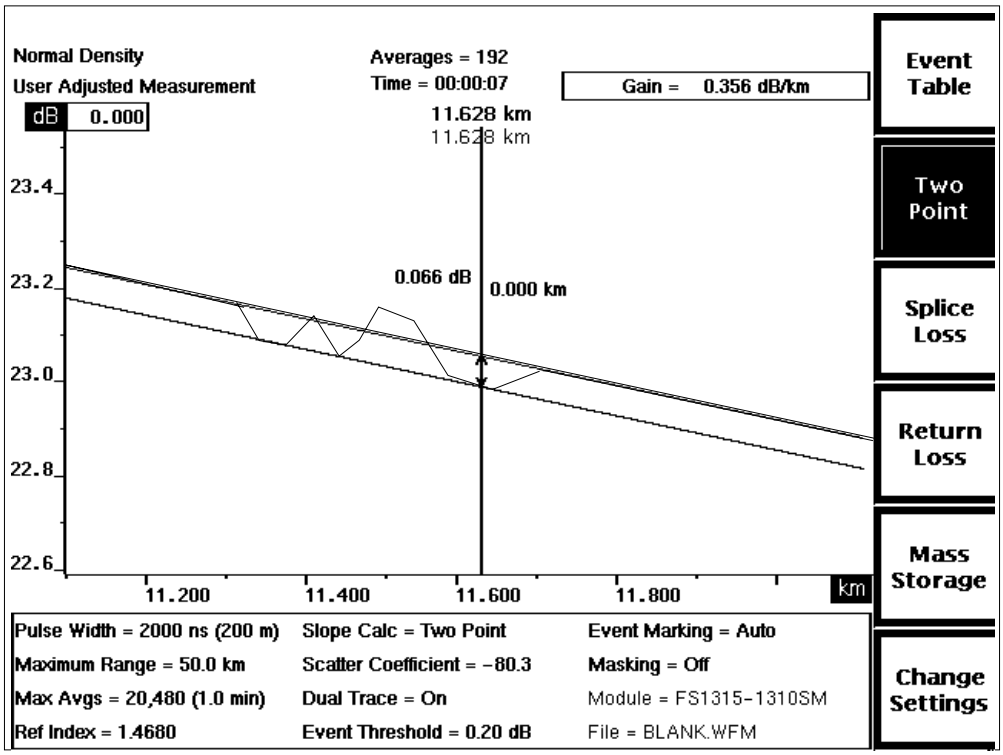


Figure 4-19. Measuring Negative Non-Linearity

Verify No Small Non-Linearities in the Vertical System (FS/FG/FM only)

Equipment required:

- ❑ 25-km singlemode or 4-km multimode test fiber
- ❑ Jumper cable
- ❑ Tek OA5002 (or equivalent) optical attenuator for singlemode modules
- ❑ Tek OA5022 (or equivalent) optical attenuator for multimode modules

1. Install the optical module to be verified into the TFP2A mainframe.
2. Turn on power to the TFP2A.
3. Connect one end of an optical jumper cable to the front-panel connector of the optical module.
4. Connect the other end of the jumper cable to the input of the optical attenuator (OA5002 for singlemode, OA5022 for multimode)
5. Connect the spool of fiber to the output of the optical attenuator.

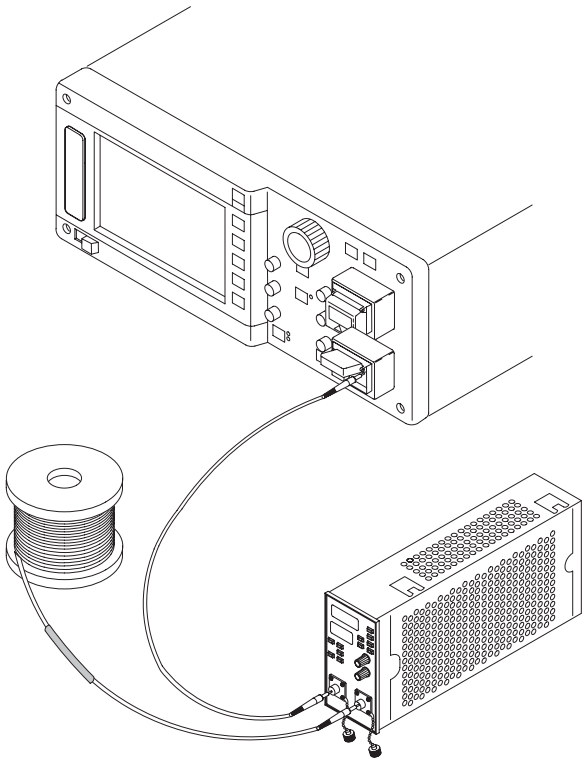


Figure 4-20. Test Set-Up with Optical Attenuator

6. Set the attenuator to zero attenuation.
7. On the TFP2A, press the **MODULE SELECT** button to select the desired wavelength.
8. Set pulse width, maximum range, and number of averages.

- ✔ Press the **Change Settings** softkey.
- ✔ The Pulse Width window should be the first one displayed when you enter the Waveform Parameters menu. If not, press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
- ✔ Turn the **CURSOR** knob to select the 50-meter pulse width (or 2-meter pulse width for 850 nm).
- ✔ Press **Next Param** to display the Maximum Range window. Turn the **CURSOR** knob to choose a maximum range greater than the length of the spool of fiber.
- ✔ Press **Next Param** to display the Max Averages window. Turn the **CURSOR** knob to set the number of averages to 4096.
- ✔ Press the **Exit** softkey to return to the acquisition screen.

9. Press **START/STOP** to begin data acquisition.
10. When the acquisition is complete, turn the **CURSOR** knob to position the active distance cursor near the center of the displayed backscatter.
11. Press **EXPAND**. Turn the waveform **POSITION** knobs to position the backscatter to cover the majority of the screen.

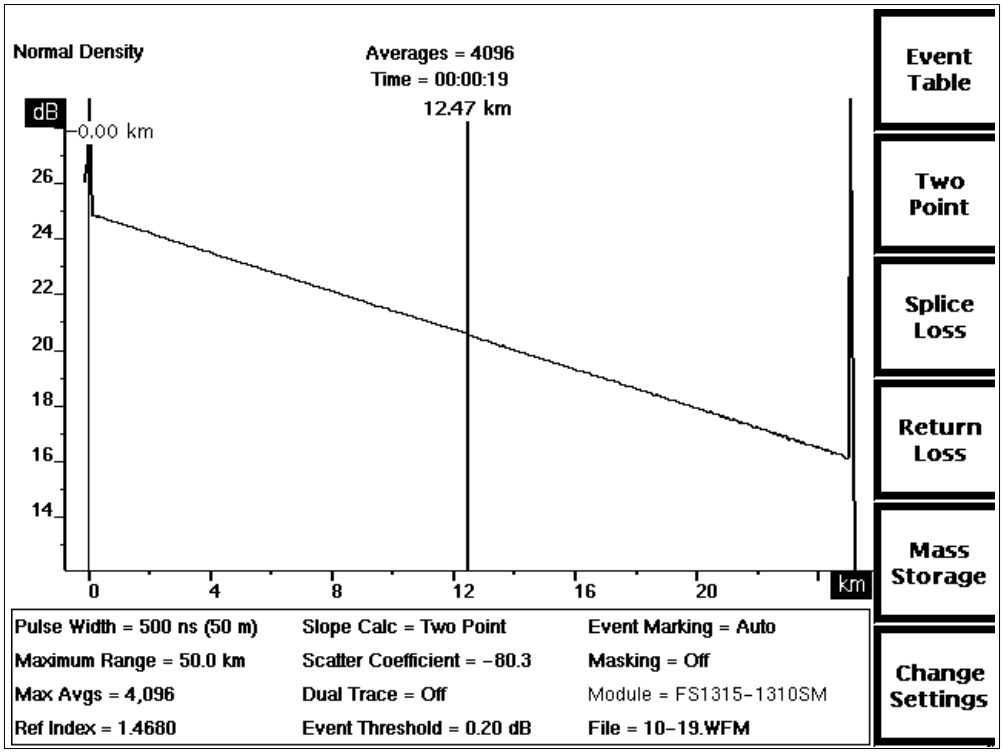


Figure 4-21. Backscatter on Reference Waveform

12. Press **STORE**. This is now the reference waveform that will be compared against other acquisitions.
13. Change the pulse width.
    - ✔ Press the **Change Settings** softkey.
    - ✔ Press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
    - ✔ Turn the **CURSOR** knob to select the longest available pulse width.
14. Turn on dual-trace mode.
    - ✔ Press the **Next Param** softkey until the Dual Trace menu is highlighted.
    - ✔ Turn the **CURSOR** knob to turn on dual-trace mode.
    - ✔ Press the **Exit** softkey to return to the acquisition screen.
15. Press **START/STOP** to start a new acquisition.
16. When the acquisition is complete, position the active waveform over the reference waveform using the waveform **POSITION** knobs. Measure the maximum non-linearities displayed on the screen. *(Refer to the previous sections on the measurement of non-linearities and differentiating between fiber irregularities and system non-linearity.)* Record this value.

NOTE *It is possible that the stored reference acquisition contains irregularities associated with system non-linearities. If this is suspected, obtain a reference acquisition using a different pulse width.*

17. Position the active cursor near the beginning of the displayed backscatter, using the **CURSOR** knob. Press **CURSOR SELECT**, then turn the **CURSOR** knob to place the second distance cursor near the end of the the displayed backscatter.
18. Press the Two Point softkey.
19. Read the two-point loss value from the display. Subtract 0.5 dB from this value.
20. Increase the attenuator attenuation by the value obtained in the previous step.
21. Press the **START/STOP** button to start a new acquisition.
22. Repeat steps 16 through 21 until the attenuation setting results in the low end of the displayed backscatter going lower than 20 dB on the screen.
23. Repeat steps 16 through 22 for pulse width shown in the table below for the selected wavelength. Verify that no small non-linearities exceed 0.05 dB.

24. Select the next wavelength by pressing the **MODULE SELECT** button. Repeat steps 3 through 23 for each wavelength installed.

Table 4-5. Small Linearity Pulse Width Settings

Wavelength	Pulse Widths
850 nm multimode	10 m, 80 cm, 30 cm
1300 nm multimode	100 m, 50 m, 5 mHR
1310 nm singlemode	1 km, 200 m, 50 m, 5 mHR
1550 nm singlemode	1 km, 200 m, 50 m, 5 mHR

Loss Measurement Accuracy (FS/FG/FM only)

Equipment required:

- ❏ 25-km singlemode test fiber for singlemode units
  4.4-km multimode test fiber (62.5/125) for multimode units
- ❏ Jumper cables. One suitable to interface between the optical module and optical attenuator and one to interface between the optical attenuator and the fiber fixture.
- ❏ Singlemode optical attenuator with known characterized linearity (for singlemode units)
- ❏ Multimode optical attenuator with known characterized linearity (for multimode units)

1. Install the optical module to be verified into the TFP2A mainframe.
2. Turn on power to the TFP2A and allow the instrument to warm up 20 minutes.
3. Connect one end of an optical jumper cable to the optical port on the front of the optical module. (62.5/125 for multimode, 9/125 for singlemode)
4. Connect the opposite end of the cable to the input of the optical attenuator.

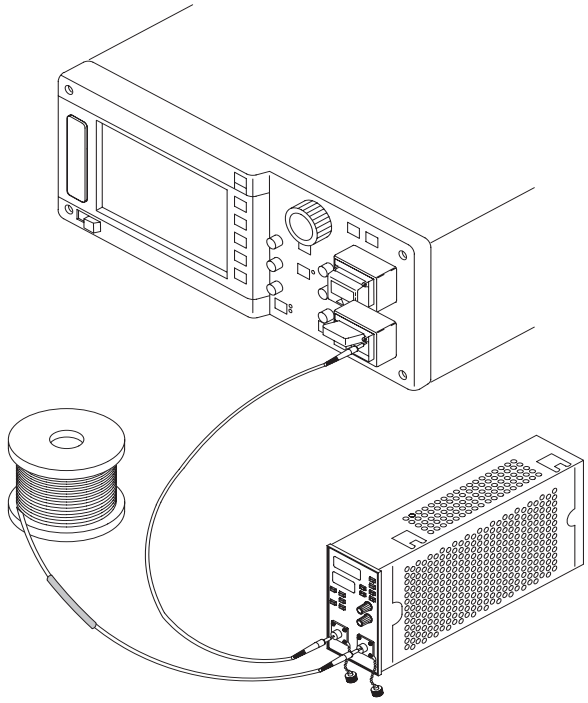


Figure 4-22. Test Set-Up with Optical Attenuator

5. Connect an optical jumper cable from the output of the attenuator to the input of the spool of optical fiber. See Figure 4-22.
6. On the TFP2A, press **MODULE SELECT** to select the desired wavelength.

7. On the TFP2A, press **CHANGE SETTINGS.** Select the longest pulse width, set maximum averages to 4096 and set maximum range to a setting longer than the length of the fiber on the spool.
8. Press **EXIT**.
9. Set the optical attenuator to the same wavelength as in step 6.
10. Set the optical attenuator to zero attenuation..
11. Press **START/STOP** to acquire an acquisition. (The acquisition must be allowed to finish completely)
12. Use the **CURSOR** knob to place the active cursor on the end reflection of the backscatter displayed on-screen. (Place the cursor in the middle of a flat top refection and at the peak of a round reflection)
13. Press and hold the **CURSOR SELECT** button to join both cursors.
14. Press the **EXPAND** button to view the top of the reflection. (High density data may be required on short pulse widths)
15. Press the **TWO POINT** button. Rotate the vertical **LOSS** knob one detent then rotate the knob back so the Two Point Loss reads 0.00 dB.
16. Rotate the **LOSS** knob to position the loss cursor at the 30 dB point. (25 dB for 5m high resolution, 80 cm and 30 cm pulse widths)

    If the reflection is less than 30 dB (or 25 dB) the possible causes are:

    - ✔ Poor or dirty optical connection. Clean all connections.
    - ✔ Fiber spool too long. Use a shorter spool.
    - ✔ Far end (of fiber spool) connector reflection too low. Add a jumper cable with a high reflection to the far end.
17. Adjust the optical attenuator to the Two Point reading displayed on the TFP2A.
18. Press **START/STOP** on the TFP2A to acquire new data.
19. Repeat steps 14 through 16 until the top of the reflection is exactly at the 30 dB point. (25 dB for 5 m high resolution, 80 cm, and 30 cm pulse widths)
20. Press the **TWO POINT** button. Rotate the vertical **LOSS** knob one detent, then rotate the knob back so the **TWO POINT** loss reads 0.00 dB.
21. Increase the optical attenuator by 15 dB. If the original reflection height was below 30 dB as is step 16, increase the attenuation to get to the 15 dB point).
22. Press **START/STOP** to acquire a new acquisition.
23. When the acquisition is complete, rotate the vertical **LOSS** knob to place the active loss marker on the top of the reflection. Verify the loss reading on-screen is 15 dB +/-.20 dB or equal to the attenuation set.
24. Press **MODULE SELECT** and select the second wavelength (if installed) and return to step 7.

25. Repeat steps 7 through 23 for each remaining pulse width.

Table 4-6. Loss Measurement Accuracy Pulse Width Settings

Module Wavelength	Pulse Widths
850 nm multimode	10 m, 80 cm, 30 cm
1300 nm multimode	100 m, 50 m, 5 mHR
1310 nm singlemode	1 km, 200 m, 50 m, 5 mHR
1550 nm singlemode	1 km, 200 m, 50 m, 5 mHR

Loss Measurement Accuracy (FL-series only)

Equipment required:

- ❏ 25-km singlemode fiber. The fiber should be low-tension wound on a spool.
- ❏ One-meter jumper
- ❏ Data sheet (provided in appendix A)

1. Connect the test fiber to the instrument using the one-meter jumper.
2. Turn power on to the FiberMaster by pressing the **POWER** button.
3. Select a wavelength by pressing the **MODULE SELECT** button until you reach the desired wavelength.
4. Select pulse width and maximum range settings.
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
   - ✔ Turn the **CURSOR** knob to select the 2-km pulse width.
   - ✔ Press **Next Param** to highlight the Maximum Range menu.
   - ✔ Turn the **CURSOR** knob to select the 25-km range setting. (Use the 25-km range setting for each repetition of this test.)
5. Set the number of averages to 262,144.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the Maximum Averages menu is highlighted.
   - ✔ Turn the **CURSOR** knob clockwise to increase the number of averages to 262,144.
6. Select LSA slope calculations.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the Slope Calc menu is highlighted.
   - ✔ Turn the **CURSOR** knob clockwise to highlight the LSA selection.

✔ Press the **Exit** softkey to return to the acquisition screen.

7. Press the **START/STOP** button to start an acquisition.
8. Press the **Two Point** softkey to enter Two Point mode.
9. Turn the **CURSOR** knob to move the active cursor to 5 km. The inactive cursor should still be positioned at 0 km.
10. Press the **CURSOR SELECT** button to switch active cursors. Do not change the position of the cursor at the start of the fiber. Turn the **CURSOR** knob to place the new active cursor at 23 km, above the noise floor. Measure the fiber slope.
11. Move the active cursor 1 dB down from the inactive cursor at 5 km. This will be approximately a 3-km span at 1310 nm and 5 km at 1550 nm.
12. Read and record the loss value.
13. Move both cursors 0.5 dB down the fiber and record the loss. The cursors are still separated by 1 dB.
14. Repeat step 13, moving the cursors down the fiber in 0.5-dB increments until the right-hand cursor reaches 23 km.
15. Repeat steps 3 through 14 for the following pulse widths, for complete coverage of the vertical scale:

    1310 nm 2 km, 200 m, 10 m (approximately 34 dB to 16 dB)
    1550 nm 2 km, 400 m, 50 m, 10 m (approximately 34 dB to 17 dB)

16. Use the average LSA loss for each pulse width to calculate a delta slope. The calculation is made by taking σ of the delta measurements and dividing by the average LSA loss, using the following formula:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n}}$$

n = number of 1-dB sections of fiber measured.

x_i = LSA loss measured on each 1-dB section of fiber (measured within the range of 15 dB and 35 dB on screen using several pulse widths to cover the range).

$\bar{x}$ = average LSA loss measured on the fiber (Use the same pulse widths as when measuring x_i, and measure overall LSA loss of fiber within 15 dB and 35 dB on screen.)

$$\bar{x} = \frac{x_{2kmPW} + x_{200mPW} + x_{10mPW}}{3} \quad \text{for 1310 nm}$$

$$\bar{x} = \frac{x_{2kmPW} + x_{400mPW} + x_{50mPW} + x_{10mPW}}{4} \quad \text{for 1550 nm}$$

Optical Output Amplitude

Equipment required:

- ❏ Singlemode or test jumper (FL only)
- ❏ Tektronix TFC200 power meter
- ❏ 20-dB attenuator for power meter (FL only)
- ❏ VT-100-compatible terminal
- ❏ RS-232 cable with terminal interface connector (described in the previous *Functional Tests* section)
- ❏ Data sheet (provided in appendix A)

FL-Series Optical Output Amplitude

1. Turn power on to the FiberMaster by pressing the **POWER** button.
2. Set the pulse width to 100 meters and the maximum range to 100 km:
   - ✔ Press the **Change Settings** softkey.
   - ✔ If necessary, press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
   - ✔ Turn the **CURSOR** knob to select the 100-meter pulse width.
   - ✔ Press the **Next Param** to highlight the Max Range menu. Turn the **CURSOR** knob to select the 100-km maximum range.
3. Set the serial port baud rate to 9600 as follows.
   - ✔ Press the **Next Menu** softkey twice to go to the System Settings menu.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the RS-232 Baud Rate parameter is highlighted.
   - ✔ Turn the **CURSOR** knob to select 9600.
   - ✔ Press the **Exit** softkey to return to the acquisition screen.
4. Connect the TFC200 optical power meter to the FiberMaster's 1310 nm optical connector using the test jumper and attenuator. Set the power meter to the appropriate wavelength (1310 nm or 1550 nm) and select dBm scale.
5. Connect the FiberMaster's RS-232 port to the VT100's RS-232 port using the specified cable.
6. Press the **MODULE SELECT** button to select the 1310-nm wavelength.
7. At the terminal, the Main Menu is displayed. Type **2** to select **Acquisition Diagnostics Menu**. Type **3** to select **Select Calibration Test**, and **2** again to select **Start Pulse Cal**.
8. Note power-meter reading.

9. Calculate peak laser power using the power-meter readings, attenuator factors, and 0.1% duty cycle:

   Laser Power (dBm) = Measured Power (dBm) + 30 + Attenuation Value (dB)
   Laser Power (mW) = $10^{\text{Laser Power (dBM)}/10}$

   Record result on data sheet.

10. Repeat steps 6 through 9 for the 1550-nm laser.

    A typical result will be between -30 dBm and -40 dBm on the TFC200 display, at both 1310 nm and 1550 nm, and 15 to 75 mW at 1310 nm and 25 to 75 mW at 1550 nm. Significantly higher values indicate a setup error. Significantly lower values may be caused by a setup error (on the power meter, attenuator, TFP2A settings, etc.), a dirty connector, or a broken optical component (laser, coupler, fiber, splice, etc.).

FM-Series Optical Output Amplitude

1. Connect the FiberMaster's RS-232 port to the VT100's RS-232 port using the specified cable.
2. Turn power on to the FiberMaster by pressing the **POWER** button.
3. Set the pulse width to 10 meters for 850 nm or 100 meters for 1300 nm.
   - ✔ Press the **Change Settings** softkey.
   - ✔ If necessary, press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.
   - ✔ Turn the **CURSOR** knob to select the 10-meter or the 100-meter pulse width.
4. Set the serial port baud rate to 9600 as follows.
   - ✔ Press the **Next Menu** softkey twice to go to the System Settings menu.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the RS-232 Baud Rate parameter is highlighted.
   - ✔ Turn the **CURSOR** knob to select 9600.
   - ✔ Press the **Exit** softkey to return to the acquisition screen.
5. Connect the TFC200 optical power meter to the FiberMaster's 850-nm optical connector or the 1300-nm optical connector. Set the power meter to the appropriate wavelength (850 nm or 1300 nm) and select dBm scale.
6. Press the **MODULE SELECT** button to select the 850- or the 1300-nm wavelength.
7. Press the **ZERO** key on the TFC200 (let the meter finish before proceeding).
8. Press **START/STOP** on the TFP2A. Let the acquisition run for 5 to 10 seconds, then press **START/STOP** again to stop the acquisition.

9. At the terminal, the Main Menu is displayed. Type **2** to select **Acquisition Diagnostics Menu**. Type **3** to select **Select Calibration Test**, and **2** again to select **Start Pulse Cal**.

10. Note the power-meter reading. The power output at the front panel must be ≥15 µW and ≤45 µW for 850 nm, and ≥30 mW and ≤45 mW for 1300 nm.

NOTE *The TFC200 makes average power readings. The average power can be translated to peak power by multiplying by 10,000 for 850 nm or by 1000 for 1300 nm. The pulse repetition rate for the pulse cal test is 1 kHz. The peak power is the average power divided by the pulse width (100 ns for 850 nm and 1000 ns for 1300 nm), multiplied by the period of the pulse repetition rate (1 ms). 1 ms/100 ns = 10000 (850). 1 ms/1000 ns = 1000 (1300).*

11. Remove the power meter from the front-panel connector.

12. Repeat steps 3 through 11 for the 1300-nm wavelength.

FS/FG-Series Optical Output Amplitude

1. Connect the FiberMaster's RS-232 port to the VT100's RS-232 port using the specified cable.

2. Turn power on to the FiberMaster by pressing the **POWER** button.

3. Set the pulse width to 100 meters.

   ✔ Press the **Change Settings** softkey.

   ✔ If necessary, press the **Next Param** or **Prev Param** softkey until the Pulse Width menu is highlighted.

   ✔ Turn the **CURSOR** knob to select the 100-meter pulse width.

4. Set the serial port baud rate to 9600 as follows.

   ✔ Press the **Next Menu** softkey twice to go to the System Settings menu.

   ✔ Press the **Next Param** or **Prev Param** softkey until the RS-232 Baud Rate parameter is highlighted.

   ✔ Turn the **CURSOR** knob to select 9600.

   ✔ Press the **Exit** softkey to return to the acquisition screen.

5. Connect the TFC200 optical power meter to the FiberMaster's 1310-nm optical connector or the 1550-nm optical connector. Set the power meter to the appropriate wavelength (1310 nm or 1550 nm) and select dBm scale.

6. Press the **MODULE SELECT** button to select the 1310- or the 1550-nm wavelength.

7. Press the **ZERO** key on the TFC200 (let the meter finish before proceeding).

8. Press **START/STOP** on the TFP2A. Let the acquisition run for 5 to 10 seconds, then press **START/STOP** again to stop the acquisition.

9. At the terminal, the Main Menu is displayed. Type **2** to select **Acquisition Diagnostics Menu**. Type **3** to select **Select Calibration Test**, and **2** again to select **Start Pulse Cal**.

10. Note the power-meter reading. The power output at the front panel must be ≥12 mW and ≤30 mW for 1310 nm, and ≥8 mW and ≤20 mW for 1550 nm.

NOTE *The TFC200 makes average power readings. The average power can be translated to peak power by multiplying 1000. The pulse repetition rate for the pulse cal test is 1 kHz. The peak power is the average power divided by the pulse width (1000 ns), multiplied by the period of the pulse repetition rate (1 ms). 1 ms/1000 ns = 1000.*

11. Remove the power meter from the front-panel connector.

12. Repeat steps 3 through 11 for the 1550-nm wavelength.

Adjustments

These adjustment procedures provide instructional steps required to recalibrate the circuits in the TFP2A mainframe following module replacement. Allow the instrument a warmup period of at least 15 minutes at 20 degrees Celsius before adjusting.

Some of these procedures require partial disassembly of the instrument to allow access to adjustment points. Refer to the *Removal and Replacement* section later in this chapter for instructions on how to disassemble the FiberMaster

Control Board Adjustments

There are two adjustments on the control board, VCO (voltage-controlled oscillator) tune voltage and display fine contrast.

Equipment required:

- ❏ Digital multimeter, Tektronix DM504A with TM-500-series power module.
- ❏ Non-metallic adjustment tool, Tektronix 013-0227-00 (must be less than 1/8-inch in diameter and over two inches long.)
- ❏ Oscilloscope, Tektronix 2465B

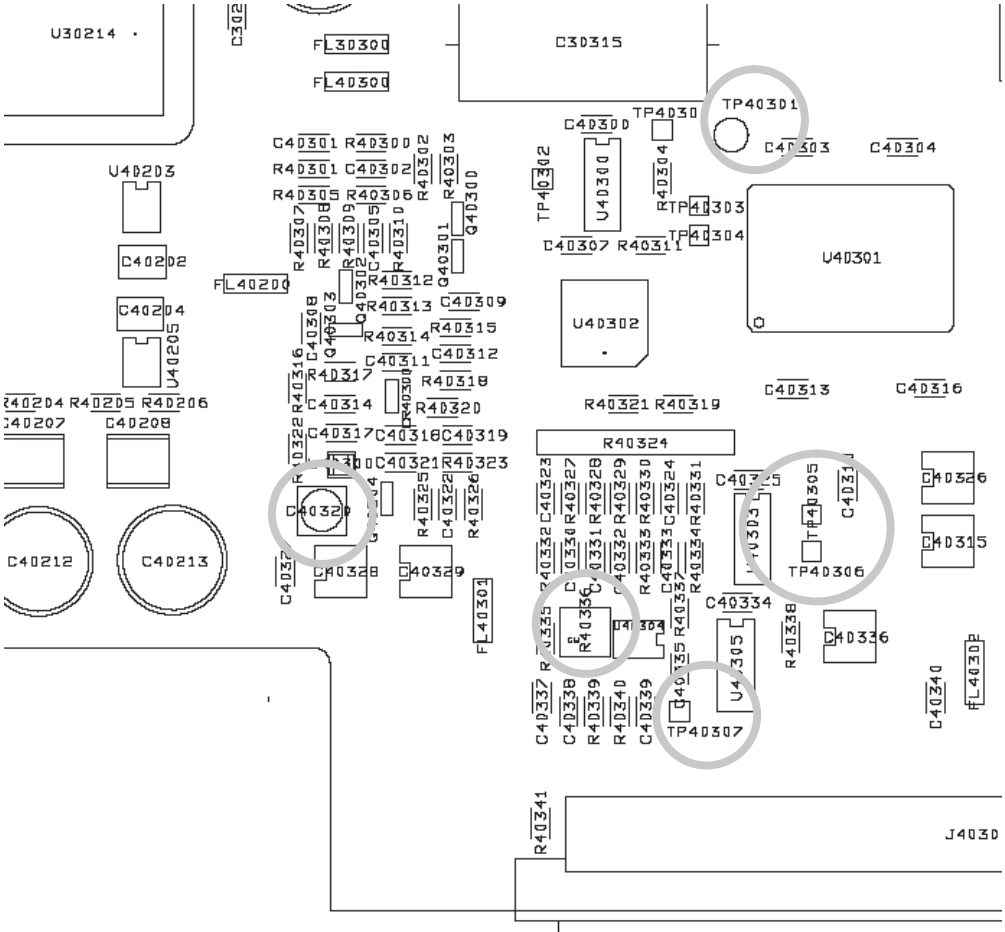


Figure 4-23. VCO Tune Voltage Adjustment

VCO Tune Voltage

1. Remove the bottom cover of the instrument to allow access to the control board.
2. Press the **POWER** button to turn on power to the instrument.
3. Set the digital multimeter to Autoranging, DC Volts.
4. Attach the low test probe to ground test point TP40301.
5. Measure voltage on TP40307, 4.00 V ± .25 V.
6. Using the adjustment tool, adjust C40320 for a reading of 4.00 V at TP40307.
7. Connect channel 1 oscilloscope probe to PLOCK TP40306.
8. Connect channel 2 oscilloscope probe to SLOCK TP40305.
9. Adjust R40336 to match the rising edges to within 5 ns.

Printer Board Adjustment

There is one adjustment on the printer board, which controls the print intensity.

Equipment required:

- ❑ Digital multimeter, Tektronix DM504A with TM-500-series power module.
- ❑ Non-metallic adjustment tool, Tektronix 013-0227-00 (must be less than 1/8-inch in diameter and over two inches long.)

1. Remove the top cover of the instrument to allow access to the printer board.
2. Turn power on to the instrument by pressing the **POWER** button.
3. On the printer board, locate six pins at JP1. Make sure there are three jumpers installed on the six pins.
4. Set the digital multimeter to Autoranging, DC Volts.
5. Ground the low test probe on the instrument's chassis.
6. Measure voltage on the test point located between potentiometer R18 and resistor R25.
7. Using the adjustment tool, adjust potentiometer R18 for a reading of 3.3 V ± 0.1 V at the test point.

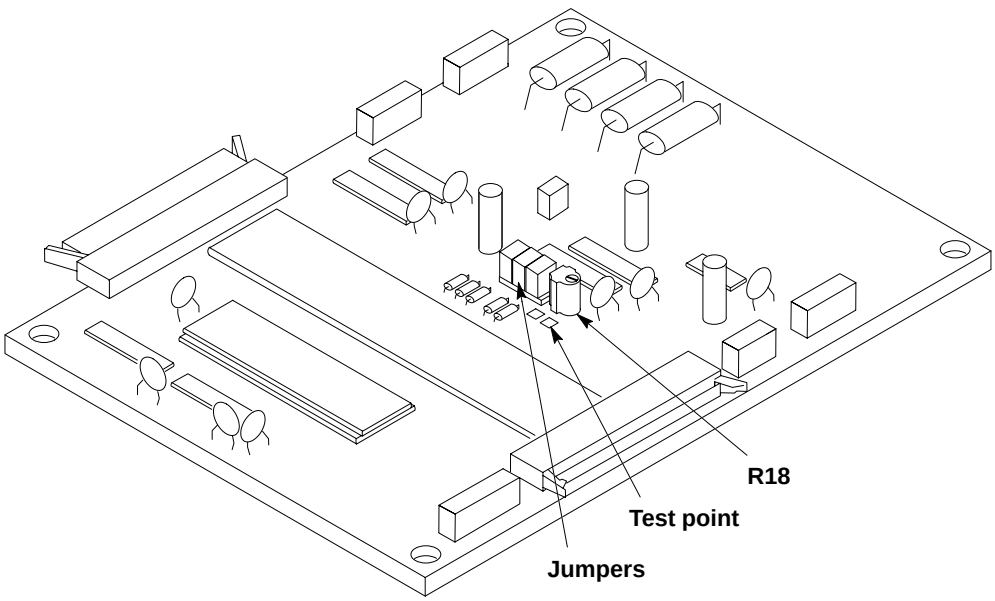


Figure 4-24. Printer Board Adjustment

8. Following FiberMaster's power-on selftests, the start-up screen displays. From this screen, display the Run Diagnostics menu by pressing the bottom softkey and the **HELP** button simultaneously.
9. Turn the **CURSOR** knob to highlight the printer test. Press the **Select Test** softkey to select the printer test.
10. Press the **START TEST** softkey to print the printer's test pattern and check print intensity.

Display Adjustments

The display adjustments involve checking one voltage level on the display board, and making a number of adjustments to tune video characteristics.

Equipment required:

- ❏ Digital multimeter, Tektronix DM504A with TM-500-series power module.
- ❏ Non-metallic adjustment tool, Tektronix 013-0227-00 (must be less than 1/8-inch in diameter and over two inches long.)
- ❏ Admiral Zenith 0.1-inch hex wrench.
- ❏ 7/64-inch hex wrench.
- ❏ Loctite 411 glue.
- ❏ CRT template
- ❏ VT-100-compatible dumb terminal
- ❏ Serial cable with black box
- ❏ Flat-bladed screwdriver

Display Board Voltage

1. Remove the top cover of the instrument and the printer assembly to allow access to the display board.
2. Press the **POWER** button to turn on power to the instrument.
3. Set the digital multimeter to Autoranging, DC Volts.
4. Attach the low test probe to the heatsink of U428.
5. Measure voltage on the tab of U438, 20.5 V ± .1 V.
6. Using the adjustment tool, adjust R444 for a reading of 20.5 V

.

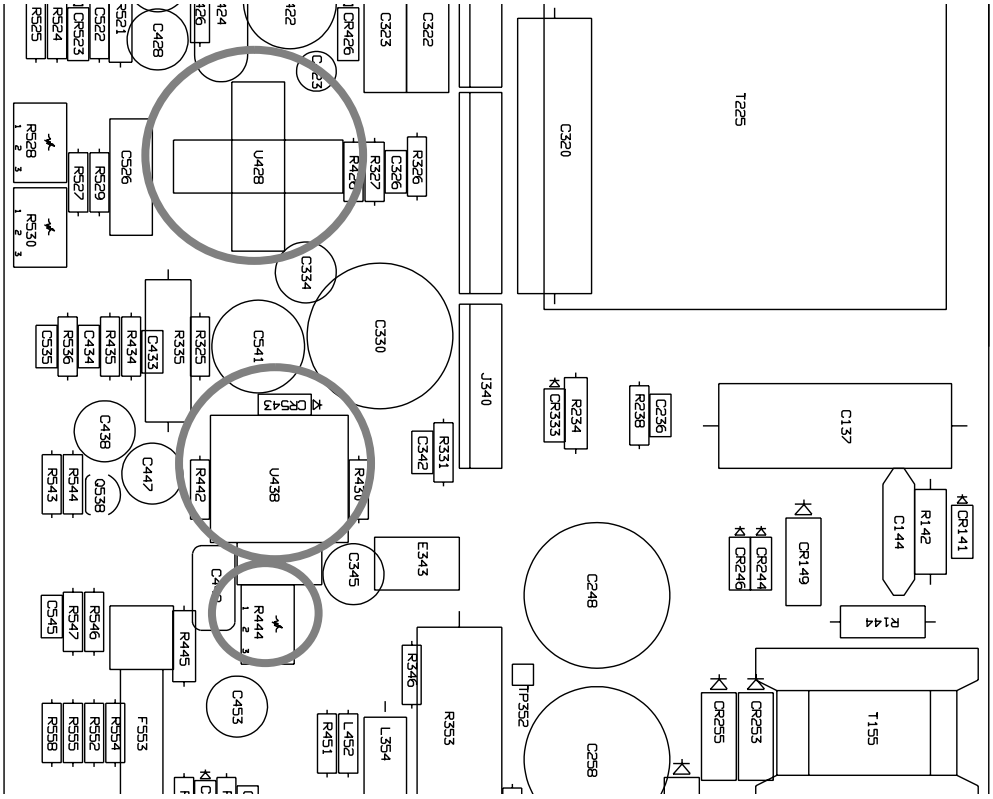


Figure 4-25. Display Board Voltage Adjustment

Video Adjustments

There are two adjustments on the CRT itself, and several on the display board that you can do to optimize display proportions and quality. The display should come from the factory at optimal adjustment, but since CRT display attributes are subjective qualities depending on user preference, instructions are given here on how to adjust a number of them.

Display CRT Alignment Pattern

Use the CRT alignment pattern that is available via FiberMaster's terminal interface for several of the following video adjustments. Display the alignment pattern as follows:

1. Connect the RS-232 port on the back of the FiberMaster to the RS-232 port on the VT-100-compatible terminal.
2. Turn on power to the instrument by pressing the **POWER** button.
3. Set the serial-port baud rates on the OTDR and the terminal to 9600 baud. Set the FiberMaster's baud rate as follows:
   - ✔ Press the **Change Settings** softkey.
   - ✔ Press the **Next Menu** softkey twice to go to the System Settings menu.
   - ✔ Press the **Next Param** or **Prev Param** softkey until the RS-232 Baud Rate parameter is highlighted.
   - ✔ Turn the **CURSOR** knob to highlight the 9600 baud rate selection.
   - ✔ Press the **Exit** softkey to return to the start-up screen.
4. Go to the Run Diagnostics menu by pressing the bottom softkey and the **HELP** button simultaneously.
5. At the terminal, the Main Menu of the terminal interface should display. Type **3** to select item 3 on the menu, **Diagnostics Menuf**.
6. On the Diagnostics Menu, select item 3, **Select Display Tests**.
7. On the Display Tests menu, select item 1, **Display Hold Time**. Enter the number of seconds to display the test pattern that you will use to align the display. For example, to display the test pattern for two minutes, enter 120.
8. Select item 5, **Alignment Pattern**, and the alignment pattern displays on the CRT.

Center and Rotate Video

1. To center the video, rotate the two ring magnets at the rear of the CRT yoke until the test pattern is centered with respect to the CRT template.

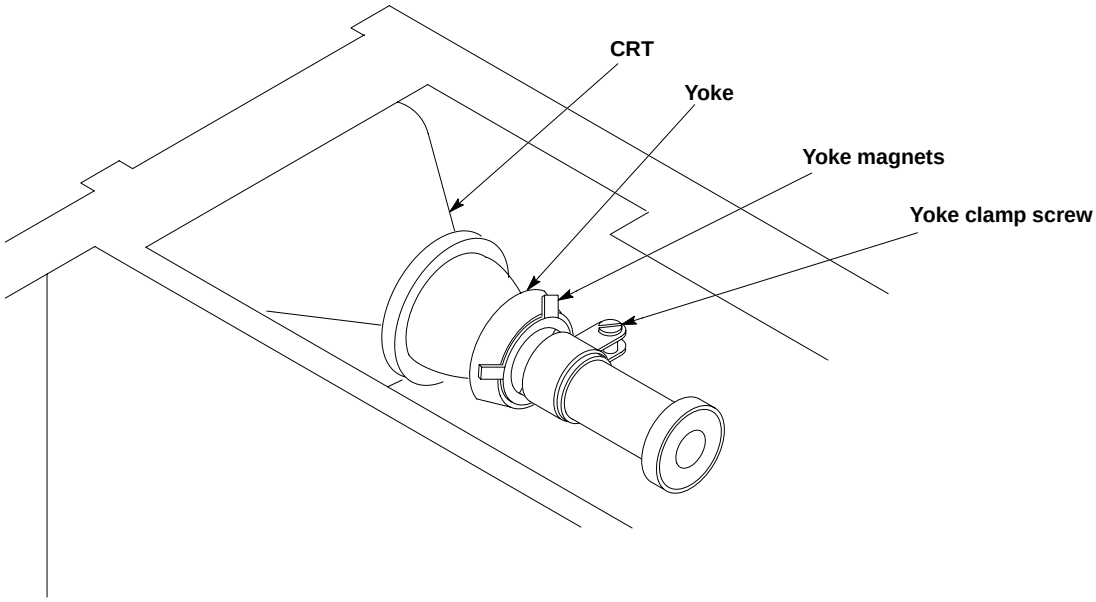


Figure 4-26. CRT Ring Magnet and Yoke Adjustments

2. To rotate the video, use a standard flat-bladed screwdriver to loosen the yoke clamp screw (5/32-inch flathead) and rotate the yoke until the video is square with respect to the CRT template.
3. After adjusting the yoke, tighten the yoke clamp screw.

Horizontal Width and Linearity
Corner Focus

See figure 4-27 for the locations on the display board of these adjustments.

1. The preset positions are glued into place at the factory. Use the Admiral Zenith .1-inch hex wrench to break the seal on the corner focus adjustment point, and a metal adjustment tool to break seals on the horizontal width and linearity adjustment points.
2. Using a plastic adjustment tool, adjust the horizontal width and linearity so the CRT template matches the test alignment pattern.
3. Using the Admiral Zenith hex wrench, adjust the corner focus of the video as desired.
4. After adjusting, secure the adjustments using Loctite 411.

Horizontal Phase
Vertical Linearity and Size
Brightness
Center Focus
Contrast

See figure 4-27 for the locations on the display board of these adjustments.

1. Use the adjustment tool to adjust the horizontal phase, vertical linearity and size, and overall expansion of the video to match the CRT template to the test alignment pattern.
2. Adjust the brightness, center focus, and contrast of the picture as desired.

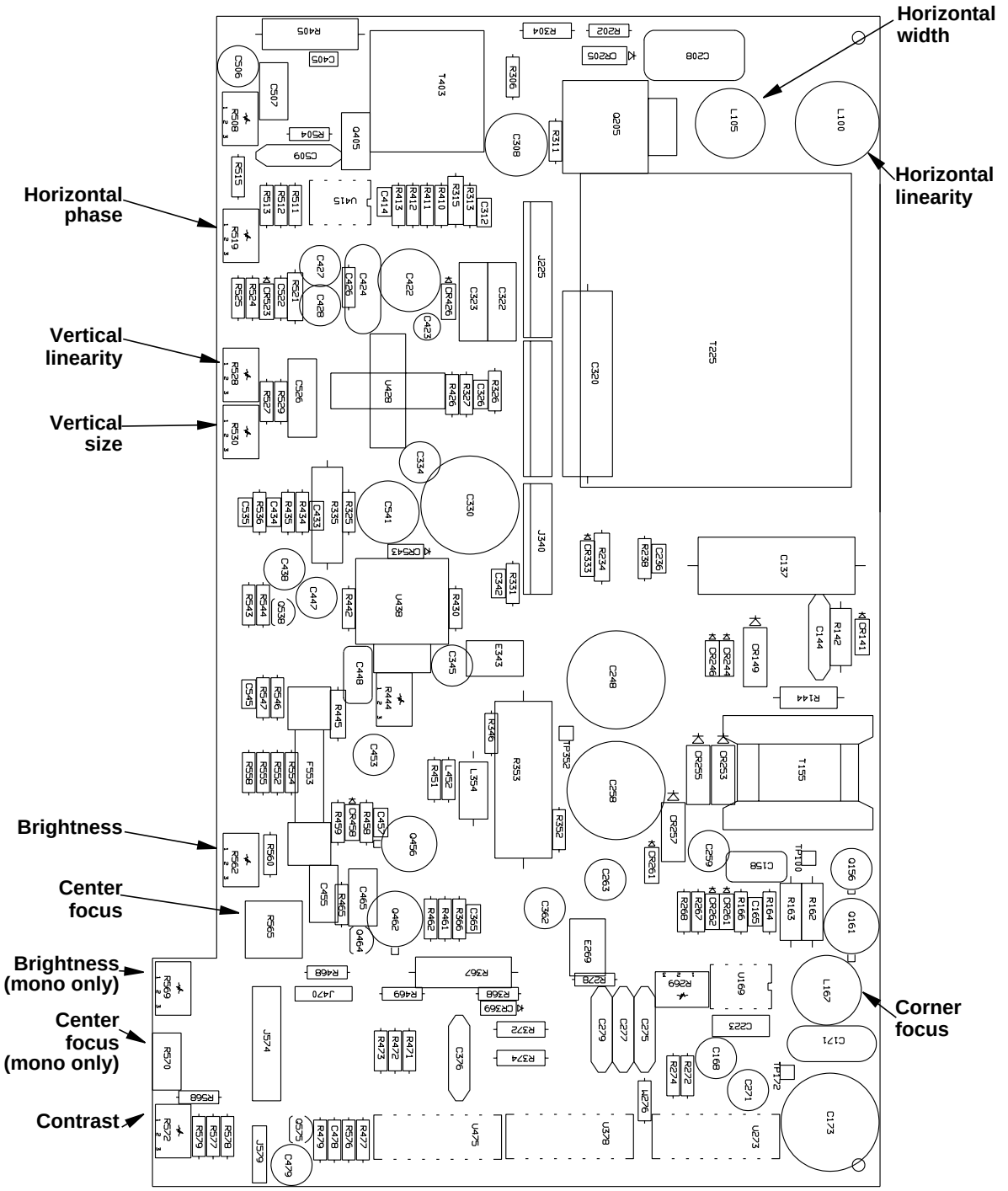


Figure 4-27. Display Board Video Adjustments

Troubleshooting and Diagnostics

This section contains information to help you isolate faulty modules in the FiberMaster. If a module needs to be replaced, follow the *Removal and Replacement Procedures* given in the following section.

Using the Diagnostics Menus

Power-on self tests are conducted each time the instrument is turned on. These tests include ROM, RAM, front-panel, acquisition hardware, and real-time clock checks. In addition to power-on self tests, a series of user-selectable self tests are provided through a menu system. These tests are used in both performance verification checks and diagnostic checks, and can be used to perform most of the module-level troubleshooting on the instrument.

If one or more power-on self tests fail, a message indicating the failure is shown on the start-up screen, and a **Self Test** softkey displays. In this case, you can enter the diagnostics menu system by pressing the softkey. The menus are also available from FiberMaster's start-up screen by pressing the **HELP** button and softkey 6 (the bottom softkey) simultaneously.

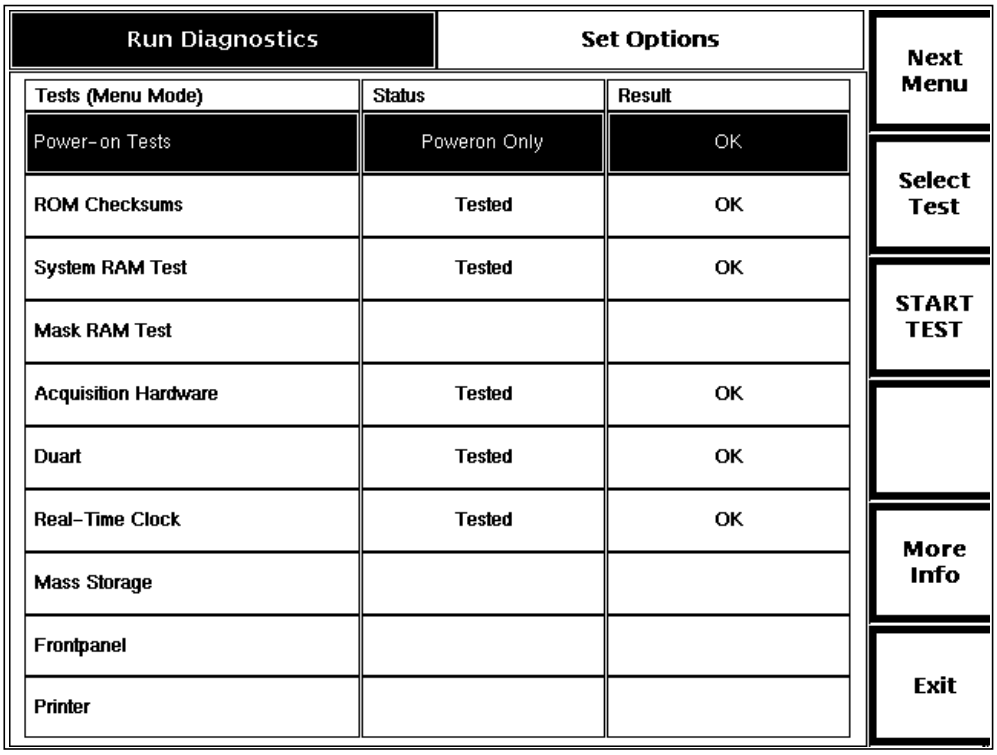


Figure 4-28. Run Diagnostics Menu

The diagnostics menus allow the selection of various self tests for the instrument to perform. The results of the tests are reported following completion of the tests.

Reading More Information on the Highlighted Test

To read more information on the currently highlighted test, press the **More Info** softkey. A description of the test displays, along with test results from the last time the test was run.

Selecting and Clearing Tests to Run

On the Run Diagnostics menu, use the distance **CURSOR** knob to select which tests to run. As the knob is turned, each test listed on the menu is highlighted. To select the highlighted test, press the **Select Test** softkey. The test is then indicated as "Selected" in the Status column on the menu.

To clear a selected test, turn the **CURSOR** knob until the test is highlighted. Press the **Select Test** softkey again. The selection is cleared.

Setting Options for the Selected Tests

A second diagnostics menu lets you choose the number of iterations to perform of the selected tests, and whether to print the results of the tests on the internal printer. Press the **Next Menu** softkey to display the Set Options menu.

Upon entry to the Set Options menu, the Iteration Count parameter is highlighted. Turn the **CURSOR** knob to increase or decrease the number of iterations, from 0 to 20. A setting for infinite iterations is also available.

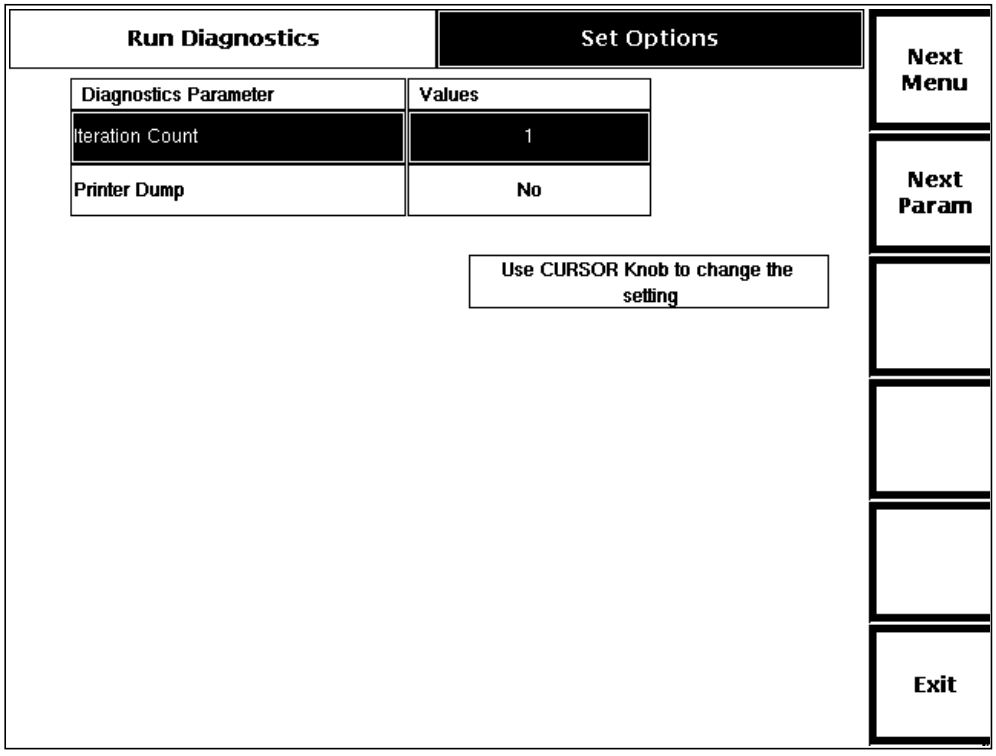


Figure 4-29. Set Options Menu

To set the printer dump parameter, press the **Next Param** softkey to highlight the parameter. Turn the **CURSOR** knob to choose either **No** or **Yes**.

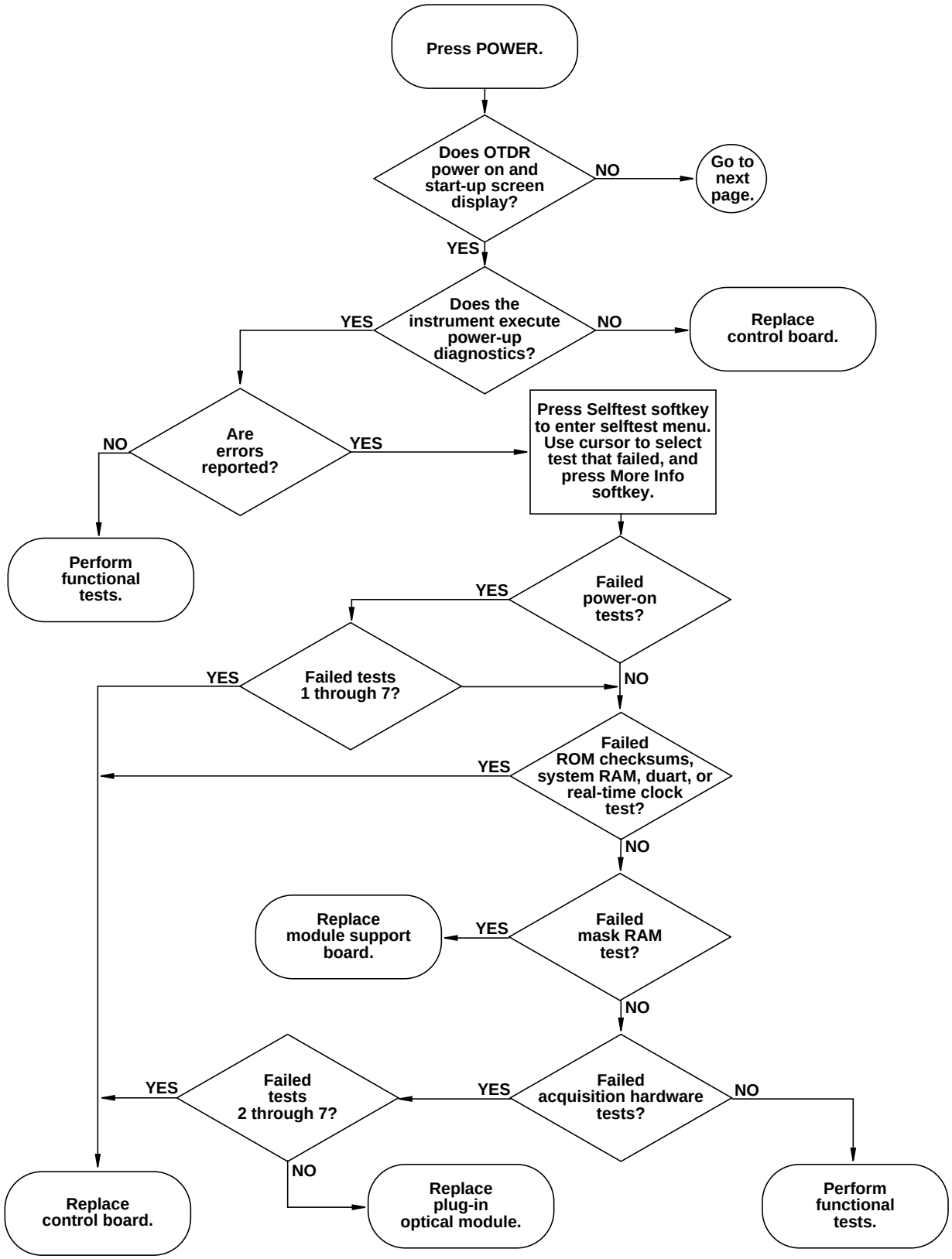
Running the Selected Tests

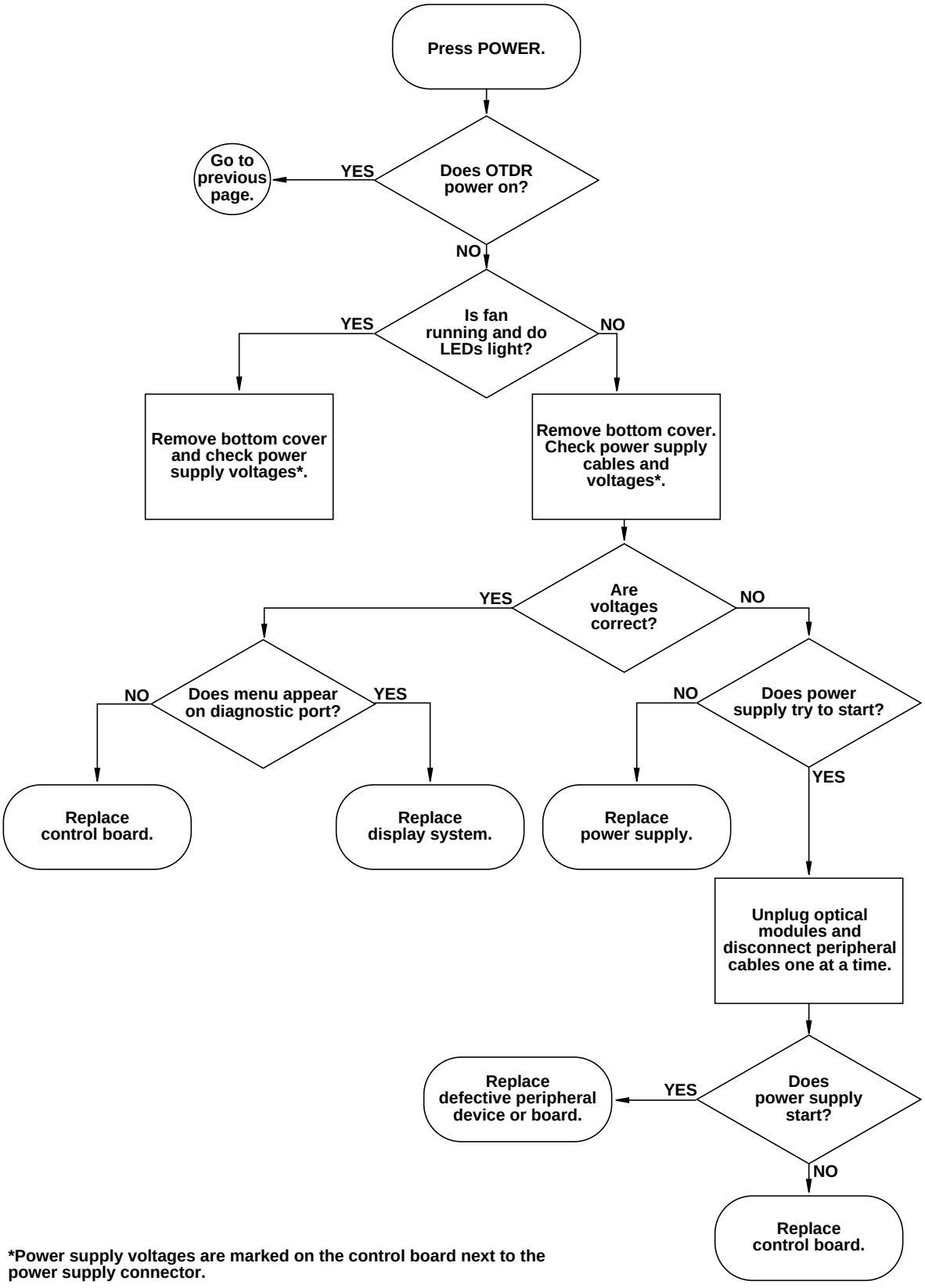
Run the selected tests by pressing the **START TESTS** softkey on the Run Diagnostics menu. When the tests are complete, each selected test is shown as "Tested" in the Status column on the menu. The Test Result column displays either "OK" or "ERROR." If errors were detected, use the **More Info** function to read more information on the test results.

Exiting the Diagnostics Menus

To exit the diagnostics menus and return to the previous display, press the **Exit** softkey.

Troubleshooting Flowchart





*Power supply voltages are marked on the control board next to the power supply connector.

Removal and Replacement Procedures

This section gives directions for removing the major modules. Any electrical or mechanical module, assembly, or part listed in the parts list in chapter 5 is considered a module.

The procedures for removing modules are given in the order logical for taking apart the entire instrument. The instructions for removing each module include which steps must be complete to allow access to that particular module. To find directions for these prerequisite steps, refer to the preceding removal instructions. For example, in order to remove the display assembly, you must first remove the instrument's covers and the printer assembly. Instructions on how to do take off the covers and printer tray are given prior to the section on removing the display assembly.

To replace a particular module, reverse the removal instructions.

WARNING *Before performing this or any other procedure in this manual, read the Operator and Service Safety Summary found at the beginning of this manual.*

Tools Required

The following table lists the tools required for removal and replacement of FiberMaster modules:

Table 4-7. Tools Required for Module-Level Maintenance and Repair

Tool:	Used for:
#1 Pozidriv Phillips-head screwdriver	Circuit boards, fan assembly, power switch
#2 Pozidriv Phillips-head screwdriver	Printer tray, display assembly, power supply, disk drive, and line filter
3/16-inch nut driver	RS-232 cable
1/4-inch nut driver	GPIB cable, primary power ground wires
11/32-inch nut driver	Fan assembly
1/4-inch end wrench	Fan air baffle
1/16-inch Allen wrench	Front-panel knobs
5/32-inch Allen wrench	Front panel assembly
3/32-inch Allen wrench	Top and bottom instrument covers, DC option

Multiple-Terminal Connectors

Some intercircuit connections are made using ribbon cables and pin connectors mounted in multiple-terminal holders. Connector orientation to the circuit board is made by matching triangles on the holder and on the connector, as illustrated below.

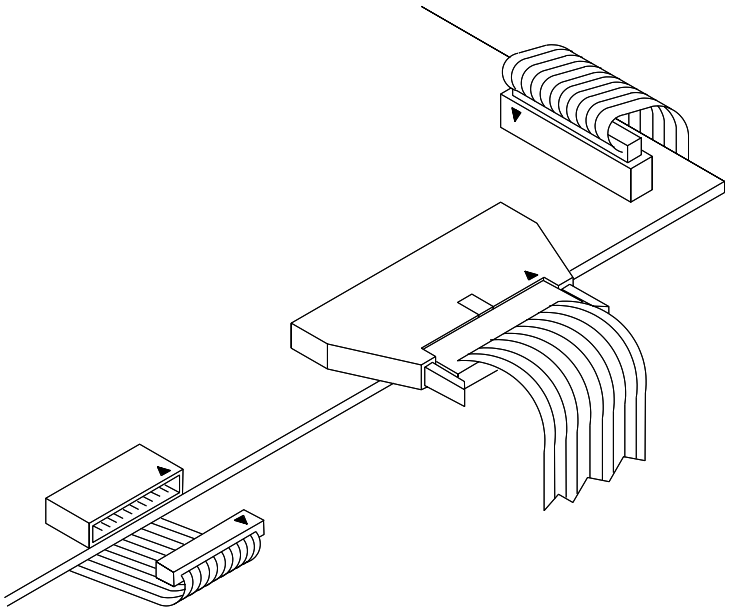


Figure 4-30. Connector Orientation

Connectors that are not keyed are not directional and can be oriented in either direction.

Covers and Front Panel

1. Unscrew four hex-receptacle cap screws on each side of the instrument, using a 3/32-inch Allen wrench
2. The covers of the instrument fit under a lip around the front-panel assembly. Remove off the top cover by sliding the cover back and lifting off.
3. Turn the instrument over and remove the bottom cover the same way—slide towards the back of the instrument and lift off.

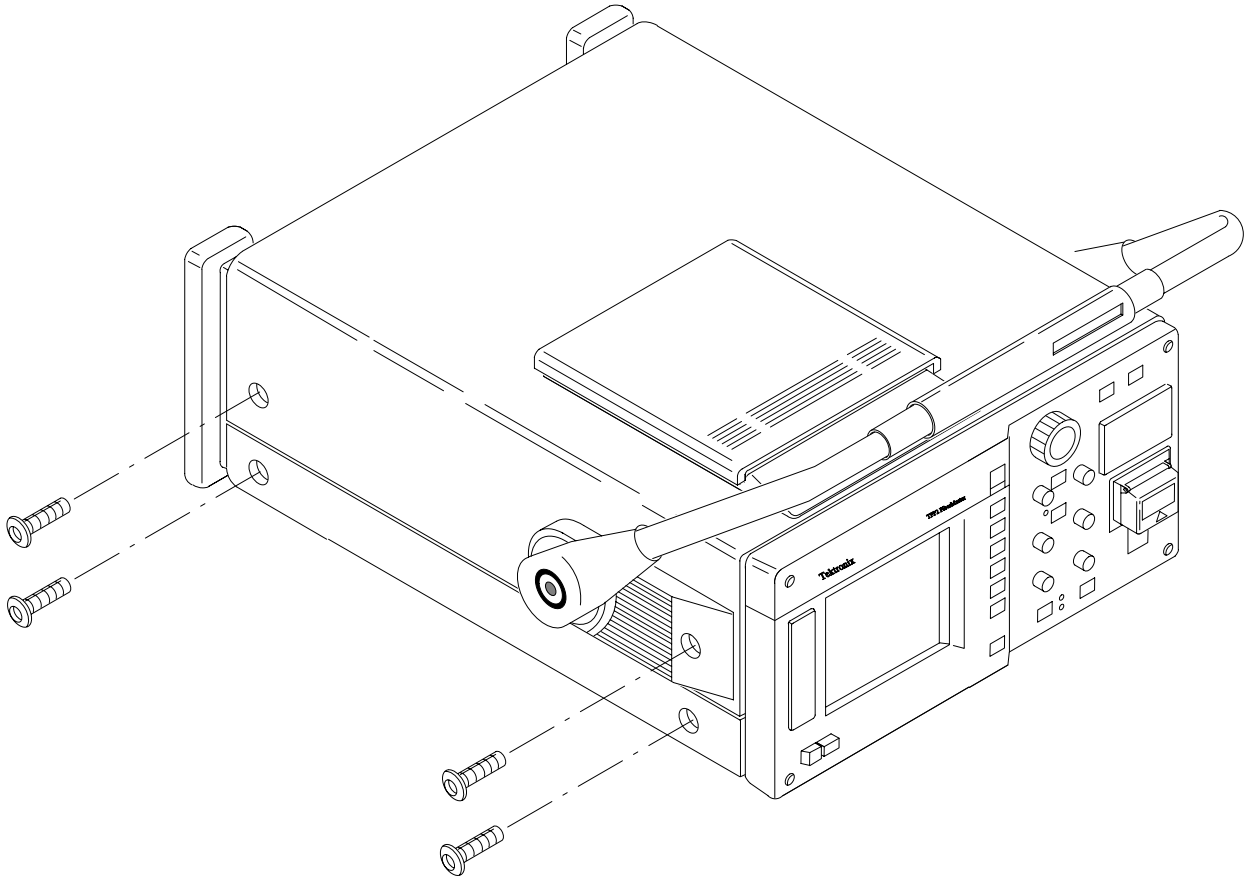


Figure 4-31. Removing Instrument Covers

NOTE *When reinstalling the top cover, insure that the lip of the front facade is engaged with the front groove of the top cover. Also make sure that the tab at the back of the chassis is engaged into the vertical half-clip at the rear of the top cover.*

4. Remove the front panel by unscrewing four hex-receptacle screws and washers, using a 5/32-inch Allen wrench. Disconnect the front-panel cable and lift off the front-panel assembly.

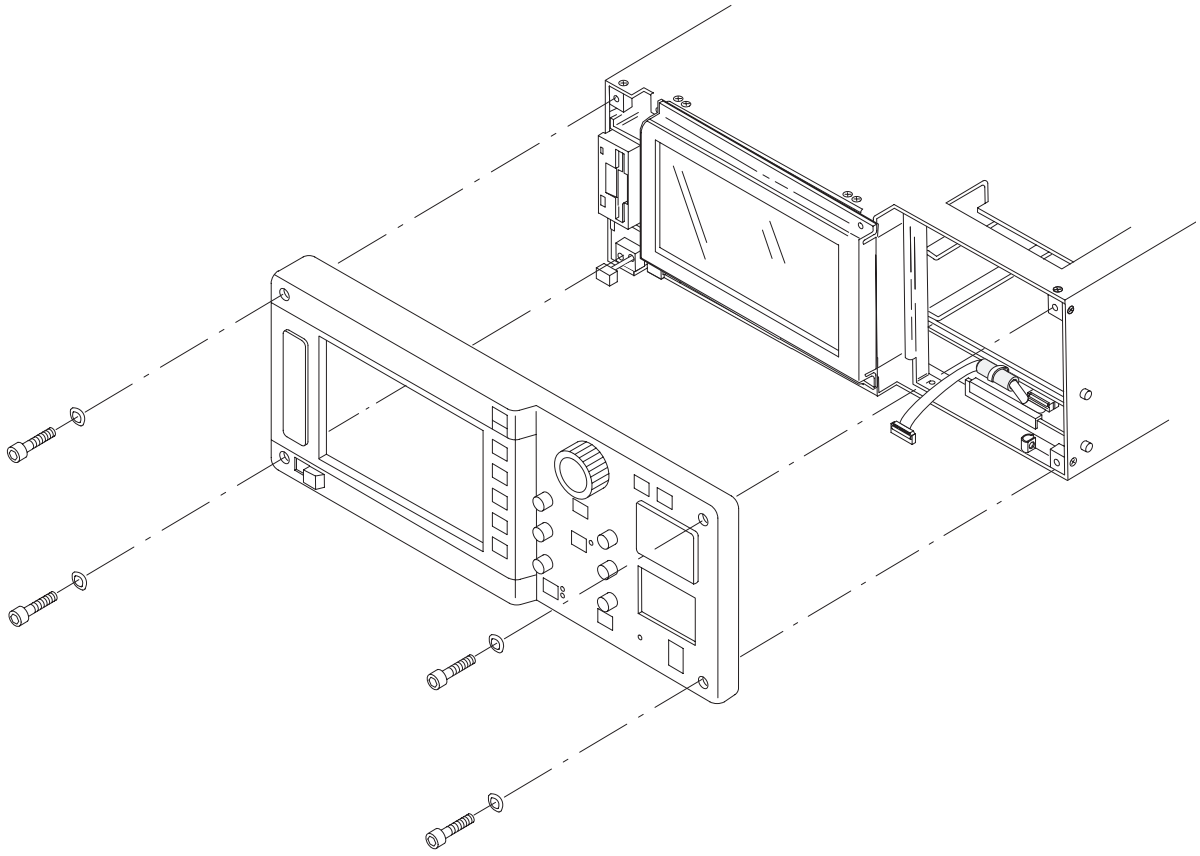


Figure 4-32. Removing Front-Panel Assembly

Back-Panel Assembly and Plug-In Optical Modules

1. Remove the left-hand side of the back panel and the optical plug-in modules by unscrewing four black quick-release screws in each corner of the back-panel assembly. Pull the back-panel assembly off the mainframe using the handle provided, disconnecting the control and module support boards from the interconnect board, which is attached to the inside of the back panel.

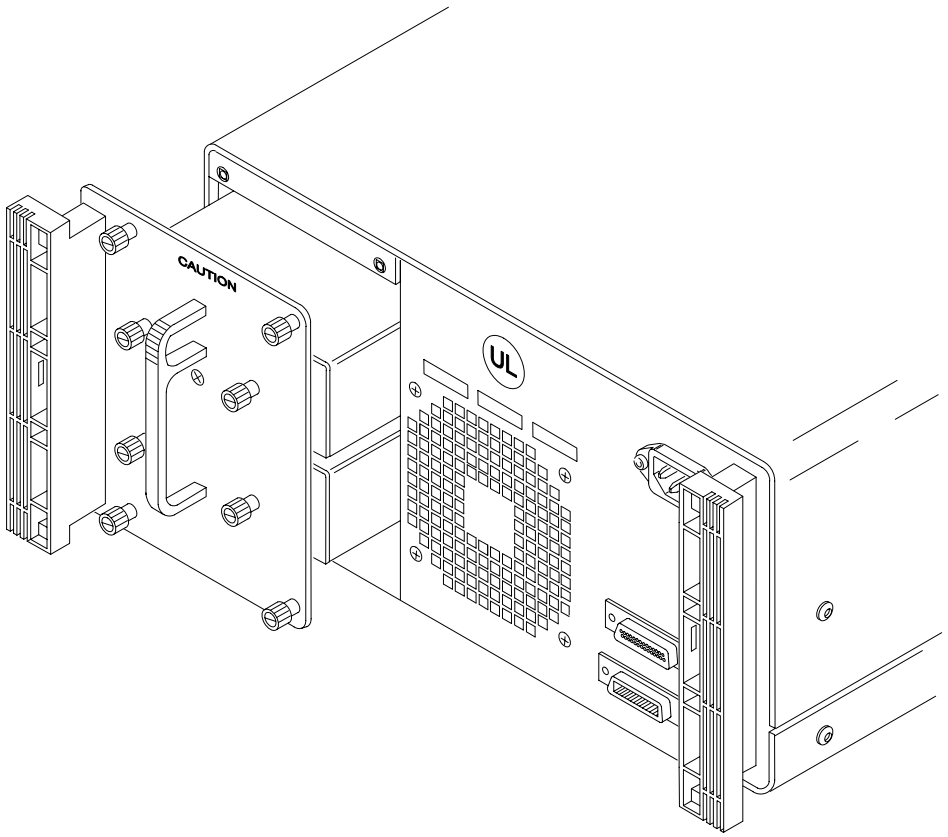


Figure 4-33. Removing the Back-Panel Assembly and Plug-In Optical Module(s)

2. Remove the plug-in optical module(s) from the back-panel assembly by unscrewing the two quick-release screws in each module, and disconnecting the module from the interconnect board. Repeat for a second module.

Control Board

Before removing the control board, take off the bottom cover of the instrument.

1. Turn instrument upside down. Disconnect the following cables from the control board:

   RS-232
   GPIB
   Fan
   Power supply
   Printer (2)
   Display board
   Disk drive (2)

   The front-panel cable is disconnected at the front panel and remains connected to the control board. It includes a ferrite core that is tied down to the control board. This cable is already disconnected if you have removed the front panel.

2. Remove 15 screws, and lift out the control board.

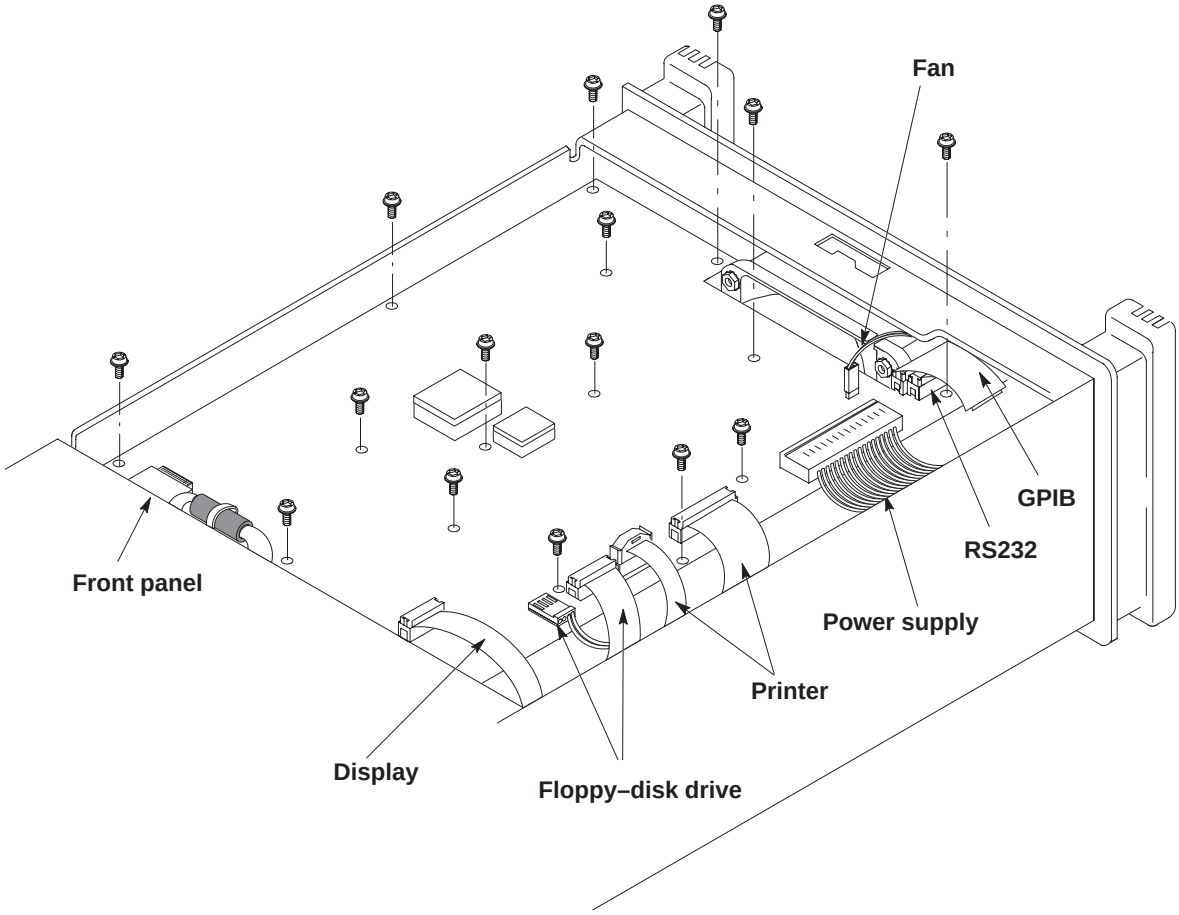


Figure 4-34. Removing the Control Board

Printer Tray and Printer

Remove the printer tray and printer to allow access to the power supply, CRT assembly, disk drive, and fan. Before you can remove the printer assembly, the two printer cables must be disconnected from the control board.

1. Using a #2 Pozidriv screwdriver, remove the six screws that fasten the printer tray to the chassis. Pull the tray forward and up.
2. Thread the two printer cables through a slot in the chassis next to the display board.

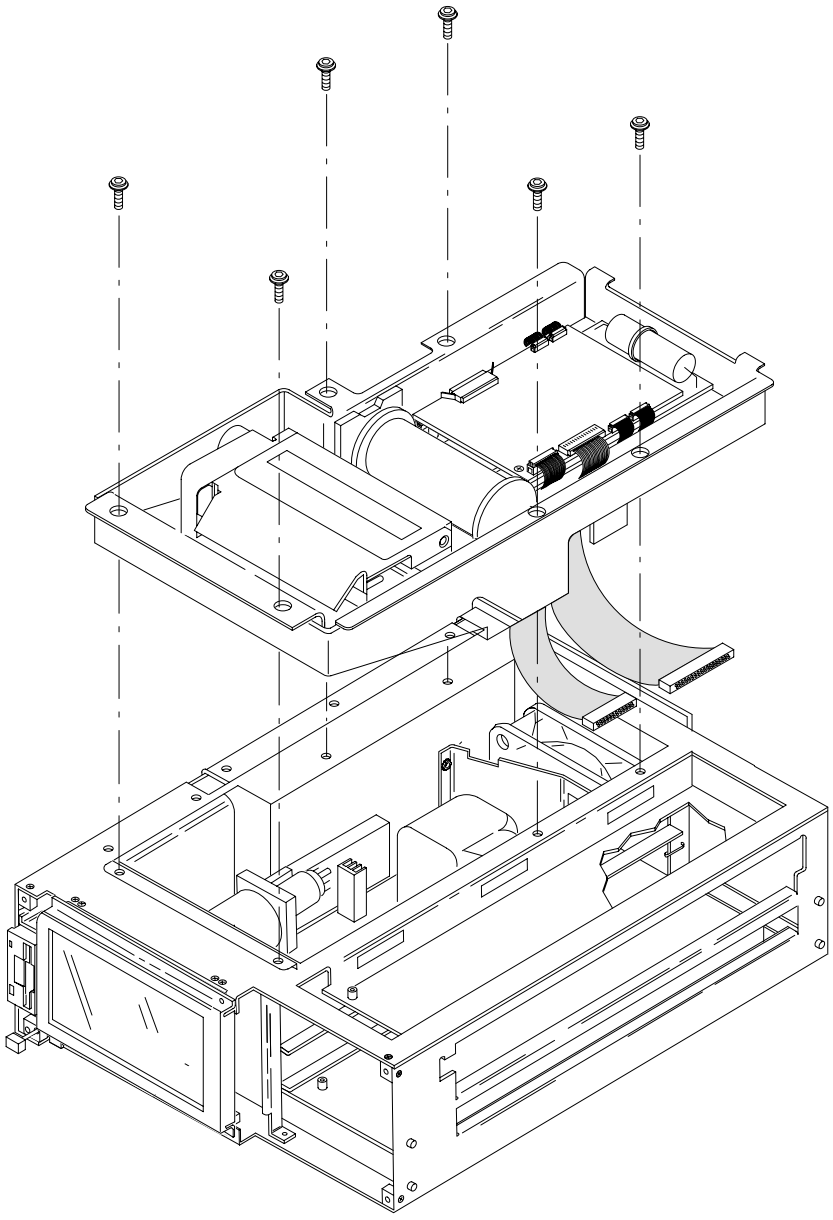


Figure 4-35. Removing the Printer Assembly

CRT, Color Shutter/Monochrome Filter, and Display Board

Before you can remove the display assembly, you must first do the following:

- ✔ Remove the front panel.
- ✔ Remove the bottom cover of the instrument and disconnect the display board cable from the control board. Thread the cable up through the chassis.
- ✔ Remove the top cover and the printer assembly.

Then remove the CRT/display assembly as follows. (Note that step 1 applies only to instruments with color CRTs):

1. (Color CRT only) Disconnect the color-shutter cable from display board (the cable goes from the upper right-hand corner for the color shutter, under the CRT, and connects to the board on the left of the tube).

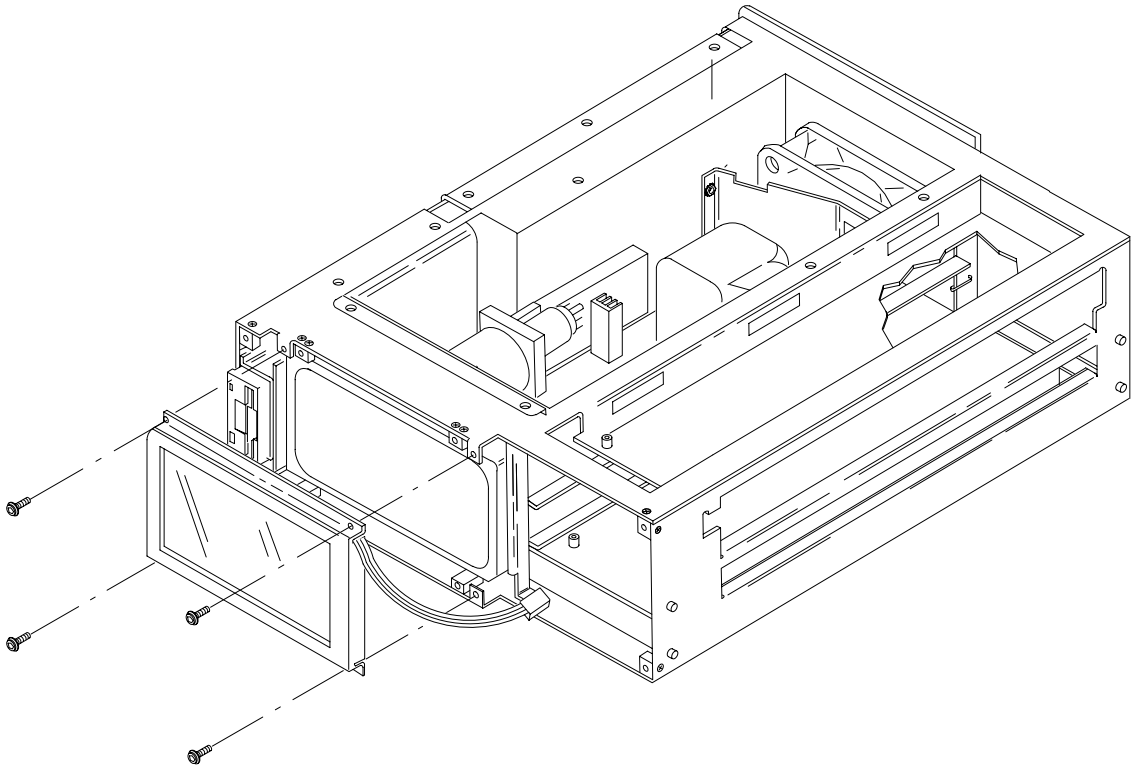


Figure 4-36. Removing the Color Shutter

2. Remove the four screws that attach the color shutter or monochrome filter to the chassis, using a #2 Pozidriv screwdriver. Remove the color shutter (figure 4-36) or monochrome filter (figure 4-37).

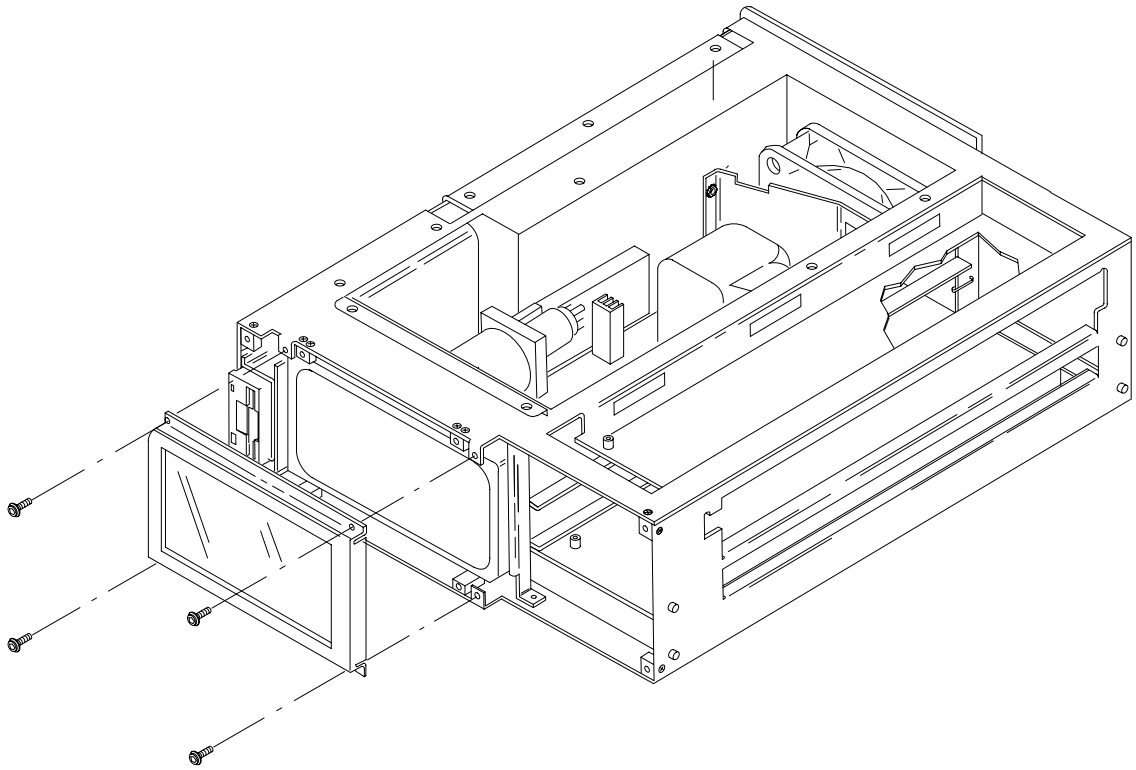


Figure 4-37. Removing the Monochrome Filter

3. Remove the six screws that attach the display board to the chassis.

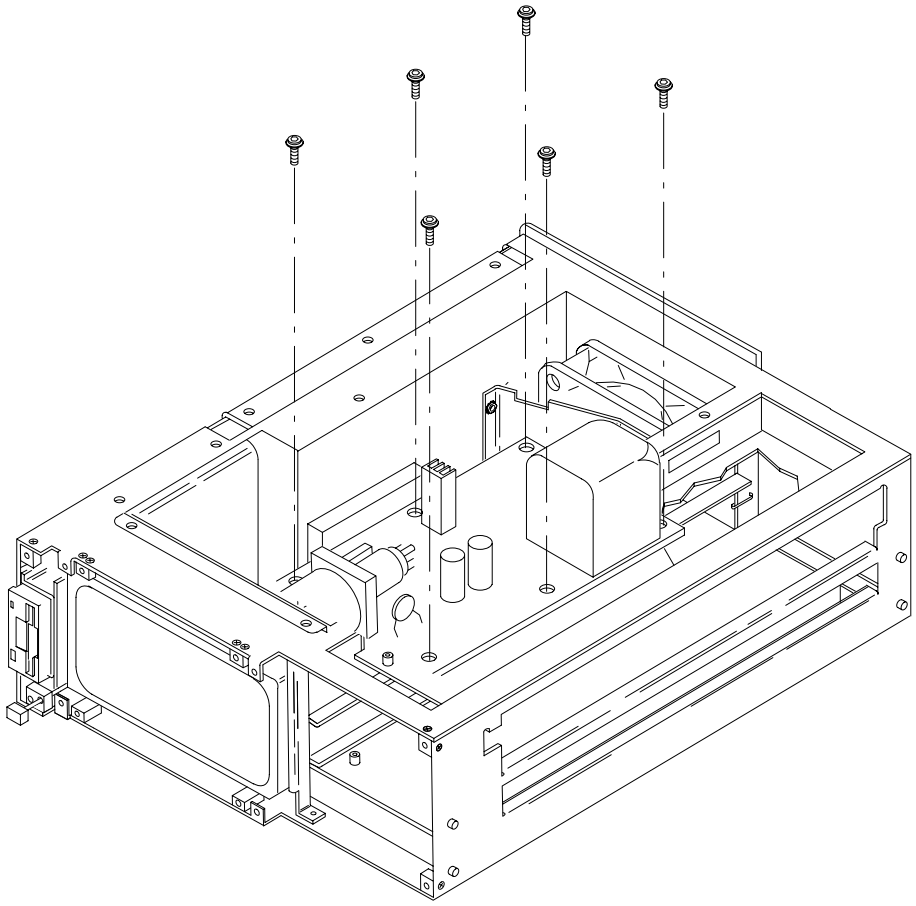


Figure 4-38. Detaching the Display Board

4. Using a #2 Pozidriv screwdriver, remove the four screws that attach the CRT to the chassis nutblocks. The ground wire at the lower left nutblock and the dagstrap at the upper right nutblock are released.

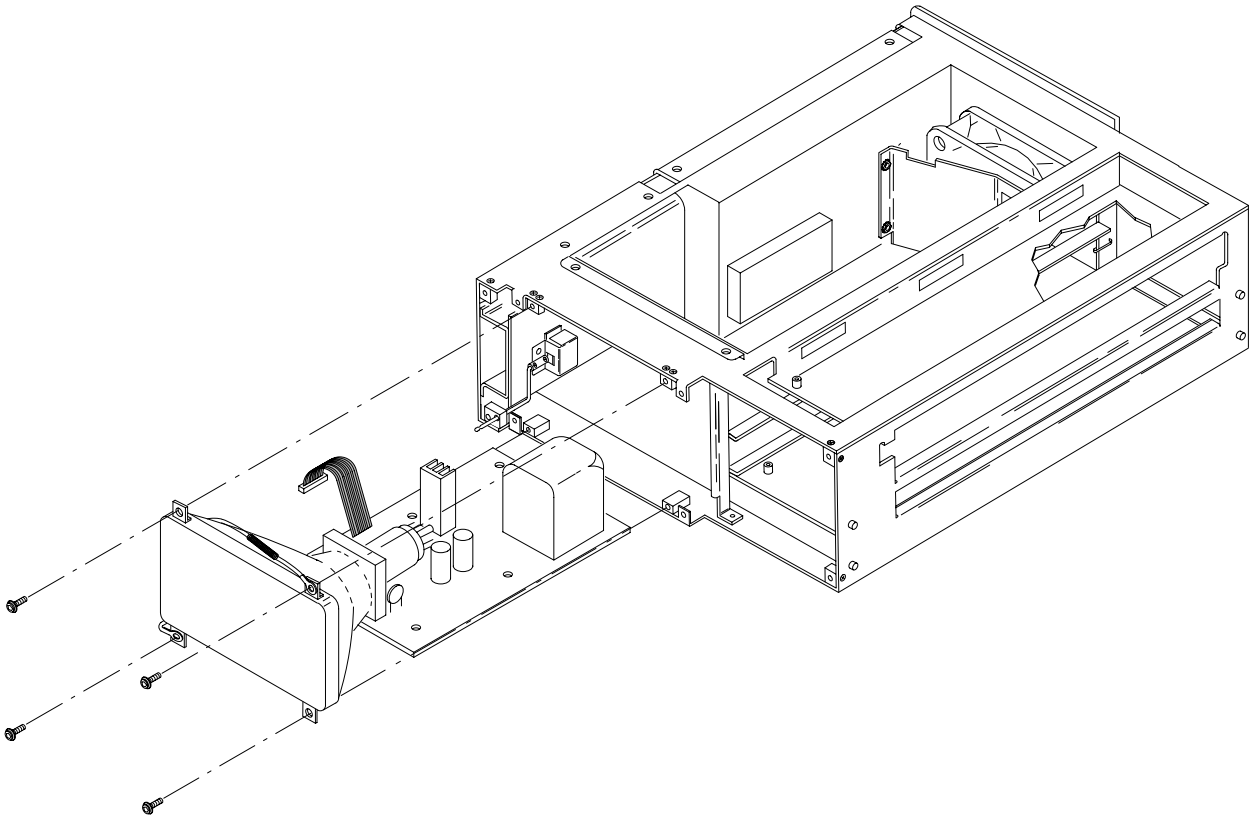


Figure 4-39. Detaching the CRT and Removing the CRT/Display Assembly

5. Slide the CRT/display assembly out through the front of the chassis.

PSI Power Supply (AC only)

The PSI power supply is shipped with instruments that do not have the DC power option. The DC option requires a different type of power supply, described in the following section.

Before you can remove the PSI power supply, you must first do the following:

- ✔ Remove the top and bottom covers of the instrument.
- ✔ Disconnect the power-supply cable from the control board.

Then remove the power supply as follows:

1. Using a #2 Pozidriv screwdriver, remove the 12 screws from the power supply cover and lift out the power supply.

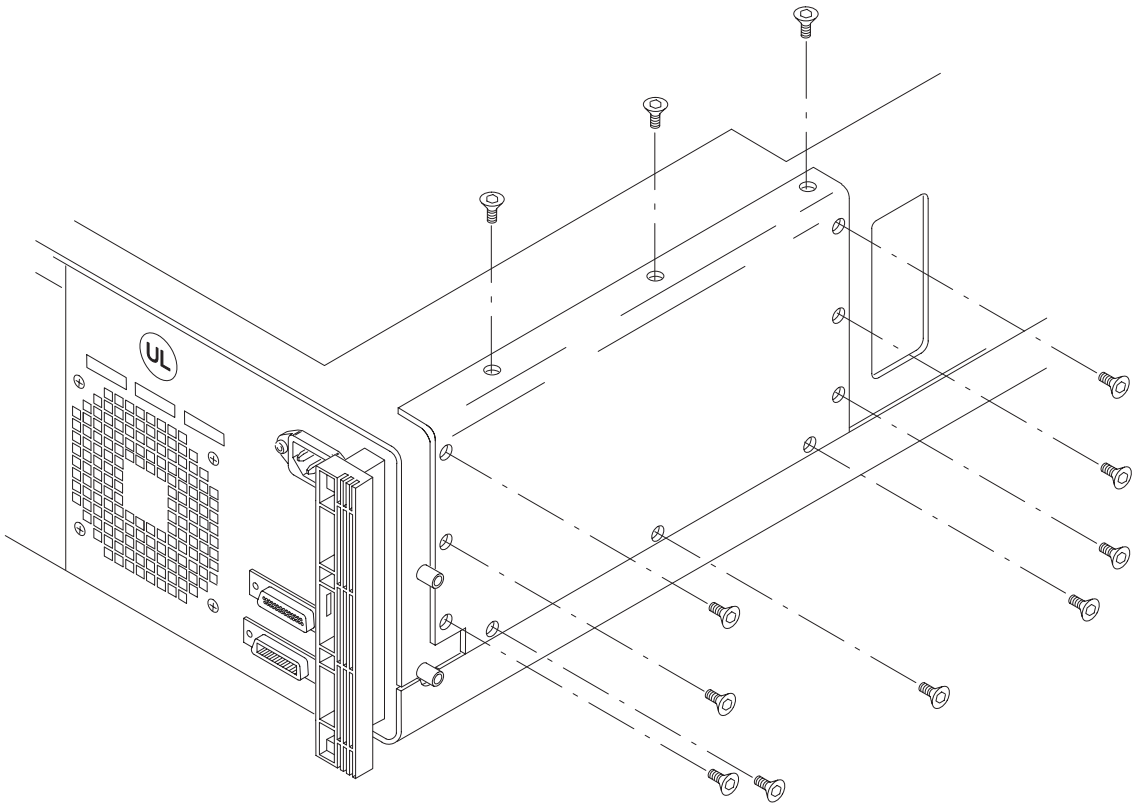


Figure 4-40. Removing the PSI Power Supply

2. Disconnect two connectors from the power supply.

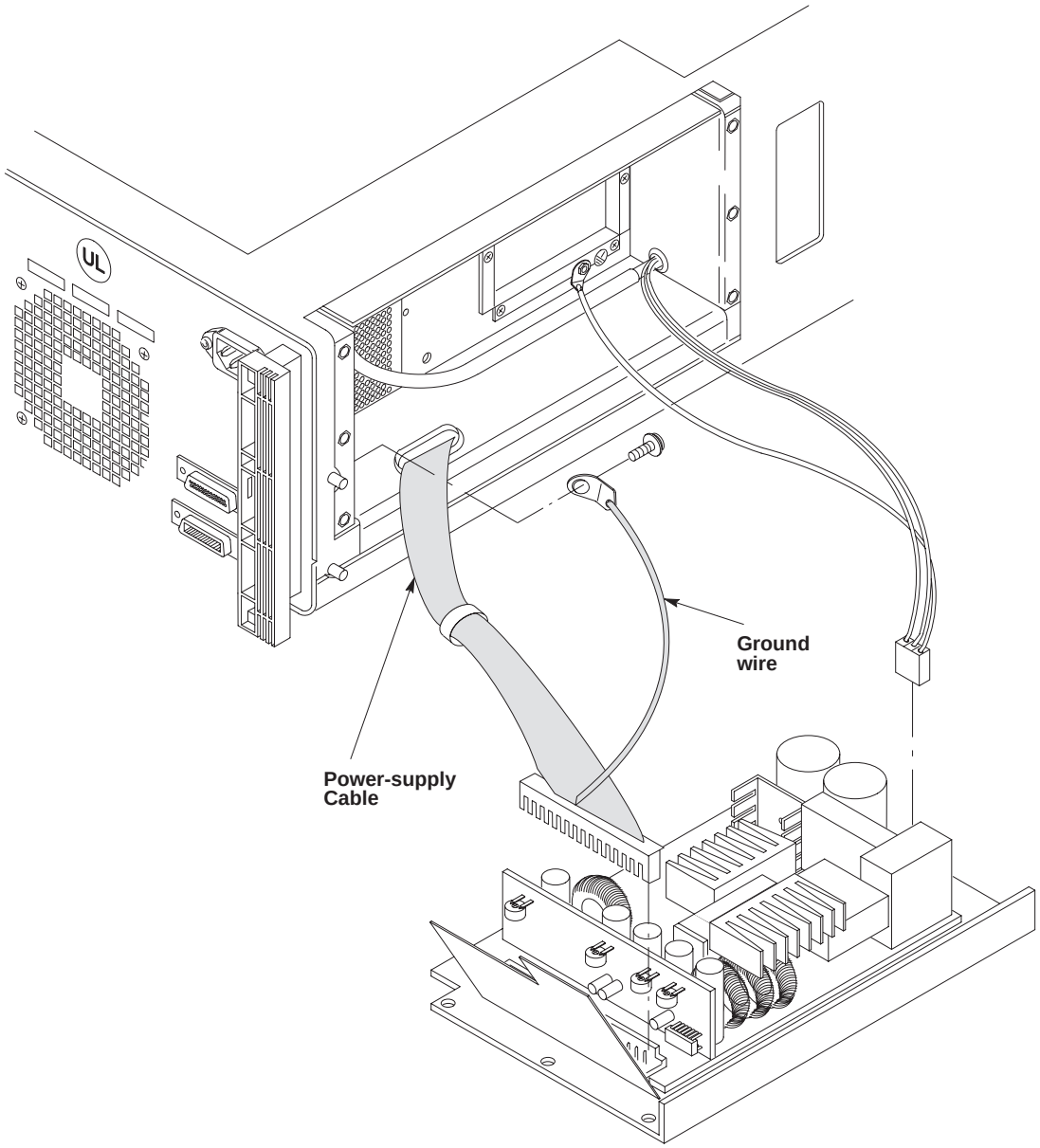


Figure 4-41. Disconnecting the PSI Power Supply

3. Using a #1 Pozidriv screwdriver, unscrew the ground wire that attaches the power-supply connector to the instrument chassis. Thread the connector that connects the power supply to the control board through the chassis and remove the cable.

IPD Power Supply and DC Power Option

The IPD power supply is shipped with all instruments that have the DC power option. Some AC-only instruments may also include this power supply.

Before you can remove the IPD power supply, you must first do the following:

- ✔ Remove the top and bottom covers of the instrument.
- ✔ Disconnect the power-supply cable from the control board.
- ✔ Remove the printer tray.
- ✔ Remove the CRT/display assembly

Then remove the power supply as follows:

1. Using a #2 Pozidriv screwdriver, remove the12 screws from the power-supply cover and lift out the power supply

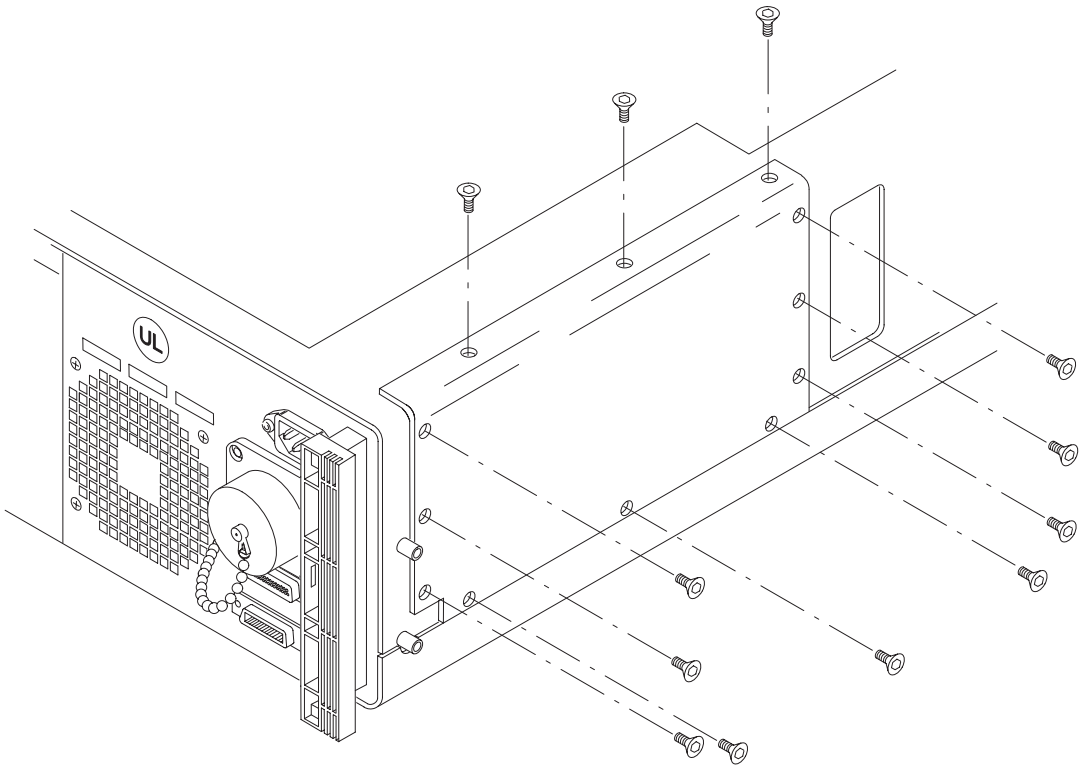


Figure 4-42. Removing the IPD Power Supply

2. Disconnect cables from the power supply, as shown below.

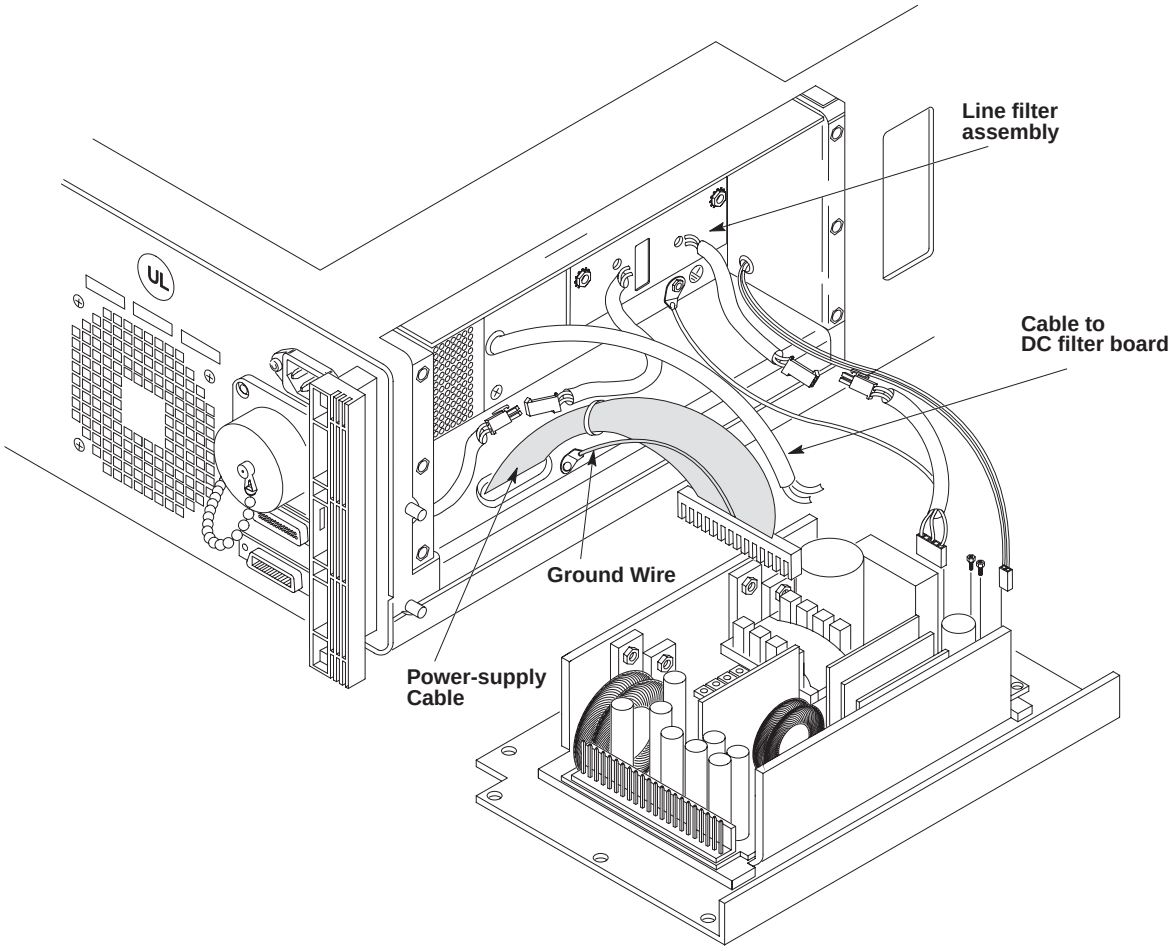


Figure 4-43. Disconnecting the IPD Power Supply

3. Using a #1 Pozidriv screwdriver, unscrew the ground wire that attaches the power-supply connector to the instrument chassis. Thread the connector that connects the power supply to the control board through the chassis and remove the cable.

4. Remove the cable that connects the DC filter board with the power supply by unscrewing two screws on the power supply. Thread the cable through the line-filter assembly.

5. Disconnect the two cables that are attached to the line-filter assembly as shown below. Use a 1/4-inch nut driver to detach the green ground wire from the line-filter assembly.

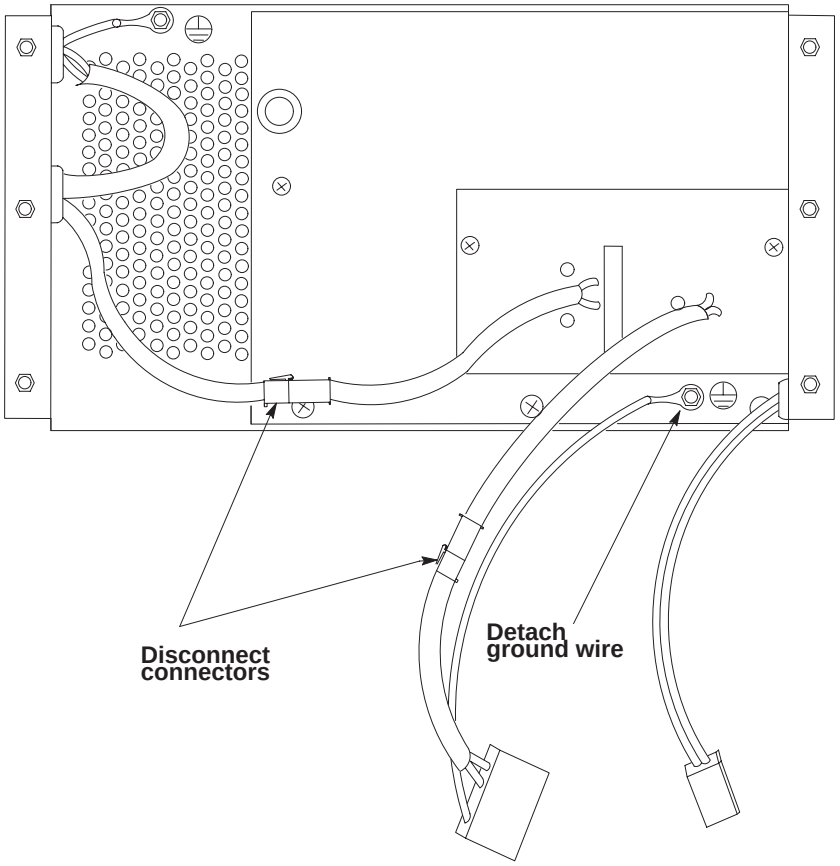


Figure 4-44. Disconnecting the Line Filter Assembly

NOTE *The ground wire, and the cable and connector attached to it, are part of the wire set. The rest of the wire set is removed with the power switch, described later in this section.*

6. Remove the line filter assembly by removing four screws from the plate that attaches the assembly to the chassis, using se a #1 Pozidriv screwdriver.

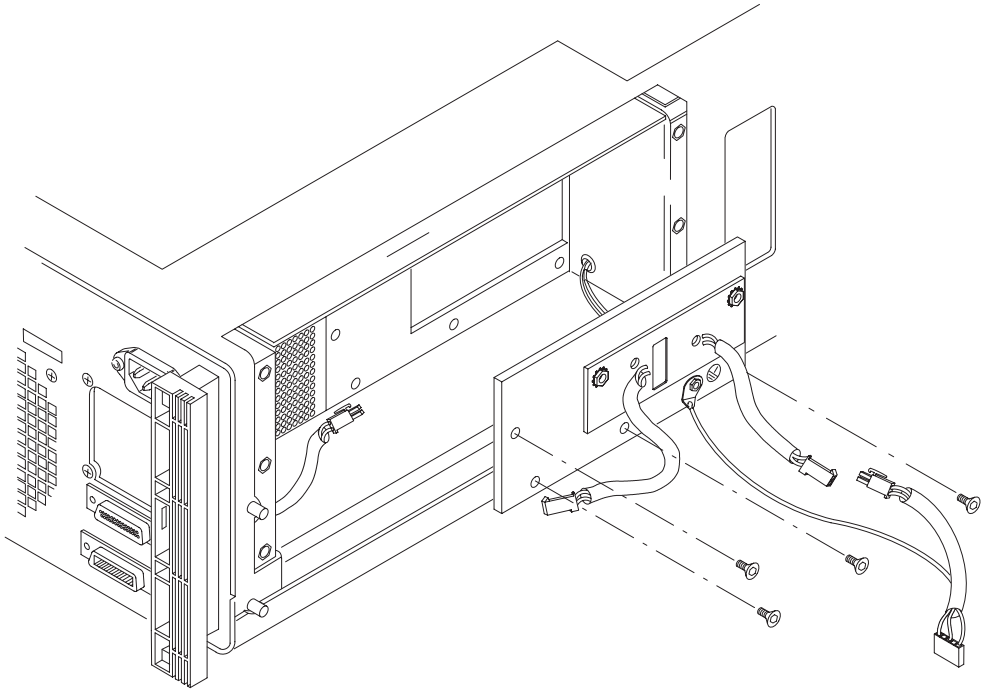


Figure 4-45. Removing the Line Filter Assembly

7. Detach the DC interlock ring from the back panel of the instrument by removing four hex-head screws using a 3/32-inch Allen wrench.
8. Disconnect four connectors that attach the wire set to the DC interlock ring. Disconnect two wires from the DC interlock ring to the DC filter board.

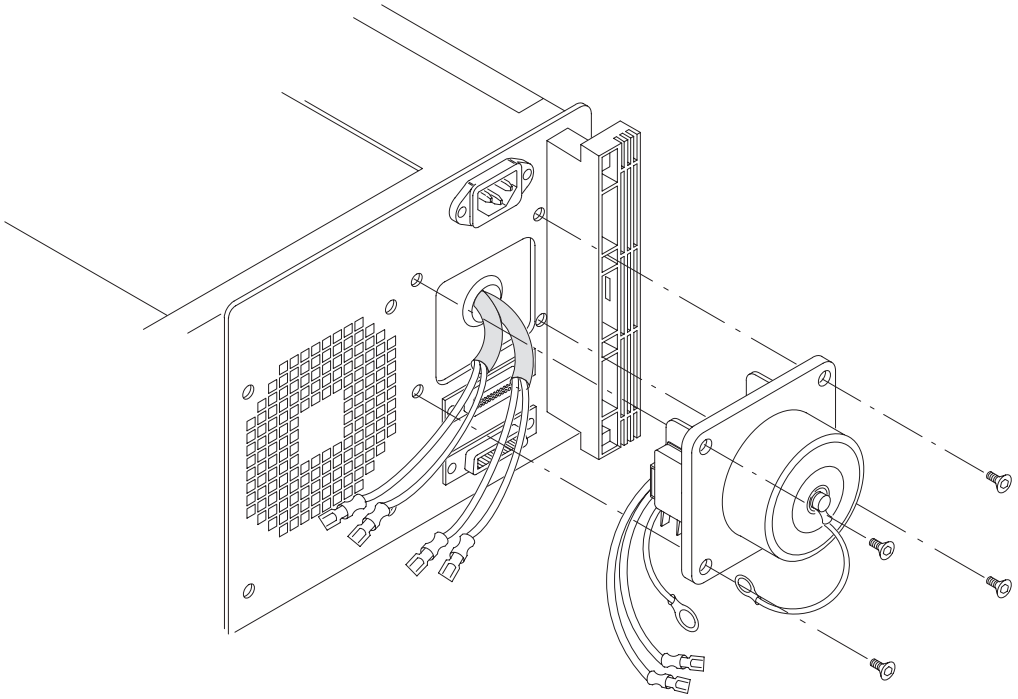


Figure 4-46. Removing the DC Interlock Ring

9. Using a 1/4-inch end wrench, remove the two nuts that attach the air baffle to the side of the chassis. Use a 11/32-inch nut driver to remove the two nuts and bolts that attach the air baffle and fan to the back panel. Lift out the air baffle and DC filter board.

10. Use a #1 Pozidriv screwdriver to detach the DC filter board from the air baffle.

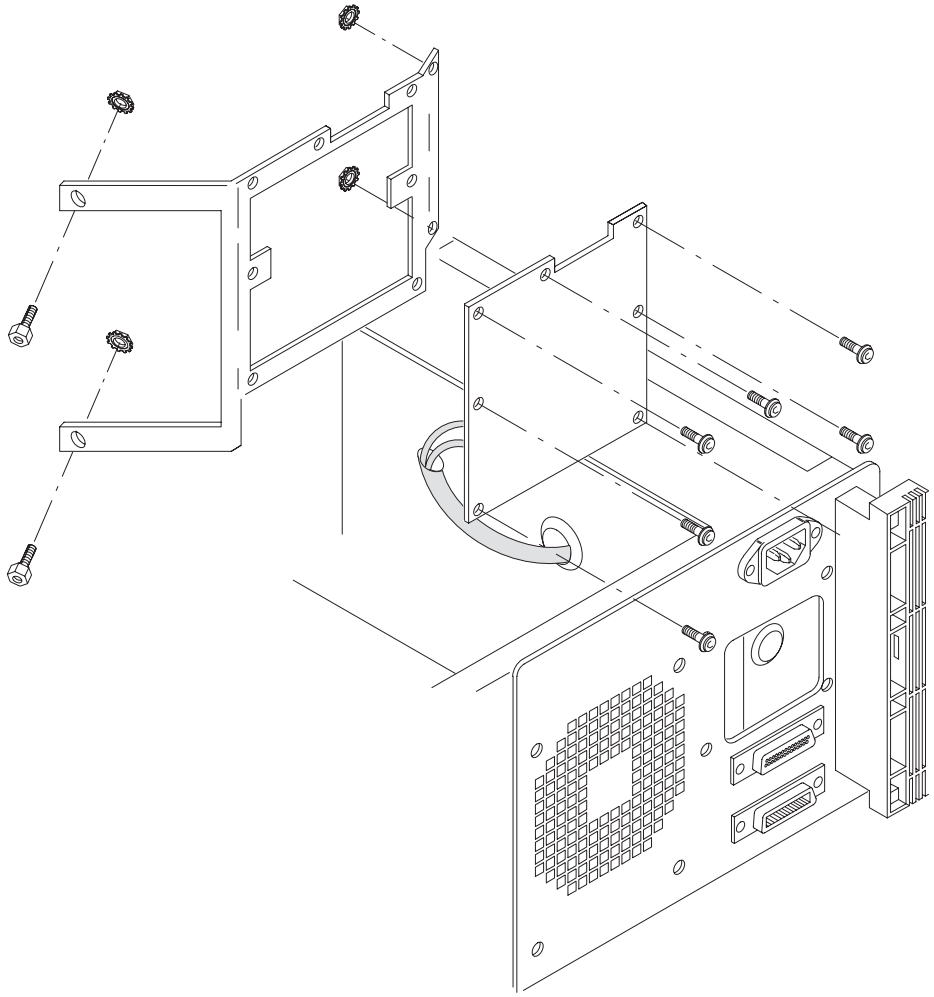


Figure 4-47. Removing the DC Filter Board

MDI - Power Supply and DC Power Option

The MDI power supply is shipped with all instruments with serial numbers of B080000 and beyond.

Before you can remove the MDI power supply, you must first do the following:

- ✔ Remove the top and bottom covers of the instrument.
- ✔ Disconnect the power-supply cable from the control board.

Then remove the power supply as follows:

1. Using a #2 Pozidriv screwdriver, remove the12 screws from the power-supply cover and lift out the power supply

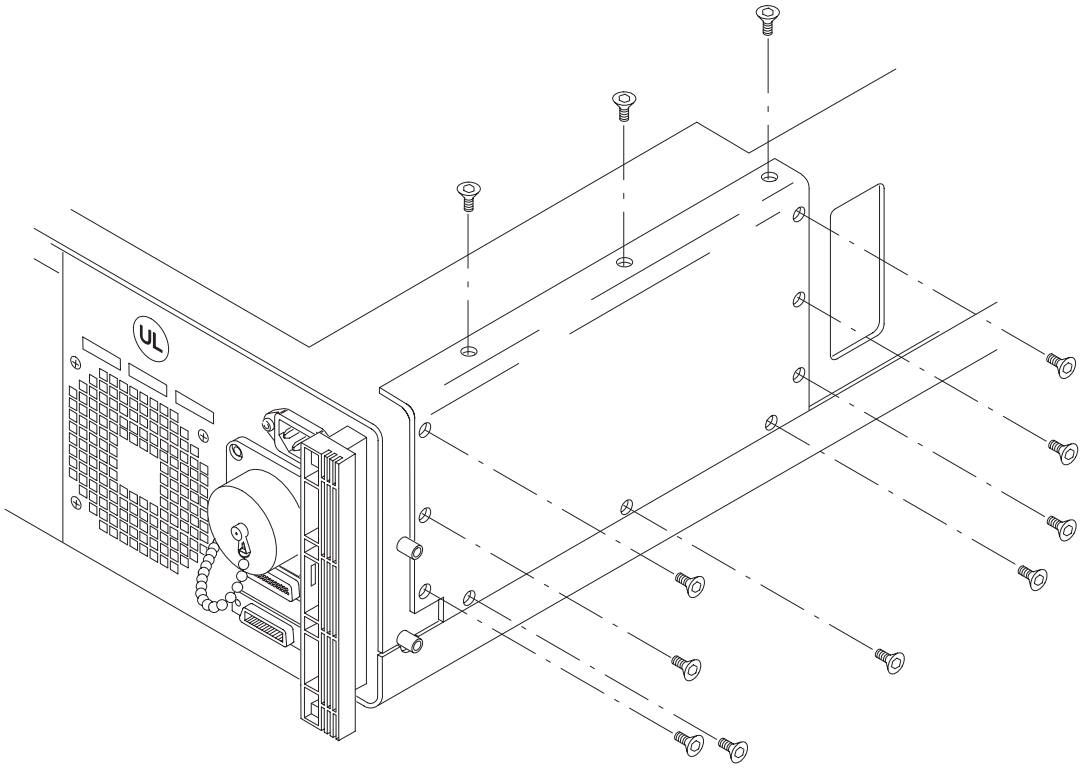


Figure 4-48. Removing the MDI Power Supply

2. Disconnect cables from the power supply, as shown below.

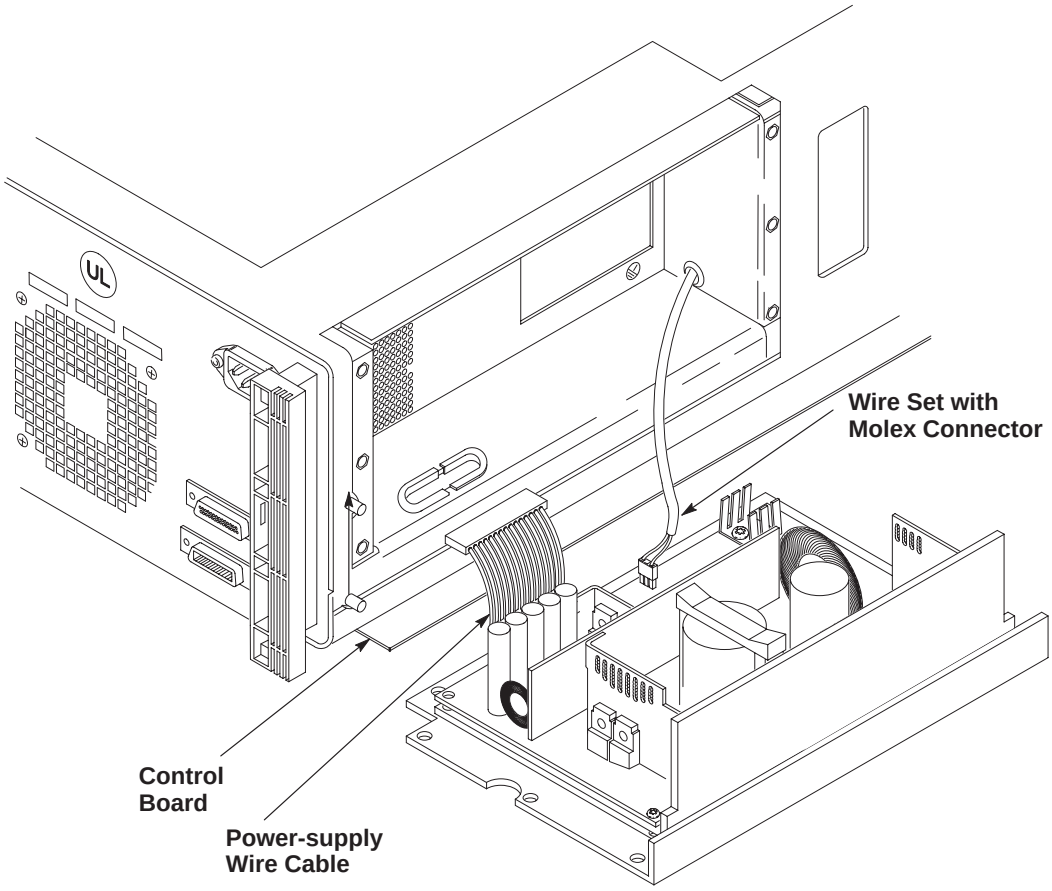


Figure 4-49. Disconnecting the MDI Power Supply

3. Unplug the power supply wire cable from the control board. Thread the connector through the chassis.

4. Remove the cable connecting the MDI Power Supply with the RFI line-filter wire set by unplugging the molex receptical from the power-supply circuit board.

5. Disconnect the following cables to remove the DC Module.

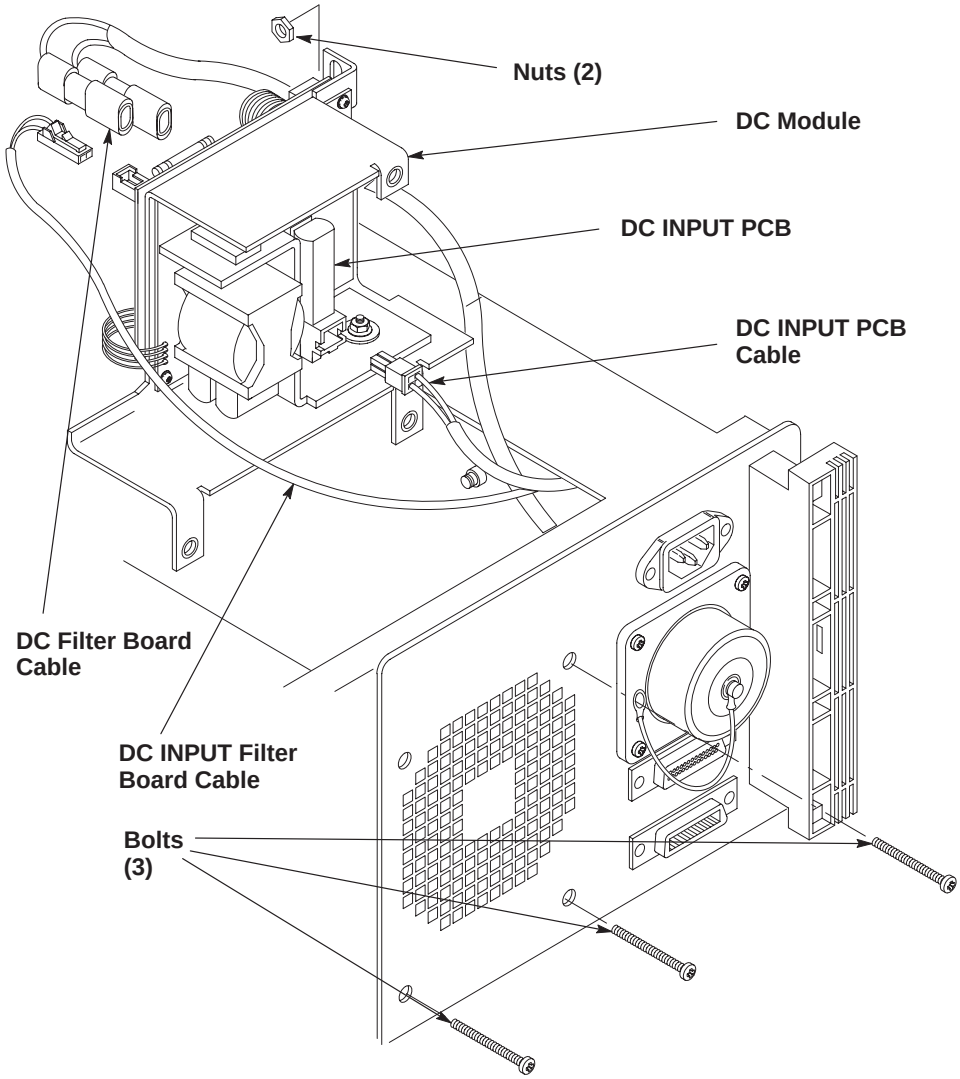


Figure 4-50. Removing the MDI DC Module

6. Use a 1/4 open end wrench to remove the two nuts attaching the DC Module to the mounting studs on the side of the chassis.
7. Using a #2 Pozidriv screwdriver, remove three bolts attaching the DC Module to the rear panel. This hardware is shared in attaching the fan.
8. Lift the module up and disconnect the DC wire set cable from the DC Input PCB.
9. Disconnect the DC wire set cable from the DC Filter Board.
10. Disconnect the DC wire set cable with quick disconnect terminals from the DC Filter Board.

Note *Torque the bolts to 9 inch-lbs. during re-assembly.*

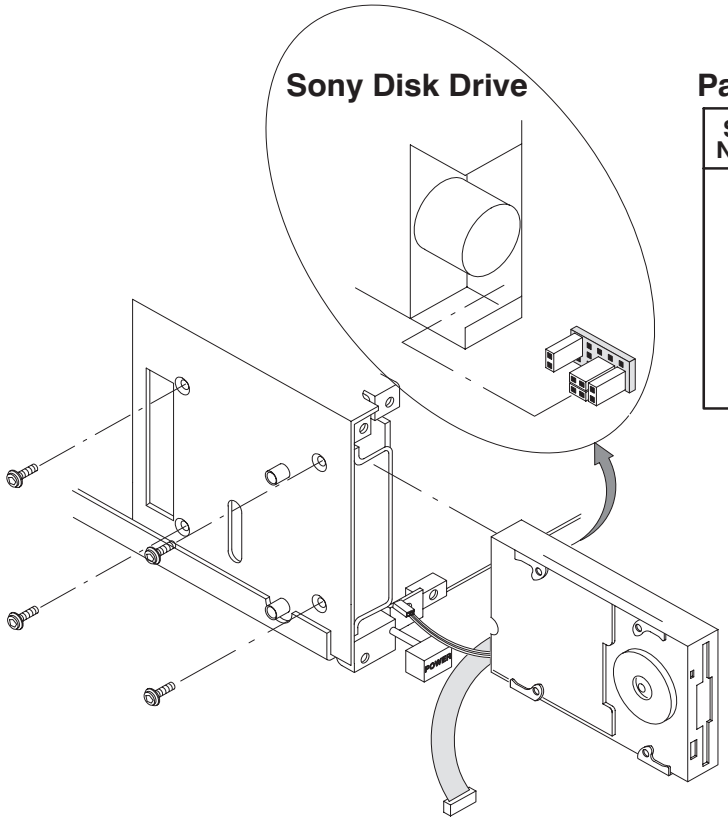
Disk Drive

Before you can remove the disk drive, you must first do the following:

- ✔ Remove the front panel.
- ✔ Remove the top and bottom covers of the instrument.
- ✔ Disconnect the two disk-drive cables from the control board.

Then remove the disk drive as follows:

1. Using a #2 Pozidriv screwdriver, remove the four screws from the side of the chassis.
2. Pull disk drive out of slot, threading the two disk-drive cables through the chassis. Dress the larger cable tightly to its previous folds to fit it through the chassis.



Panasonic Disk Drive

Switch Number	Switch Setting
SW1	DC
SW2	OUT
SW3	DO
SW4	N/A
SW5	PC
SW6	MO

Figure 4-51. Removing the Floppy-Disk Drive

NOTE *When installing a Sony disk drive, make sure the jumpers on the drive are configured as shown in the detail on figure 4-51. When installing a Panasonic disk drive, reference the table above to make sure the slide switchs are set correctly.*

Module Support Board

Before you can remove the module support board, you must first do the following:

- ✔ Remove the top cover of the instrument.
- ✔ Remove the back-panel assembly and plug-in optical modules.

Then remove the module support board as follows:

1. Using a #1 Pozidriv screwdriver, remove six screws from the module support board and lift it out of chassis.

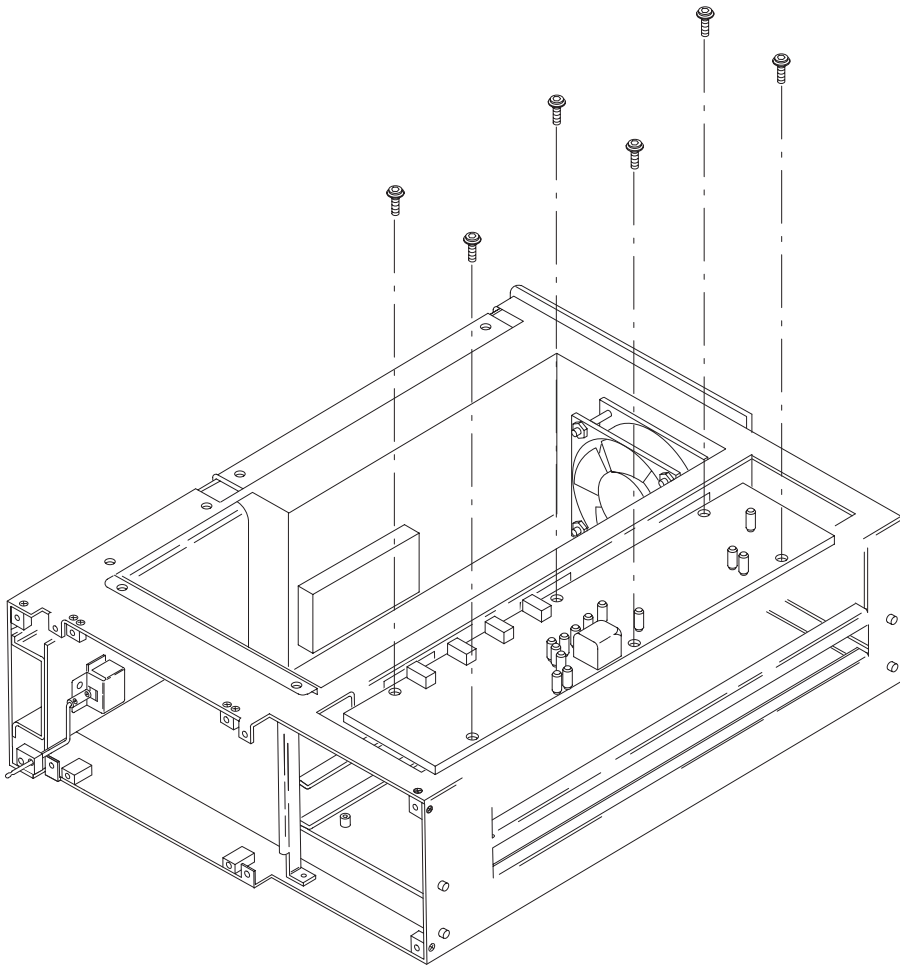


Figure 4-52. Removing the Module Support Board

Interconnect Board

Before you can remove the interconnect board, you must take the back-panel assembly off the instrument and remove the plug-in optical modules.

1. The interconnect board is attached to the inside of the back-panel assembly. Using a #1 Pozidriv screwdriver, remove five screws from the interconnect board to detach it from the back-panel assembly.

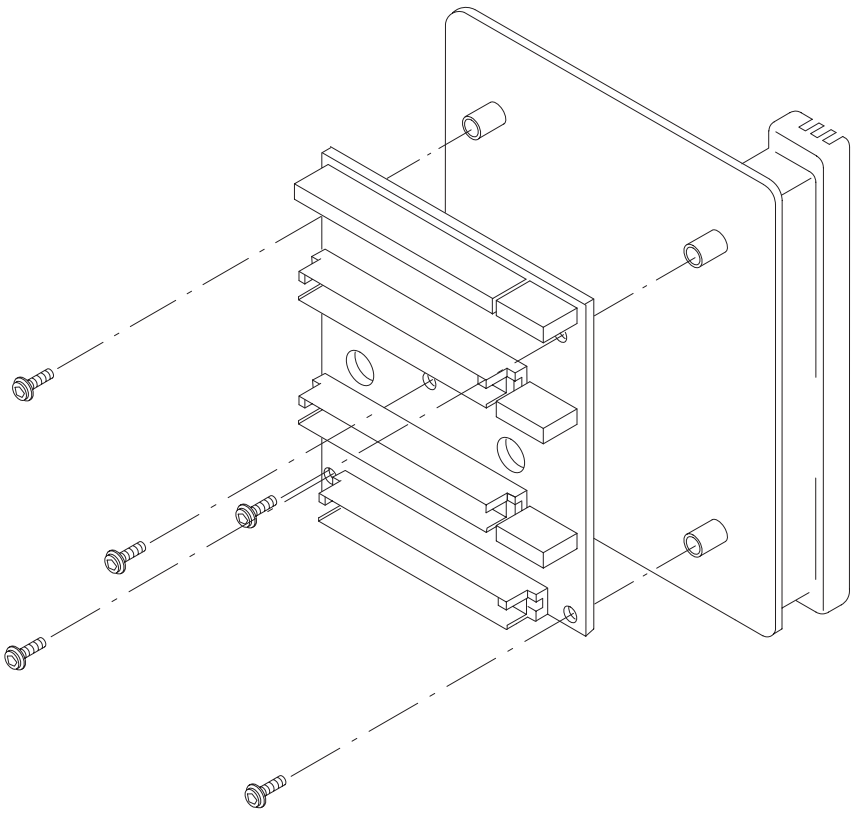


Figure 4-53. Detaching the Interconnect Board

Fan

Before you can remove the fan, you must first do the following:

- ✔ Remove the top and bottom covers of the instrument.
- ✔ Remove the printer assembly.
- ✔ Remove the CRT/display assembly.
- ✔ Disconnect the fan cable from the control board.

Then remove the fan as follows:

1. Use a 1/4-inch end wrench to remove the two bolts that attach the air baffle to the side of the chassis. Use an 11/32-inch nut driver to remove the two nuts and bolts that attach the air baffle and fan to the back panel. Lift out the air baffle.

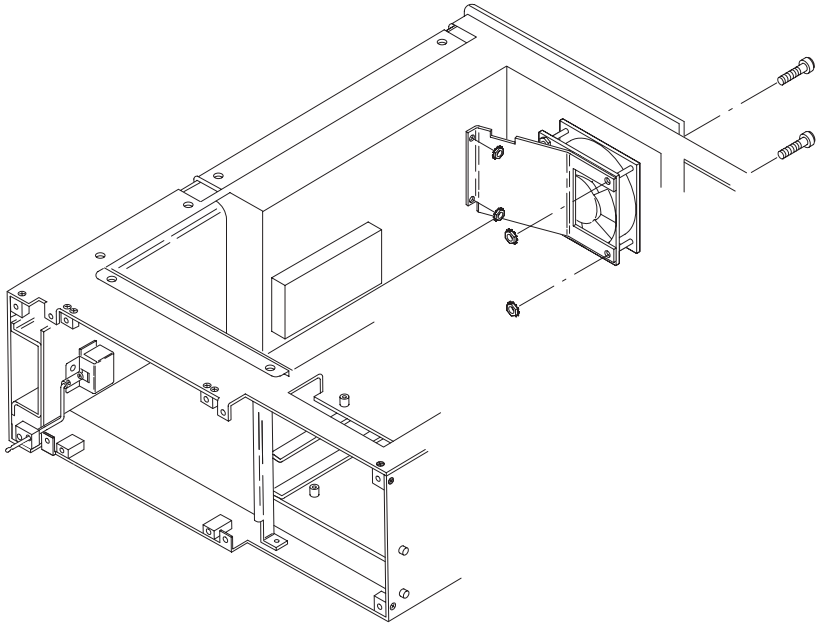


Figure 4-54. Detaching the Air Baffle and Fan from the Back Panel

2. Remove the remaining two nuts and bolts that attach the fan to the back panel, and lift out the fan.

NOTE *Torque these bolts and nuts to 9 inch-lbs. during re-assembly.*

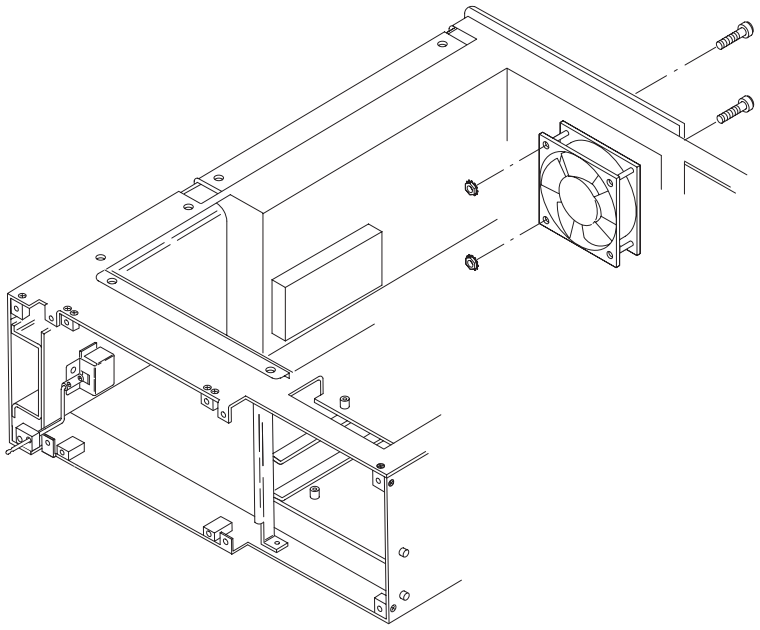


Figure 4-55. Detaching the Fan from the Back Panel

Power Switch, Wire Set, and Line Filter

Before you can remove the power switch, wire set, and line filter, you must first do the following:

- ✔ Remove the front panel.
- ✔ Remove the top and bottom covers of the instrument.
- ✔ Remove the printer assembly.
- ✔ Remove the CRT/display assembly.
- ✔ Remove the disk drive.
- ✔ Remove the power supply.

Then remove the power switch, wire set, and line filter as follows:

1. Using a 0.5-inch Allen wrench, remove the switch coupler by loosening the set screw nearest the power switch bracket.

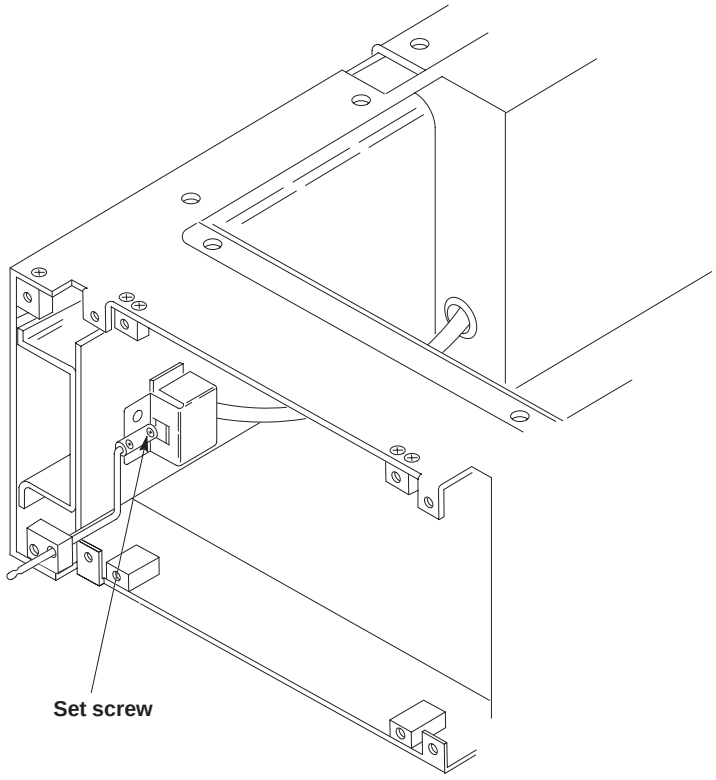


Figure 4-56. Removing the Power Switch Coupler

2. Using a #1 Pozidriv screwdriver, remove the two screws that attach the power switch bracket to the chassis. These screws are accessible through a hole in the left side of the chassis, and through the disk drive slot, as shown below.

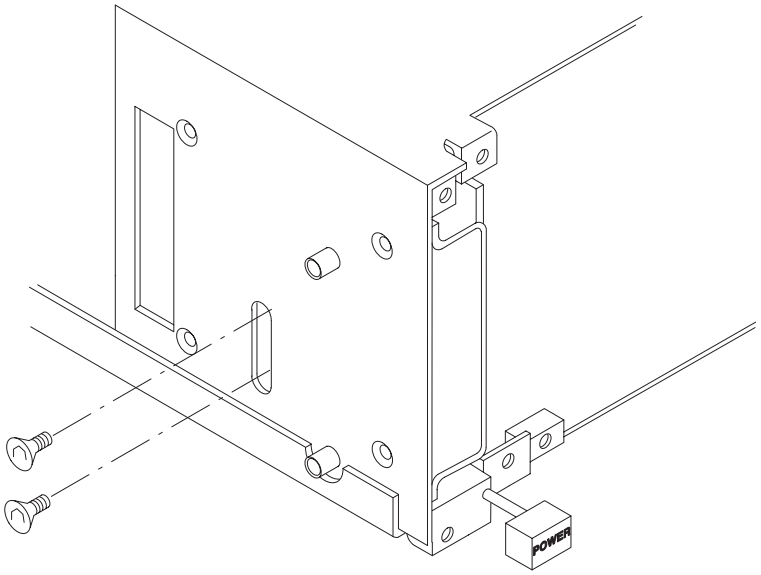


Figure 4-57. Removing the Power Switch Bracket

3. After removing the power switch and bracket from the chassis, use a #1 Pozidriv screwdriver to unscrew the power switch from the bracket.
4. Unsolder the switch from the wire set.
5. Using a 1/4-inch nut driver, detach the two green ground wires that are attached to the chassis inside the power supply cavity.

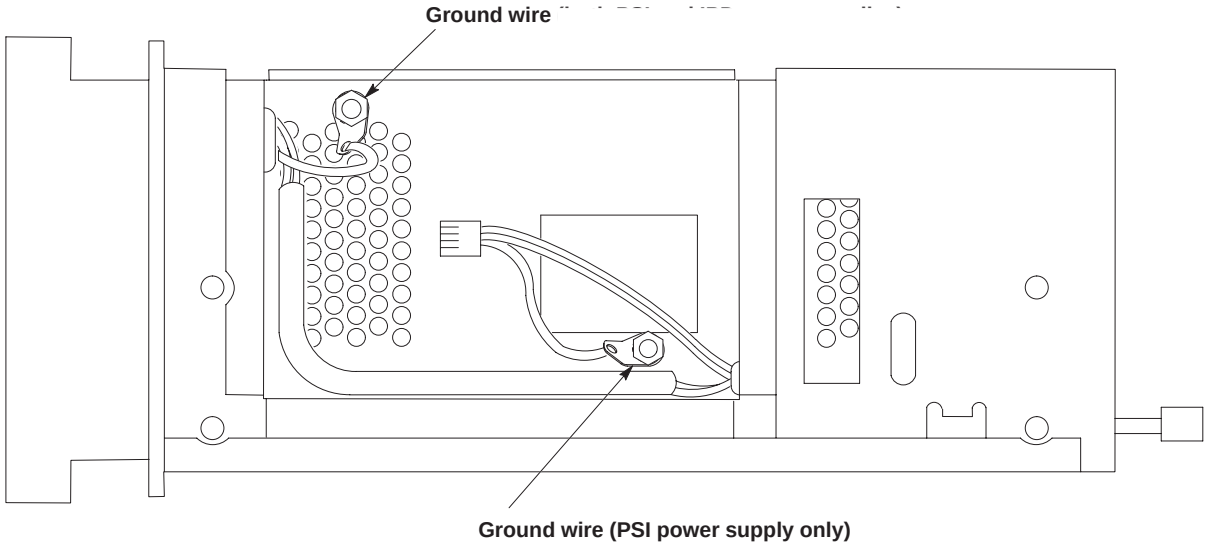


Figure 4-58. Detaching the Ground Wires from the Chassis

NOTE *The ground wire coming from the AC line filter is the only one you need to remove if you have the IPD power supply (used with the DC option 17, and with some AC-only units).*

6. Using a #2 Pozidriv screwdriver, remove the line filter from the back panel. You can then thread the wire set through the chassis and out the back panel.

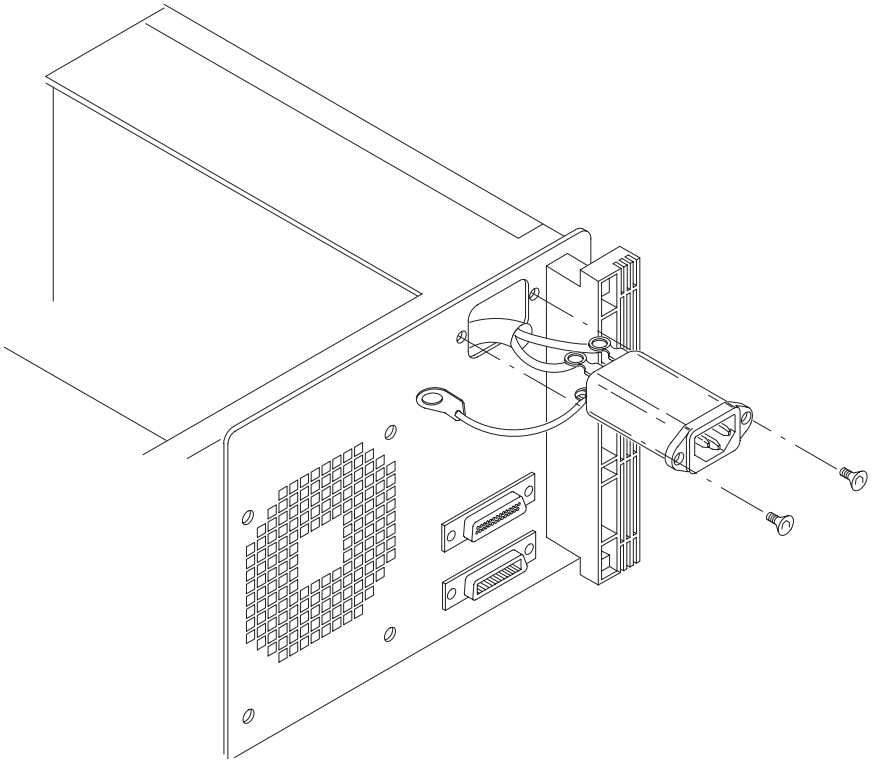


Figure 4-59. Removing the Line Filter and Wire Set

7. Unsolder the wire set from the line filter.

5 Replaceable Parts List

This chapter contains a list of the modules that are replaceable for the TFP2A FiberMaster. Use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available from your Tektronix Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to provide benefit of the latest circuit improvements developed by our engineering department. It is important when ordering parts to include the following information in your order:

- ✔ Part number
- ✔ Instrument type or model number
- ✔ Serial number
- ✔ Modification number (if applicable)

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

Module Replacement

The TFP2A FiberMaster is serviced by module replacement, so there are three options you should consider:

- ❑ Module exchange—in some cases you can exchange your module for a remanufactured module. These modules cost significantly less than new modules and meet the same factory specifications. For more information about the module exchange program, call 1-800-835-9433.
- ❑ Module repair—you can ship your module to us for repair, and we will repair and return the same module to you.
- ❑ New modules—you can purchase new replacement modules in the same way as other replacement parts.

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 all the information you need for ordering replacement parts.

This parts list is indented to indicate item relationships. The following is an example of the indentation system used in the Name and Description column of the list:

Assembly and/or component
. Detail part of assembly or component
.. Parts of detail part

Abbreviations conform to American National Standards Institute (ANSI) standard Y1.1.

Tektronix Part Number

Use this part number when ordering a replacement part from Tektronix.

Serial/Model No.

These columns show the serial numbers of the first and last instruments in which the part was used. No entry in these columns indicates that the part is used in all instruments.

Name and Description

In this parts list, an item name is separated from its description by a colon (:). Because of space limitations, an item name may sometimes appear to be incomplete. For additional item name identification, refer to the U.S. Federal Cataloging Handbook H6-1.

Mfr. Code and Part Number

These columns list the code number of the manufacturer of the part, and that manufacturer's part number. Refer to the Mfg. Code Number to Manufacturer cross index for the names and addresses of the manufacturers listed.

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
TK0435	LEWIS SCREW CO	4300 S RACINE AVE	CHICAGO, IL 60609–3320
TK2231	ELECTRONIC ASSEMBLERS INC	616 INDUSTRIAL SUITE 10	HOOD RIVER, OR 97031
TK2237	WEST COAST TELECOM INC SUB OF KAO CORP OF AMERICA	10300 SW NIMBUS AVE	PORTLAND, OR 97223
TK2469	UNITREK CORPORATION	3000 LEWIS & CLARK WAY SUITE #2	VANCOUVER, WA 98601
TK2496	OEM INC	1555 SW CRYSTAL LAKE DRIVE PO BOX 831	CORVALLIS, OR 97339
TK2517	NMB CORPORATION	1735 TECHNOLOGY DRIVE SUITE 700	SAN JOSE, CA 95110
0DWW6	MICRO POWER ELECTRONICS	7973 SW CIRRUS DRIVE, BLDG. #22	BEAVERTON, OR 97005
0GV52	SCHAFFNER	325 LEHIGH	UNION, NJ 07083
0JRZ5	GASKET TECHNOLOGY	478 NE 219TH AVENUE	TROUTDALE,OR 97060
0JR03	ZMAN MAGNETICS INC	7633 S 180TH	KENT, WA 98032
0JR05	TRIQUEST CORP	3000 LEWIS AND CLARK WAY	VANCOUVER, WA 98661–2999
0J260	COMTEK MANUF OF OREGON	PO BOX 4200	BEAVERTON,OR 97076–4200
0J4Z2	PRECISION PRINTERS	964 GOLDEN GATE TERRACE	GRAND VALLEY, CA 95945
0J7N9	MCX INC	30608 SAN ANTONIO ST	HAYWARD, CA 94544
0J9P4	DELTA ENGINEERING	19500 SW TETON	TUALATIN, OR 97062
0J9P9	GEROME MFG CO INC	PO BOX 737	NEWBERG, OR 97132
0KB01	STAUFFER SUPPLY	810 SE SHERMAN	PORTLAND, OR 97214
00779	AMP INC	2800 FULLING MILL PO BOX 3608	HARRISBURG, PA 17105
01536	TEXTRON INC, CAMCAR DIV SEMS PRODUCTS UNIT	1818 CHRISTINA ST	ROCKFORD, IL 61108
12327	FREEWAY CORP	9301 ALLEN DRIVE	CLEVELAND, OH 44125–4632
22526	BERG ELECTRONICS INC (DUPONT)	857 OLD TRAIL RD	ETTERS, PA 17319
22670	G M NAMEPLATE INC	2040 15TH AVE WEST	SEATTLE, WA 98119–2728
26233	NYLOK FASTENER CORP	1161 E SANDHILL AVE, SUITE D PO BOX 5228	CARSON, CA 90749
27819	GALILEO ELECTRO–OPTICS CORP	PO BOX 550 GALILEO PARK	STURBRIDGE, MA 01566
31918	ITT SCHADOW INC	8081 WALLACE RD	EDEN PRAIRIE, MN 55344–2224
5Y400	TRIAX METAL PRODUCTS INC DIV OF BEAVERTON PARTS MFG CO	1800 216TH AVE NW	HILLSBORO, OR 97124–6629
50463	POWER SYSTEMS INC	45 GRIFIN ROAD	SOUTH LINFIELD, CT 06002
55566	R A F ELECTRONIC HARDWARE INC	95 SILVERMINE RD	SEYMOUR, CT 06483–3915
57003	CHOMERICS INC	23839 S BANNING BLVD	CARSON, CA 90745–6225
7X318	KASO PLASTICS INC	11015 A NE 39TH	VANCOUVER, WA 98662
70485	ATLANTIC INDIA RUBBER WORKS INC	571 W POLK ST	CHICAGO, IL 60607
73743	FISCHER SPECIAL MFG CO	111 INDUSTRIAL RD	COLD SPRINGS, KY 41076–9749
77252	PHILADELPHIA STEEL AND WIRE CORP	2828 CHARTER ROAD	PHILADELPHIA, PA 19154–2111
78189	ILLINOIS TOOL WORKS INC SHAKEPROOF DIV	ST CHARLES ROAD	ELGIN, IL 60120
8X345	NORTHWEST SPRING & MFG CO	5858 WILLOW LANE	LAKE OSWEGO, OR 97034–5343
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077–0001
83385	MICRODOT MFG INC GREER–CENTRAL DIV	3221 W BIG BEAVER RD	TROY, MI 48098
85471	BOYD CORP	13885 RAMONA AVE	CHINO, CA 91710
91929	HONEYWELL INC – MICRO SWITCH DIV	11 W SPRING ST	FREEPORT, IL 61032
93907	TEXTRON INC – CAMCAR DIV	600 18TH AVE	ROCKFORD, IL 61108–5181

Component Number	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Name & Description	Mfr. Code	Mfr. Part No.
A1	672–1443–00	B070000	B072039	CKT BD ASSY:CONTROL W/SOFTWARE, TFP2A	80009	672–1443–00
	672–1443–00	B070500	B070500	CKT BD ASSY:CONTROL W/SOFTWARE, TFP2A/M	80009	672–1443–00
A1	672–1443–02	B072040		CKT BD ASSY:CONTROL W/SOFTWARE, TFP2A	80009	672–1443–02
	672–1443–02	B070501		CKT BD ASSY:CONTROL W/SOFTWARE, TFP2A/M	80009	672–1443–02
				CONTROL BD ASSY CONSISTS OF 671–3301–XX AND S/W (SEE OPT ACCYS)		
A2	671–3600–00	B070000	B072237	CKT BD ASSY:FRONT PANEL, TFP2A	80009	671–3600–00
	671–3600–00	B070000	B070515	CKT BD ASSY:FRONT PANEL, TFP2AM	80009	671–3600–00
A2	671–3600–01	B072238		CKT BD ASSY:FRONT PANEL, TFP2A	80009	671–3600–01
	671–3600–01	B070516		CKT BD ASSY:FRONT PANEL, TFP2AM	80009	671–3600–01
A3	118–8555–01	B070000	B079999	POWER SUPPLY ASSY: PSI,225W (AC ONLY)	50463	118–8555–01
	118–8554–02	B070000	B079999	POWER SUPPLY ASSY: IPD,200W (DC OPT 17 SUPPLY)	80009	118–8554–02
A3	118–9414–00	B080000		POWER SUPPLY ASSY: MDI,180W	80009	118–9414–00
	118–9413–00	B080000		POWER SUPPLY ASSY: MDI,250W (DC ONLY)	80009	118–9413–00
A3A1	118–8666–01	B070000	B079999	LINE FILTER ASSY:AC (USED W/IPD ONLY}	0JR03	118–8666–01
A4	671–0944–02			CKT BD ASSY:INTERCONNECT	80009	671–0944–02
A5	671–2548–00			CKT BD ASSY:MODULE SUPPORT	80009	671–2548–00
A6	644–0796–00			PRINTER ASSY: **OPTION 16**	80009	644–0796–00
A6A1	671–1061–00			CKT BD ASSY:PRINTER POWER DISTRIBUTION	80009	671–1061–00
A6A2	118–8358–00			CKT BD ASSY:PRINTER	80009	118–8358–00
A6A3	118–7636–00			PRINTER:THERMAL PRINTHEAD W/CABLES	80009	118–7636–00
A7	640–0072–00	B070000	B072426	COLOR MONITOR ASSY:W/O COLOR SHUTTER	80009	640–0072–00
	640–0072–03	B072427		COLOR MONITOR ASSY:W/O COLOR SHUTTER	80009	640–0072–03
A7M	644–0792–00	B070000	B070534	CRT ASSY:MONOCHROME DISPLAY	80009	644–0792–00
	644–0792–03	B070535		CRT ASSY:MONOCHROME DISPLAY	80009	644–0792–03
A8	118–9132–00	B070000	B082732	DISC DRIVE:FLOPPY, TFP2A	80009	118–9132–00
	118–9132–00	B070000	B080594	DISC DRIVE:FLOPPY, TFP2A/M	80009	118–9132–00
	118–9132–01	B082733		DISC DRIVE:FLOPPY, TFP2A	80009	118–9132–01
	118–9132–01	B080595		DISC DRIVE:FLOPPY, TFP2A/M	80009	118–9132–01
A9				INTERNAL RAM:1 MEGABITE **(OPTION 14)**		
A9A1	671–1564–00			CKT BD ASSY:RAM DRIVE INTERNAL MEMORY	80009	671–1564–00
A10	671–2226–01	B070000	B079999	CKT BD ASSY:DC FILTER **(OPTION 17)**	80009	671–2226–01

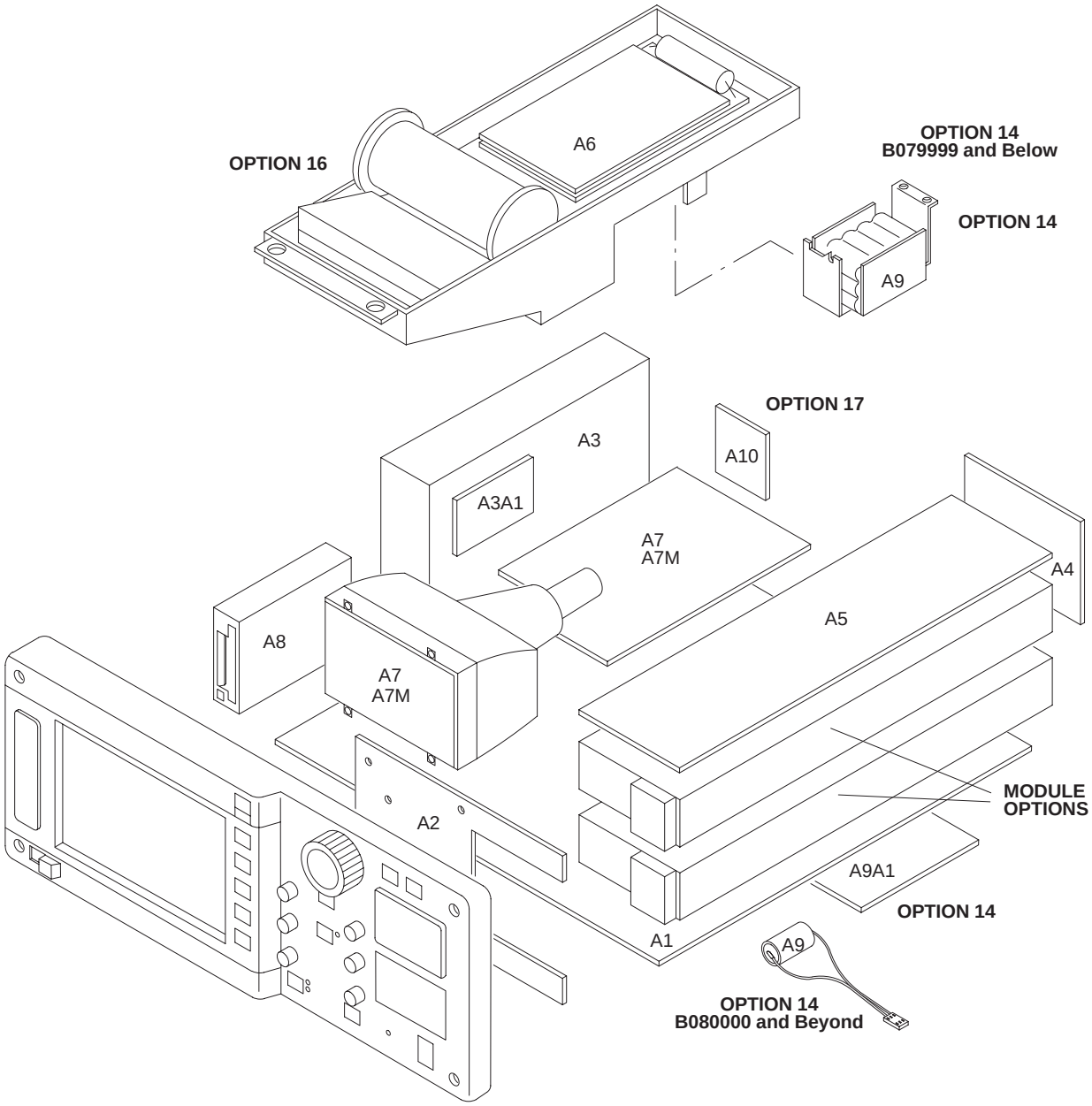


Figure 5-1. Electrical Module Overview

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5-2					CASE		
–1	200–3566–00			1	COVER,FRONT PANEL:	0JR05	200–3566–00
–2	644–0800–00			1	CABPACK ASSY:TOP	80009	644–0800–00
	644–0793–00			1	CABPACK ASSY:OPTION 16 ONLY	80009	644–0793–00
–3	426–2356–01			1	. FRAME,PRINTER:6.3 X 0.5	0JR05	426–2356–01
–4	200–3567–01			1	. LID,PRINTER COVER:	0JR05	200–3567–01
–5	348–1249–00			1	. GASKET,ELASTOMER:0.053 CONDUCT SILICON	57003	10–04–3560–1285
–6	212–0193–00			4	SCR,EXT RLV:8–32 X 0.375 BUTTON HD,HEX,SS,BLK OXIDE	0KB01	ORD BY DESCR
–7	202–0279–01			1	CASE HALF:BOTTOM.SHEET METAL	0J9P4	202–0279–01
–8	348–0419–00			4	FOOT,CABINET:BLACK POLYURETHANE	7X318	348–0419–00

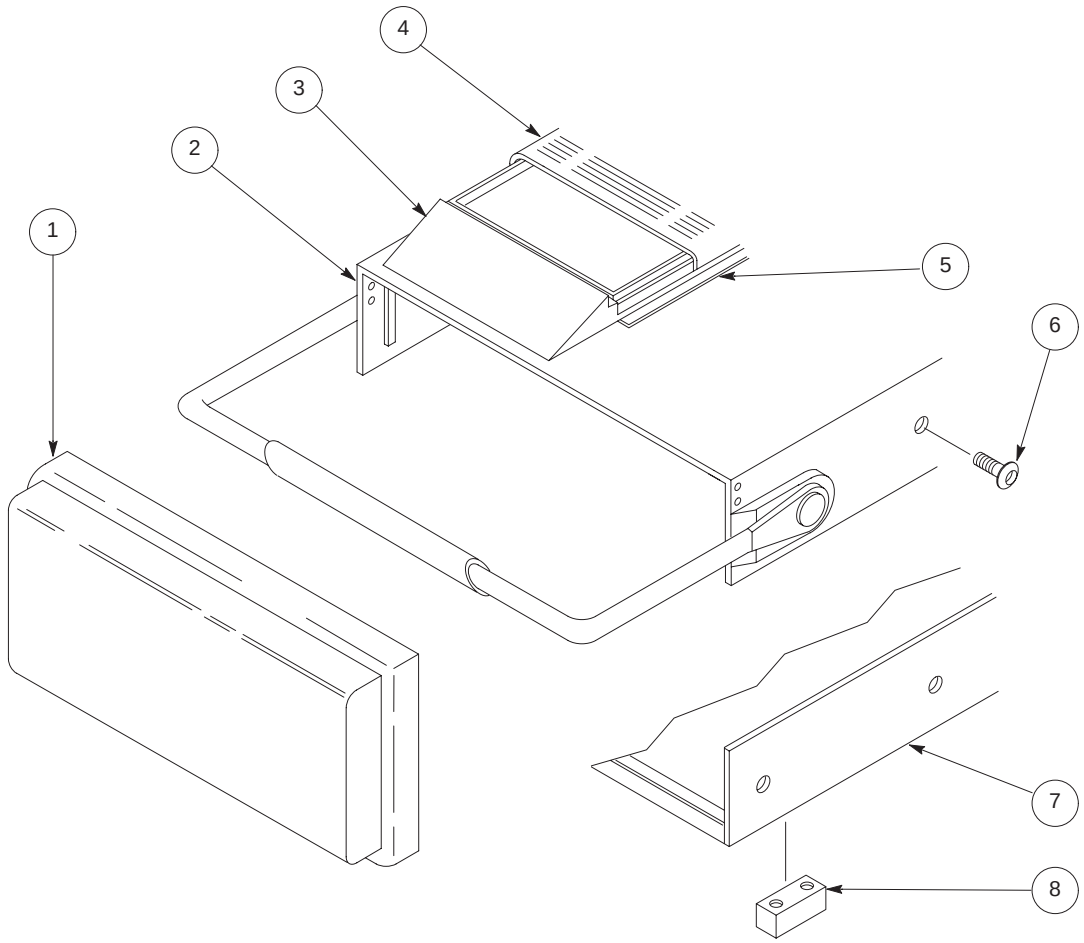


Figure 5-2. Case

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5-3					FRONT PANEL		
–1	212–0718–00			4	SCREW,CAP:10–32 X 0.75,SCH,SS,BLK OXIDE,HEX	0KB01	ORD BY DESCR
–2	210–1035–00			4	WSHR,SPR TNSN:0.195 X 0.328 X 0.006	0KB01	ORD BY DESCR
–3	333–4164–00			1	PANEL,FRONT:TFP2A	7X318	333–4164–00
	333–4161–00			1	PANEL,FRONT:TFP2AM	7X318	333–4161–00
	378–0363–00			4	. LENS,LIGHT CANE:0.120 X 0.415 L	27819	378–0363–00
–4	384–1680–00			1	SHAFT,EXTENSION:0.941 X 0.568,AL	5Y400	384–1680–00
–5	376–0237–00			1	CPLG,PWR SWITCH:1.0 X 0.358,AL	5Y400	376–0237–00
	213–0205–00			2	. SETSCREW:4–40 X 0.188,HEX SKT,NYLON PT	26233	ORD BY DESCR
–6	——— ———			1	CKT BD ASSY:FRONT PANEL (SEE A2 REPL)		
–7	260–2477–00			1	SW,PB:14 BUTTON,ELASTOMERIC SWITCHMAT	80009	260–2477–00
–8	210–1085–00			1	WASHER,FLAT:0.375 ID X 0.75 OD X 0.032	12327	ORD BY DESCR
–9	333–3572–00			1	OPTION PANEL,FRONT:OPTICS MODULE	0JR05	333–3572–00
–10	——— ———				KEYCAP, ACTUATORS:SMOKE TAN,0.6 X 0.4,NYLON ABS ALLOY		
	366–0710–01			1	PUSH BUTTON:SMOKE TAN,MKD HARD COPY	0JR05	366–0710–01
	366–0711–01			1	PUSH BUTTON:SMOKE TAN,CURSOR (HELP)	0JR05	366–0711–01
	366–2115–01			1	PUSH BUTTON:MODULE SELECT	0JR05	366–2115–01
	366–2116–01			1	PUSH BUTTON:START/STOP	0JR05	366–2116–01
	366–2117–01			1	PUSH BUTTON:CURSOR SELECT	0JR05	366–2117–01
	366–2118–01			1	PUSH BUTTON:EXPAND	0JR05	366–2118–01
	366–2119–01			1	PUSH BUTTON:WFM SELECT	0JR05	366–2119–01
	366–2120–01			1	PUSH BUTTON:STORE	0JR05	366–2120–01
–11	366–2100–00			6	KNOB:SMOKE TAN	0JR05	366–2100–00
					NOTE:EACH KNOB INCLUDES:		
	213–0246–00			1	. SETSCREW:5–40 X 0.094,HEX SKT,CUP	80009	213–0246–00
–12	366–0709–01			6	CAP,KNOB:SMOKE TAN,O.4 X 0.6,NON–ILLUM	0JR05	366–0709–01
–13	220–0495–00			1	NUT,PLAIN,HEX:0.375–32 X 0.438 HEX	73743	ORD BY DESCR
–14	214–4339–00			1	SPRING,DETENT:0.710 X 0.217,SS	8X345	214–4339–00
–15	210–1502–00			1	WSHR,FLAT:0.375 X 0.750 X 0.032,WHITE NYLON	0KB01	210–1502–00
–16	366–2099–01			1	KNOB:TAN,BLANK,0.25 X 1.375 X 0.4	80009	366–2099–01
	213–0153–00			1	. SETSCREW:5–40 X 0.125,HEX SKT	0KB01	ORD BY DESCR
–17	366–2141–01			1	PUSH BUTTON:BLACK,POWER	0JR05	366–2141–01

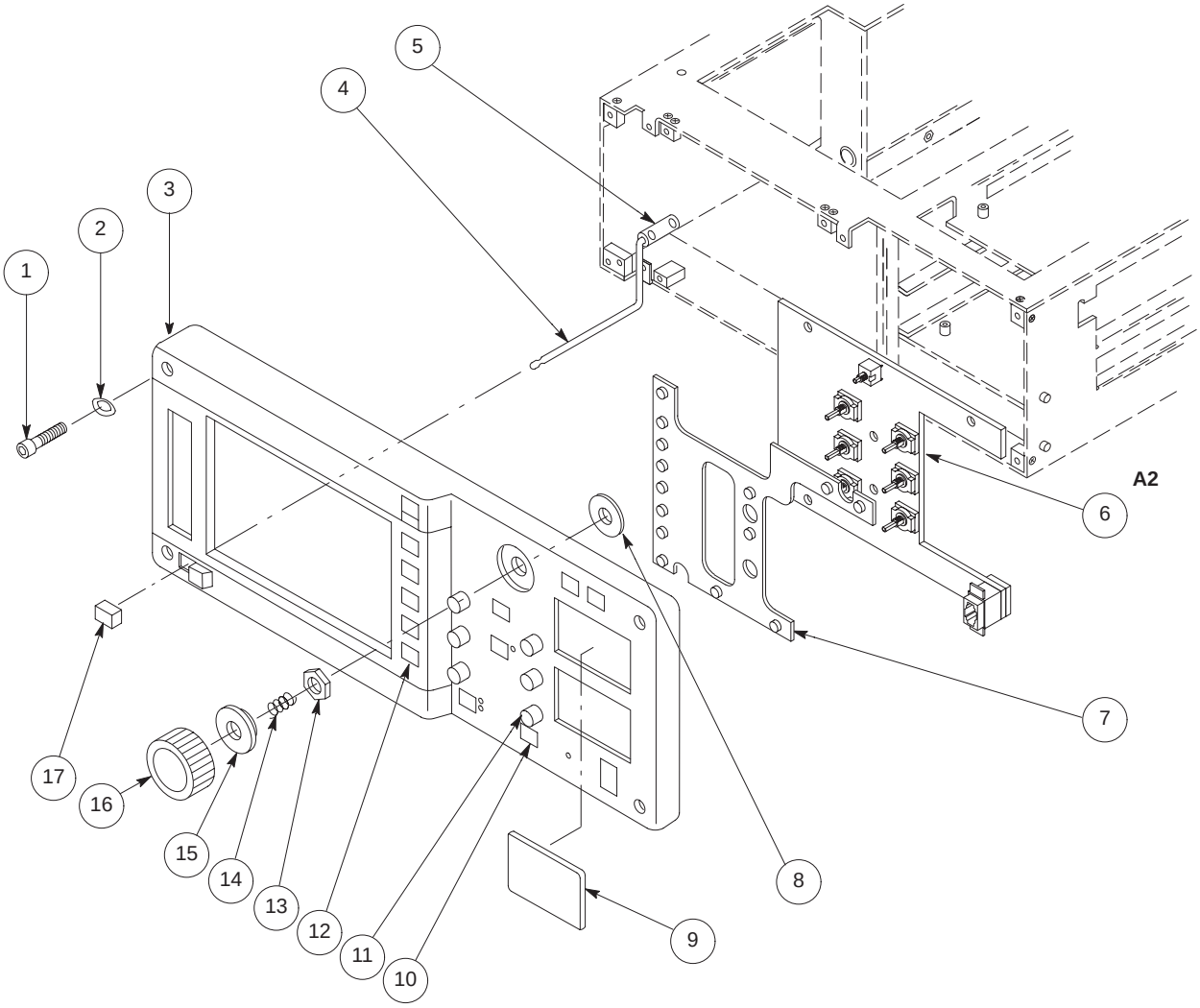


Figure 5-3. Front Panel

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5-4					CHASSIS W/CRT AND ELECTRICAL ASSYS.		
–1	211–0658–00			4	SCR,ASSEM WSHR:632 X 0.312,PNH,POZ	78189	S51–060545–0X
–2	119–3166–02			1	COLOR SHUTTER ASSY:W/O COLOR SHUTTER,TFP2A	80009	119–3166–02
	119–4139–00			1	FILTER,STATIC DIS:MONOCHROME CRT,TFP2AM	80009	119–4139–00
–3	333–3570–02			1	PANEL, REAR:0.125 POLY/POLYURETHANE FORM	80009	333–3570–02
–4	211–0658–00			4	SCR,ASSEM WSHR:632 X 0.312,PNH,POZ	78189	S51–060545–0X
–5	——— ———			1	MONITOR ASSY:SEE A7 REPL		
–6	174–1785–00			1	CA ASSY,SP,ELEC:3,18 AWG,DAG STRAP	TK2469	174–1785–00
–7	174–1994–00			1	CA ASSY,SP,ELEC:16,28 AWG,8.0 L,RIBBON	TK2469	174–1994–00
–8	——— ———			1	DISC DRIVE ASSY:SEE A8 REPL		
–9	——— ———			1	CKT BD ASSY:MODULE SUPPORT (SEE A5 REPL)		
–10	610–0784–05	B070000	B082786	1	CHASSIS ASSY:MAIN, TFP2A	0J260	610–0784–05
	610–0784–05	B070000	B080594	1	CHASSIS ASSY:MAIN, TFP2AM	0J260	610–0784–05
	610–0784–06	B082787		1	CHASSIS ASSY:MAIN, TFP2A	0J260	610–0784–06
	610–0784–06	B080595		1	CHASSIS ASSY:MAIN, TFP2AM	0J260	610–0784–06
–11	——— ———			1	CIRCUIT BD ASSY:CONTROL(SEE A1 REPL)		
–12	131–3199–00			2	CONN,SHUNT:FEMALE,1 X 2,JUMPER (NOTE:AT J10103 AND J10300 ON TFP2AM ONLY)	22526	68786–202
–13	174–1515–01			1	CA ASSY,SP,ELEC:FRONT PANEL CABLE W/FERRITE BEAD	80009	174–1515–01
–14	210–0005–00			2	WASHER,LOCK:#6 EXT,0.02 THK	78189	1106–00
–14	361–1687–00			2	SPACER:NYLON,0.188 X .375 X .218	55566	1185–12–N–0
–15	407–4357–00			1	BRACKET,CKT BD:ADAPT,CONTROL BD RETROFIT	0J9P4	407–4357–00
–16	214–4691–00			1	SPRING,GND CLIP:GROUND STRIP,BERYLLIUM,	80009	214–4691–00
–17	252–0571–00			1	NEOPRENE EXTR:CHAN,0.234 X 0.156	85471	ORD BY DESCR

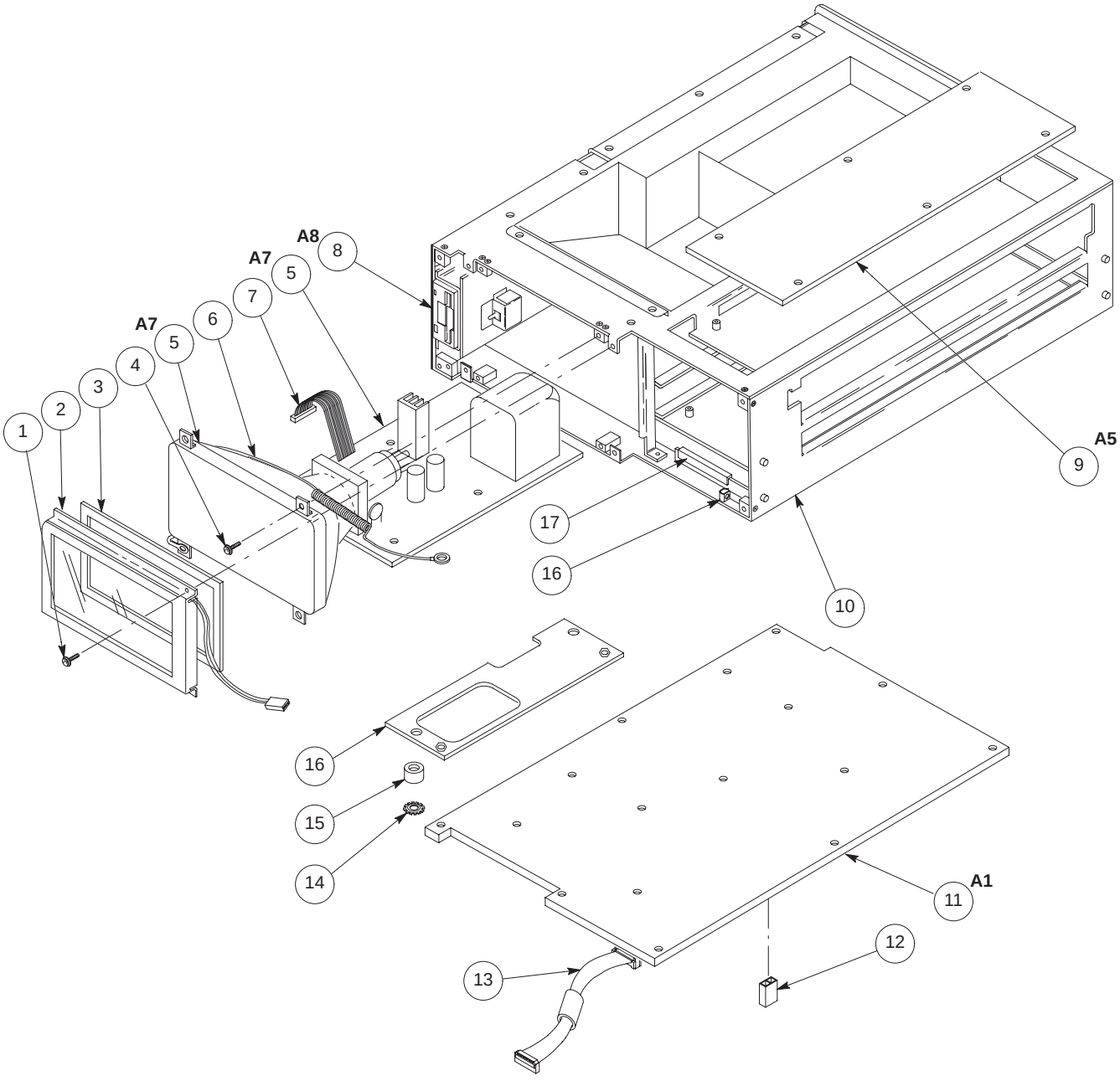


Figure 5-4. Chassis with CRT and Circuit Boards

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5-5		B070000	B079999		POWER SUPPLY:PSI, AC ONLY (B079999 and Below)		
–1	174–2564–01			1	CA ASSY,PWR:CPM,14,18 AWG,7.0 L	0J7N9	174–2564–01
	211–0661–00			1	SCR,ASSEM,WA:4–40 X 0.25,PNH,POZ	01536	821–01655–024
					NOTE:ATTACHING HARDWARE NOT ILLUSTRATED		
–2	348–0145–00			2	GROMMET,PLASTIC:GRAY,U SHAPE,0.48 ID	0JR05	ORD BY DESCR
–3	198–5744–01			1	WIRE SET,ELEC:W/GROUND AND LUG	80009	198–5744–01
–4	337–3794–00			1	SHLD,FILTER BD:6.5 X 4.875 MUMETAL,0.14 THK	0J9P9	337–3794–00
–5	334–3379–01			2	MARKER,IDENT:MKD GROUND SYMBOL	22670	ORD BY DESCR
–6	348–0005–00			1	GROMMET,RUBBER:ROUND,BLK,0.375 ID	70485	230X–36017
–7	——— ———			1	PSI POWER SUPPLY:(SEE A3 REPL)		
–8	200–3569–00			1	COVER,PWR SUPPLY:ALUMINUM	0J260	200–3569–00

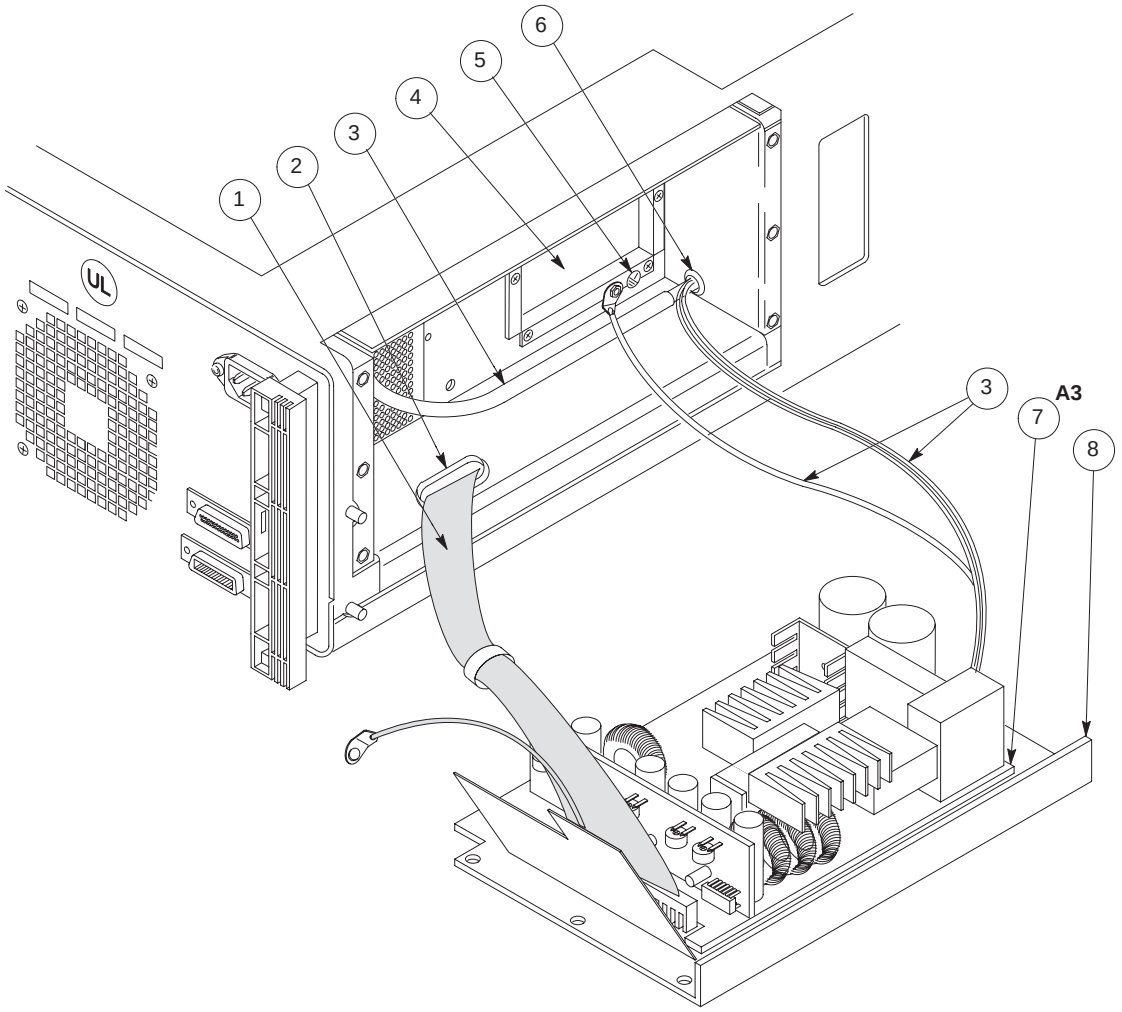


Figure 5-5. Power Supply: PSI (B079999 and Below)

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5-6		B070000	B079999		POWER SUPPLY:IPD (B079999 amd Below)		
–1	118–8666–01			1	LINE FILTER ASSY:(SEE A3A1 REPL)	0JR03	118–8666–01
–2	334–3379–01			2	MARKER,IDENT:MKD GROUND SYMBOL	22670	ORD BY DESCR
–3	348–0005–00			1	GROMMET,PLASTIC:BLACK,ROUND,0.375 ID	70485	230x–36017
–4	198–5771–01	B070000	B072216	1	WIRE SET,ELEC:CA ASSY,AC LINE FILTER,TFP2A (W/GROUND,LUG, LINE FILTER AND SWITCH)	80009	198–5771–01
	198–5771–02	B072217		1	WIRE SET,ELEC:AC LINE FILT W/WIRING & CONN,TFP2A	80009	198–5771–02
	198–5771–01	B070000	B070515	1	WIRE SET,ELEC:CA ASSY,AC LINE FILTER,TFP2AM (W/GROUND,LUG, LINE FILTER AND SWITCH)	80009	198–5771–01
	198–5771–02	B070516		1	WIRE SET,ELEC:AC LINE FILT W/WIRING & CONN,TFP2AM	80009	198–5771–02
–5	200–3569–01			1	COVER,PWR SUPPLY:ALUMINUM	0J260	200–3569–01
–6	——— ———			1	IPD POWER SUPPLY:(SEE A3 REPL)		
–7	174–2564–01			1	CA ASSY,PWR:CPM,14,18 AWG,7.0 L	0J7N9	174–2564–01
	211–0661–00			1	SCR,ASSEM,WA:4–40 X 0.25,PNH,POZ NOTE:ATTACHING HARDWARE NOT ILLUSTRATED	01536	821–01655–024
–8	348–0145–00			2	GROMMET,RUBBER:GRAY,U SHAPE,0.48 ID	0JR05	ORD BY DESCR
–9	——— ———				SEE DC POWER OPTION 17		

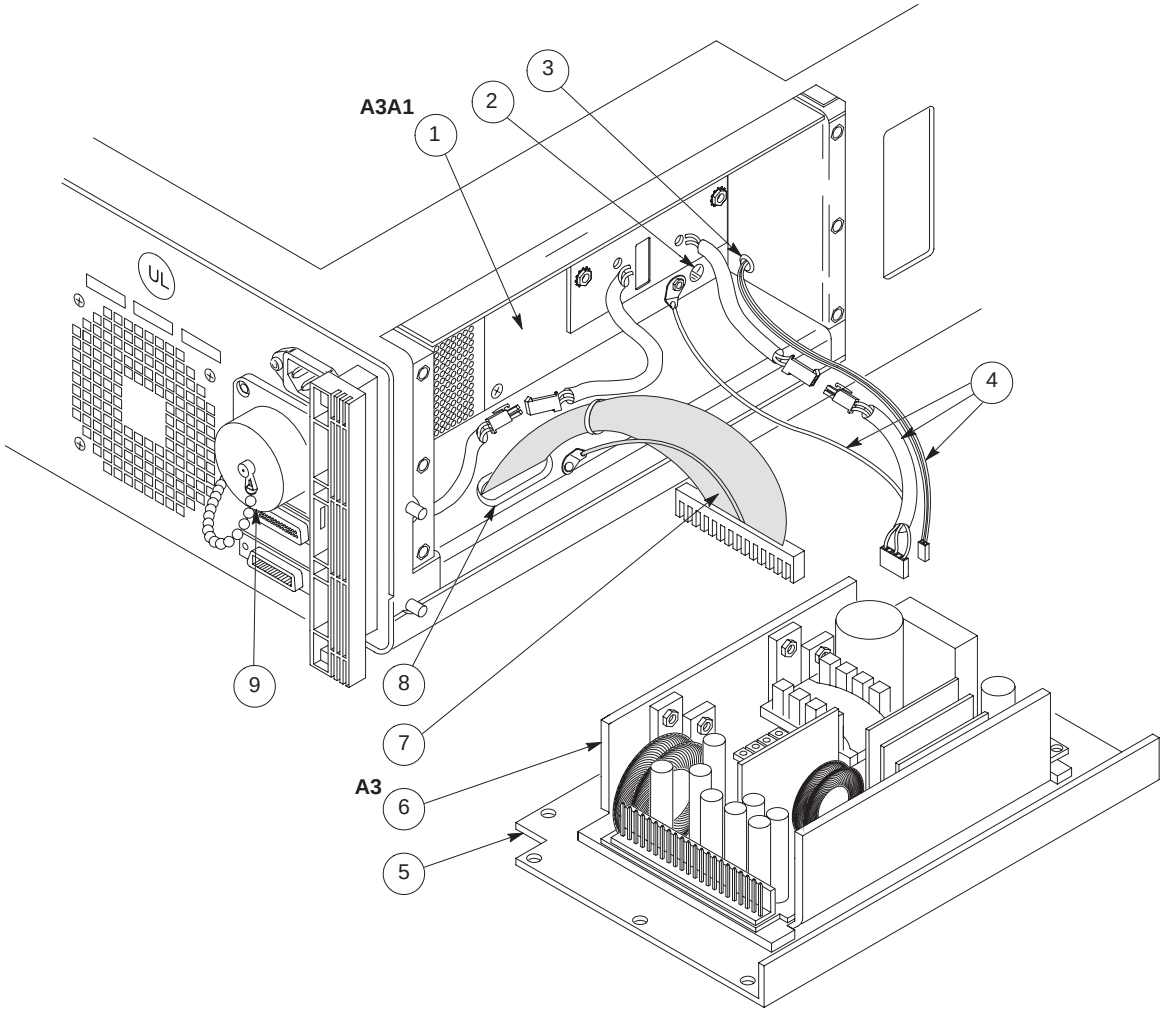


Figure 5-6. Power Supply: IPD (B079999 and Below)

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5-7		B080000			POWER SUPPLY:MDI (B080000 and Beyond)		
–1	198–5857–00	B080000	B082786	1	WIRE SET,ELEC:DESCRETE,AC PWR,SDI, TFP2A	0J7N9	198–5857–00
	198–5857–00	B080000	B080594	1	WIRE SET,ELEC:DESCRETE,AC PWR,SDI, TFP2AM	0J7N9	198–5857–00
	198–5857–01	B082787		1	WIRE SET,ELEC:DESCRETE,AC PWR,SDI, TFP2A	0J7N9	198–5857–01
	198–5857–01	B080595		1	WIRE SET,ELEC:DESCRETE,AC PWR,SDI, TFP2AM	0J7N9	198–5857–01
–2	334–3379–01			2	MARKER,IDENT:MARKED GROUND SYMBOL	22670	ORD BY DESCR
–3	——— ———				DC WIRE SET:SEE DC POWER, OPTION 17		
–4	118–9414–00			1	POWER SUPPLY ASSY:MDI,180W (SEE A3 REPL)	80009	118–9414–00
–5	211–0502–00			12	SCREW,MACH:6–32 X 0.188,FLH,100 DEG,POZ	TK0435	ORD BY DESCR

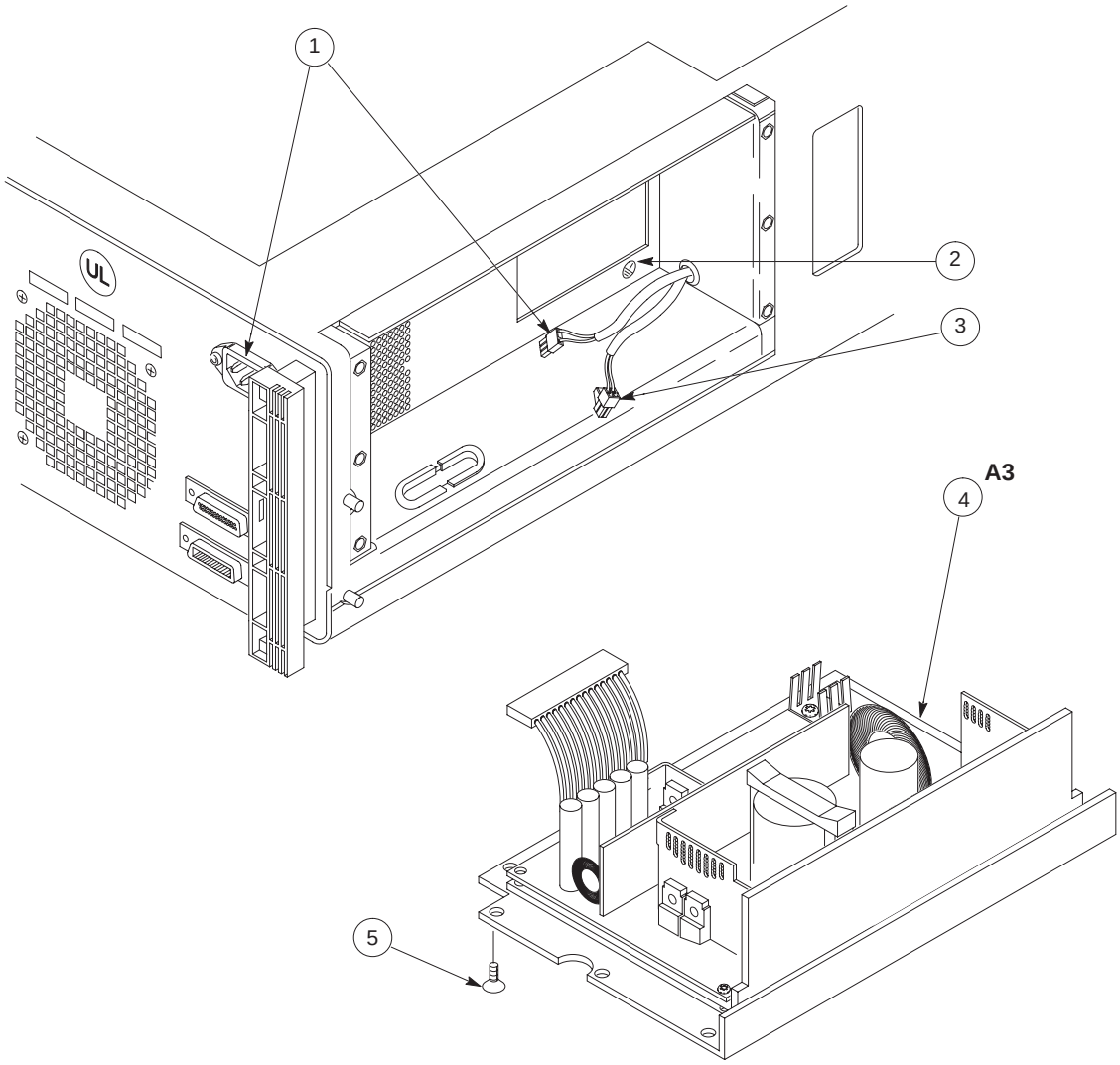


Figure 5-7. Power Supply: MDI (B080000 and Beyond)

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5-8					CHASSIS MOUNTED ELECTRICAL PARTS		
–1	260–2650–00			1	SWITCH,POWER:DPDT,6A 250VAC,1A 100VDC (SUBPART OF IPD & MDI POWER SUPPLY WIRE SETS)	31918	NE1801EEN3901
	260–1849–02	B072216		1	SW,PWR:DPDT,PUSH PUSH ALTERNATE ACTION,**TFP2A** (SUBPART OF PSI POWER SUPPLY WIRE SET, AC ONLY)	31918	130220
	260–1849–02	B070515		1	SW,PWR:DPDT,PUSH PUSH ALTERNATE ACTION,**TFP2AM** (SUBPART OF PSI POWER SUPPLY WIRE SET, AC ONLY)	31918	130220
–2	211–0022–00			2	SCR,MACH:2–56 X 0.188,PNH,POZ	83385	210–0458–00
–3	210–0458–00			4	NUT,PL,ASSEM WA:8–32 X 0.344 (NOTE: QTY 4 WITH AC UNIT – QTY 1 WITH AC/DC UNIT)	0KB01	ORD BY DESCR
–4	119–5003–00			1	FAN,DC:TUBEAXIAL,12V,0.5A,6W,CONN	TK2517	4715ML–012P540
–5	119–3574–00	B070000	B079999	1	FILTER,RFI:3A,115/230VAC,50/400HZ W/LUGS (NOTE: REPLACEABLE PART FOR PSI PWR SPLY ONLY)	0GV52	FN323–3/01
	——— ———	B080000			SUBPART OF POWER SUPPLY WIRE SETS		
–6	211–0559–00			2	SCR,MACH:6–32 X 0.375,FLH,100 DEG,POZ	0KB01	ORD BY DESCR
–7	210–0994–00			2	WSHR,FLAT:0.125 X 0.25 X 0.022,STL CD PL	12327	ORD BY DESCR
–8	210–0017–00			2	WSHR,LOCK:#5 SPLIT,0.035 THK,STL CD PL	0KB01	ORD BY DESCR
–9	131–0890–01			2	LOCK,CONN:4–40 X 0.312 L,HEX	00779	205818–2
–10	129–1085–00			2	SPACER,POST:0.25L,4–40,BRS,0.25 HEX	0KB01	ORD BY DESCR
–11	210–0056–00			2	WSHR,LOCK:#10 SPLIT,0.047 THK,BRZ	77252	ORD BY DESCR
–12	174–2042–01			1	CA ASSY SP:IDC,24,28 AWG,5.5 L,RIBBON W/FERRITE	0J7N9	174–2042–01
–13	174–1437–00			1	CA ASSY SP ELEC:RS232,24,28 AWG,5.0 L	80009	174–1437–00
–14	212–0102–00			4	SCR,EXT RLV:8–32 X 2.0,PNH,POZ (NOTE: SHARES MTG HARDWARE W/ DC PWR SPLY ASSY)	0KB01	ORD BY DESC

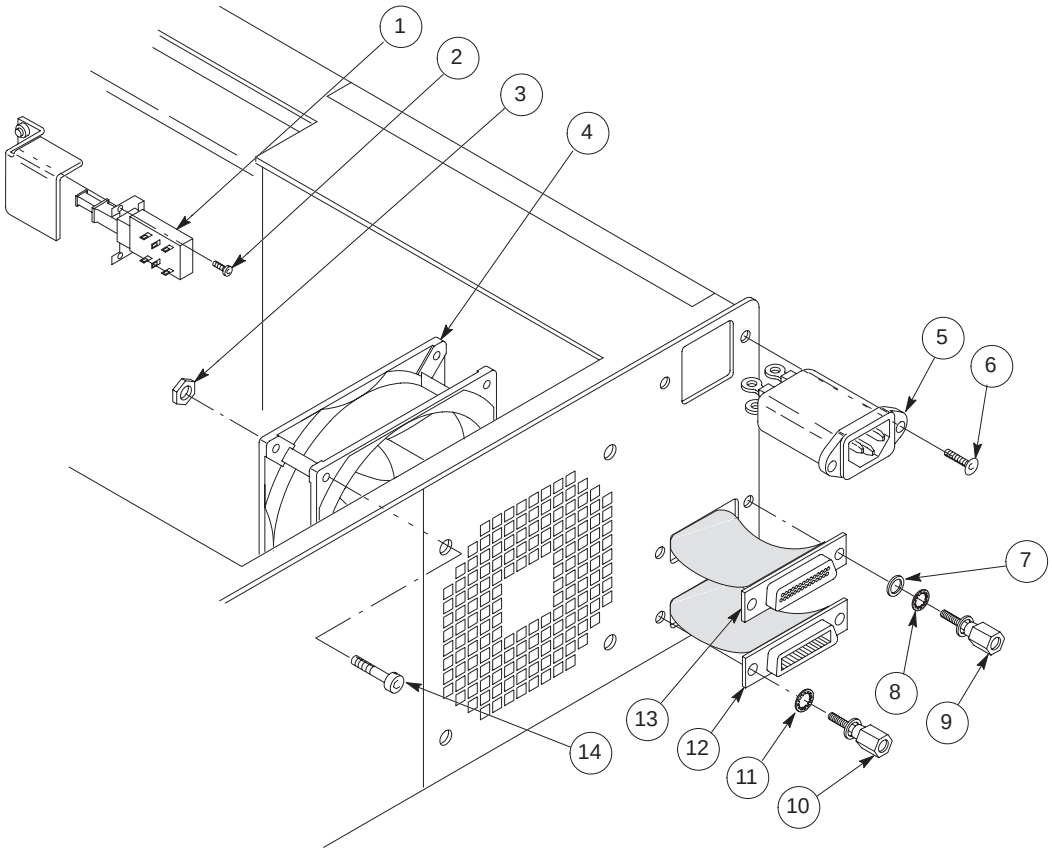


Figure 5-8. Chassis-Mounted Electrical Parts

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5-9					BACK		
–1	212–0718–00			3	SCREW,CAP:10–32 X 0.75,SCH,SS,BLK OXIDE,HEX REC	0KB01	ORD BY DESCR
–2	348–1115–00			1	FOOT,CABINET:SLATE GRAY,PLSTC	0JR05	348–1115–00
–3	200–4025–00			1	COVER,OPT PORT:ALUMINUM	TK2496	200–4025–00
–4	644–0797–00			1	END PLATE ASSY:MODULE	80009	644–0797–00
–5	——— ———			1	. CKT BD ASSY:INTERCONNECT (SEE A4 REPL)		

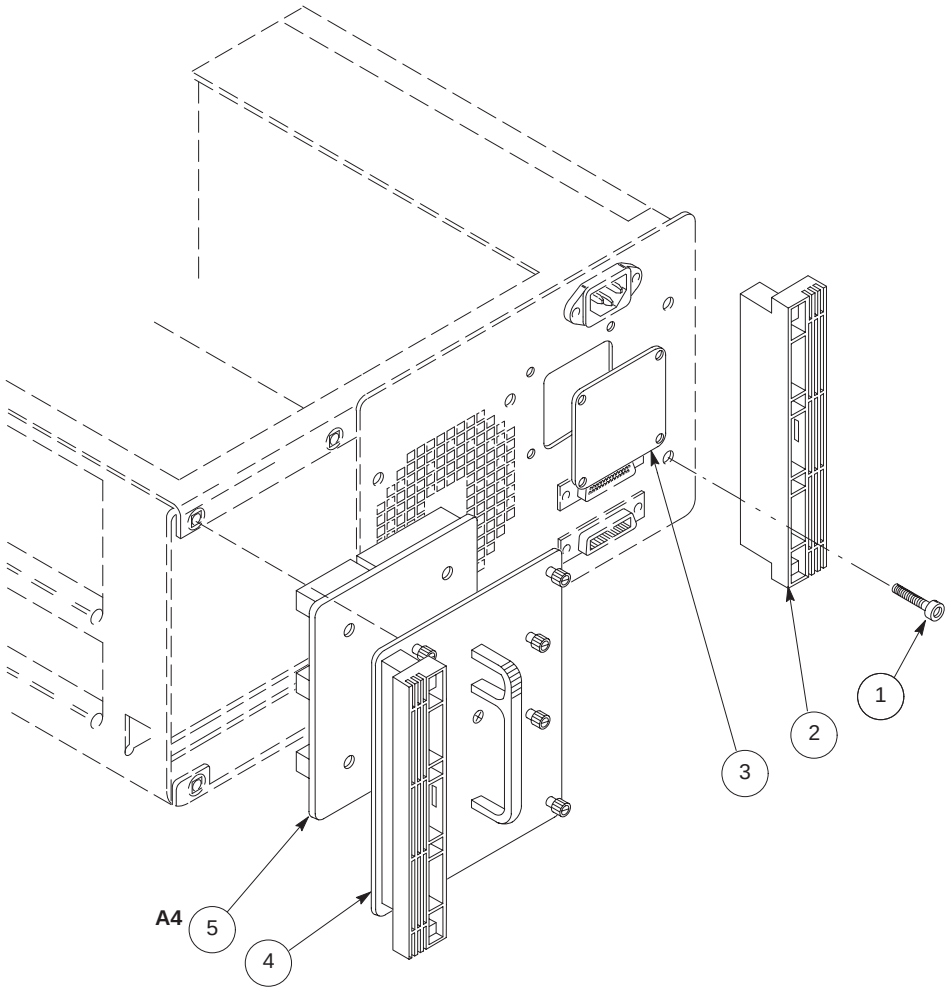


Figure 5-9. Back

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5-10	644–0796–00				PRINTER ASSEMBLY: OPTION 16	80009	644–0796–00
–1	351–0907–00			1	. GUIDE,PAPER:ALUMINUM	TK1943	351–0907–00
–2	211–0796–00			2	. SCR,MACH:M3–0.5 X 0.6MM L,FL HEAD,POZ	0KB01	ORD BY DESCR
–3	386–5947–01			2	. FLANGE,PAPER:FTP–1040FH	61271	FTP–040HF
–4	006–7682–00			1	. PAPER,CHART:THERMAL,30 METER ROLL	9Z397	006–7682–00
–5	——— ———				. CASE TOP:(SEE FIG 5–2 RMPL)		
–6	211–0661–00			4	. SCR,ASSEM WSHR:4–40 X 0.25,PNH,POZ	01536	821–01655–024
–7	174–1993–00			1	. CA ASSY,SP,ELEC:10,28 AWG,9.5L RIBBON	TK2469	174–1993–00
–8	129–1002–00			4	. SPACER,POST:0.485,4–40 INT/EXT 0.188	2J927	129–1002–00
–9	211–0602–00			4	. SCR,ASSEM WSHR:6–32 X 0.438,PNH,POZ	93907	821–16570
–10	352–0938–01			2	. HOLDER,PPR STAND:FTP–040HS	TK2256	352–0938–01
–11	174–1516–00			1	. CA ASSY,SP,ELEC:30,28 AWG,9.5 L,RIBBON	TK2469	174–1516–00
–12	174–1517–00			1	. CA ASSY,SP,ELEC:4,22 AWG,3.0 L,RIBBON	TK2469	174–1517–00
–13	174–1990–00			1	. CA ASSY,SP,ELEC:6,22 AWG,3.0 L,RIBBON	TK2469	174–1990–00
–14	——— ———			1	. CKT BD ASSY:(SEE A6A2 REPL)		
–15	174–1534–00			1	. CA ASSY,SP,ELEC:8,22 AWG,3.0 L,RIBBON	TK2469	174–1534–00
–16	174–1905–00			1	. CA ASSY,SP,ELEC:26,28 AWG,3.0 L,RIBBON	TK2469	174–1905–00
–17	174–1992–00			1	. CA ASSY,SP,ELEC:2,22 AWG,3.0 L	TK2469	174–1992–00
–18	174–1991–00			1	. CA ASSY,SP,ELEC:3,22 AWG,3.0 L	TK2469	174–1991–00
–19	——— ———				. CKT BD ASSY:(SEE A6A1 REPL)		
–20	253–0188–00			1	. . TAPE,PRESS SENS:URETHANE FOAM	80009	253–0188–00
–21	211–0661–00			1	. . SCR,ASSEM WSHR:4–40 X 0.25,PNH,POZ	01536	821–01655–024
–22	220–0829–00			1	. . NUT,PRESSMOUNT:4–40 X 0.216 OD,STL CD PL	46384	KF2–440
–23	344–0405–00			1	. CLIP,RETAINER:COMP MTG,1.63 OD STEEL	1Y013	3505–8026
–24	174–1512–00			1	. CA ASSY,SP,ELEC:26,28 AWG,7.0 L,RIBBON	TK2469	174–1512–00
–25	351–0919–00			1	. SLIDE,PAPER:0.010 X 0.500 X 2.0 POLY FILM	0JRZ5	351–0919–00
–26	407–4112–00			1	. BRKT,PPTR TRAY:AL	TK1943	407–4112–00
–27	211–0796–00			3	. SCR,MACH:M3–0.5 X 0.6MM L,FL HEAD,POZ	0KB01	ORD BY DESCR
–28	436–0207–01			1	. PRINTER TRAY	0J9P4	436–0207–01
–29	348–1195–00			1	. BUMPER,BUTTON:0.500 X 0.375,BLK	2K262	348–1195–00
–30	337–3790–00	B070000	B082693	1	. SHIELD,ELEC:0.014 MUMETAL, TFP2A	0J9P9	337–3790–00
	337–3790–00	B070000	B080592	1	. SHIELD,ELEC:0.014 MUMETAL, TFP2AM	0J9P9	337–3790–00
	337–3790–01	B082694		1	. SHIELD,ELEC:0.014 MUMETAL, TFP2A	0J9P9	337–3790–01
	337–3790–01	B080593		1	. SHIELD,ELEC:0.014 MUMETAL, TFP2AM	0J9P9	337–3790–01
–31	——— ———		?		. PRINTHEAD W/ CABLES:(SEE A6A3 REPL)		

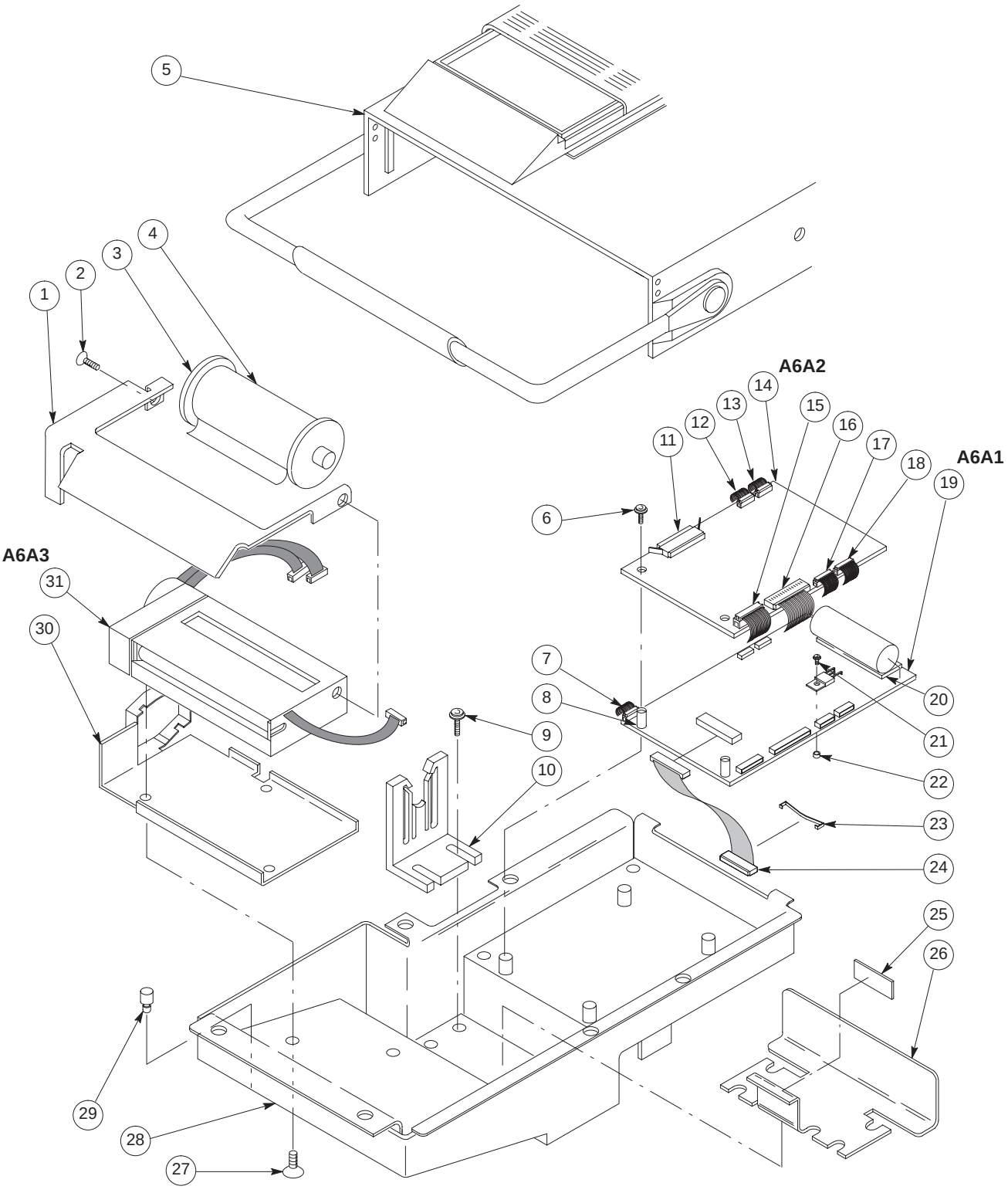


Figure 5-10. Printer Assembly: Option 16

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5-11					**A9** INTERNAL RAM, **OPTION 14**		
–1	342–0952–00			1	INSULATOR,ELEC:0.020 AMITE FISHPAPER	0JRZ5	342–0952–00
–2	——— ———			1	CKT BD ASSY:RAM DRIVE INTERNAL MEMORY (SEE **A9A1** REPL) NOTE: FIG #3,4,5 MOUNT ON BOTTOM OF PRINTER TRAY		
–3	146–0083–02	B070000	B079999	1	BATTERY PACK:3.00V,12.6AH, W/ CABLE	0DWW6	146–0083–02
–4	348–0656–00	B070000	B079999	10	PAD,CUSH: 1.0 X 0.5 X 0.062 SILICON RBR TAPE	0J260	348–0656–00
–5	352–1007–01	B070000	B079999	1	HOLDER,BATTERY:METAL NOTE: FIG #6,7 MOUNT ON CONTROL BOARD	0J260	352–1007–01
–6	343–0549–00	B080000		2	STRAP,TIEDOWN:0.098 W X 4.0 L,ZYTEL	06383	PLT1M
–7	146–0119–00	B080000		1	BATTERY:3V,1200MAH,2/3A LITHIUM BATTERY ASSY	0DWW6	146–0119–00

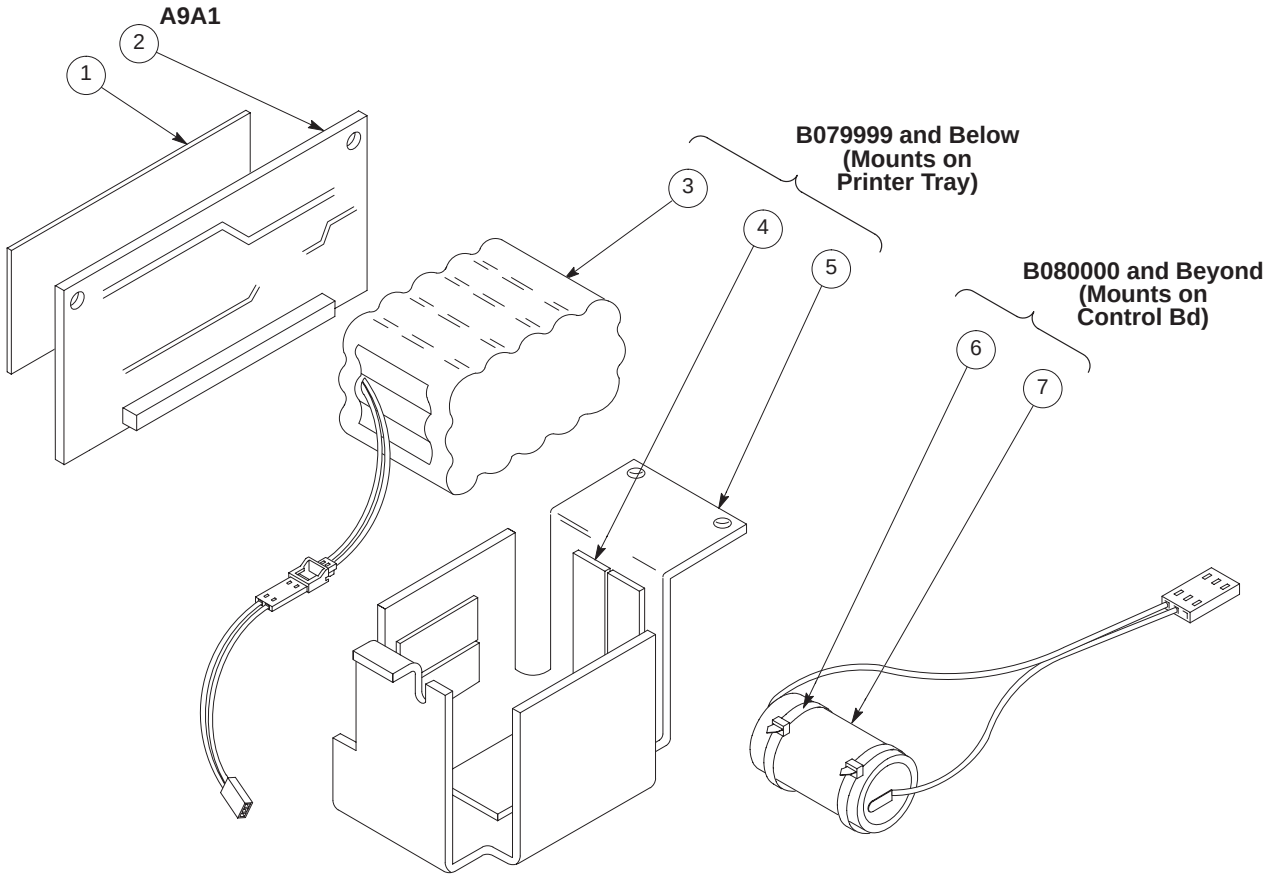


Figure 5-11. Internal RAM

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5-12		B070000	B079999		DC POWER: OPTION 17 (B079999 and Below)		
–1	378–0391–01			1	BAFFLE,AIR:0.062,5052–H32 AL ALLOY	0J9P4	378–0391–01
–2	——— ———			1	CKT BD ASSY: (SEE A10 REPL)		
–3	348–0005–00			1	GROMMET,RUBBER:BLACK,ROUND,0.562 ID	70485	230X–36017
–4	348–0006–00			1	GROMMET,RUBBER:BALCK,ROUND,O.562 ID	70485	1720–26006
–5	161–0280–00			1	CABLE ASSY,PWR:DC OPTION	TK2231	161–0280–00
–6	103–0320–00			1	ADAPTER,CONN:DC OPTION	TK2496	103–0320–00
–7	212–0193–00			4	SCREW,EXT RLV:8–32 X 0.375 BUTTON HEAD,HEX,SS,BLK	OKB01	212–0193–00
–8	211–0014–00			4	SCREW,MACH:4–40 X 0.5,PNH,POZ	93907	ORD BY DESCR
–9	200–4053–01			1	CAP ASSEMBLY:DC OPTION	80009	200–4053–01
–10	198–5785–02			1	WIRE SET,ELEC:DC OPTION,CONN TO FILTER	80009	198–5785–02
–11	334–8330–00			1	MARKER,IDENT:MKD 10–32 VDC,INTERLOCK PLATE	0J4Z2	334–8330–00
–12	407–3407–00			1	BRACKET,SWITCH:ALUMINUM	0J9P4	407–3407–00
–13	342–0959–00			2	INSULATOR:FISHPAPER	2K262	342–0959–00
–14	260–2572–00			2	SWITCH,SENS:SPNO,11A,125VAC	91929	V3L–141–D8
–15	211–0152–00			4	SCR,ASSEM WSHR:4–40 X 0.625,PNH,POZ	TK0435	ORD BY DESCR
–16	198–5787–00			1	WIRE SET,ELEC:DC POWER CABLE ASSY	TK2469	198–5787–00

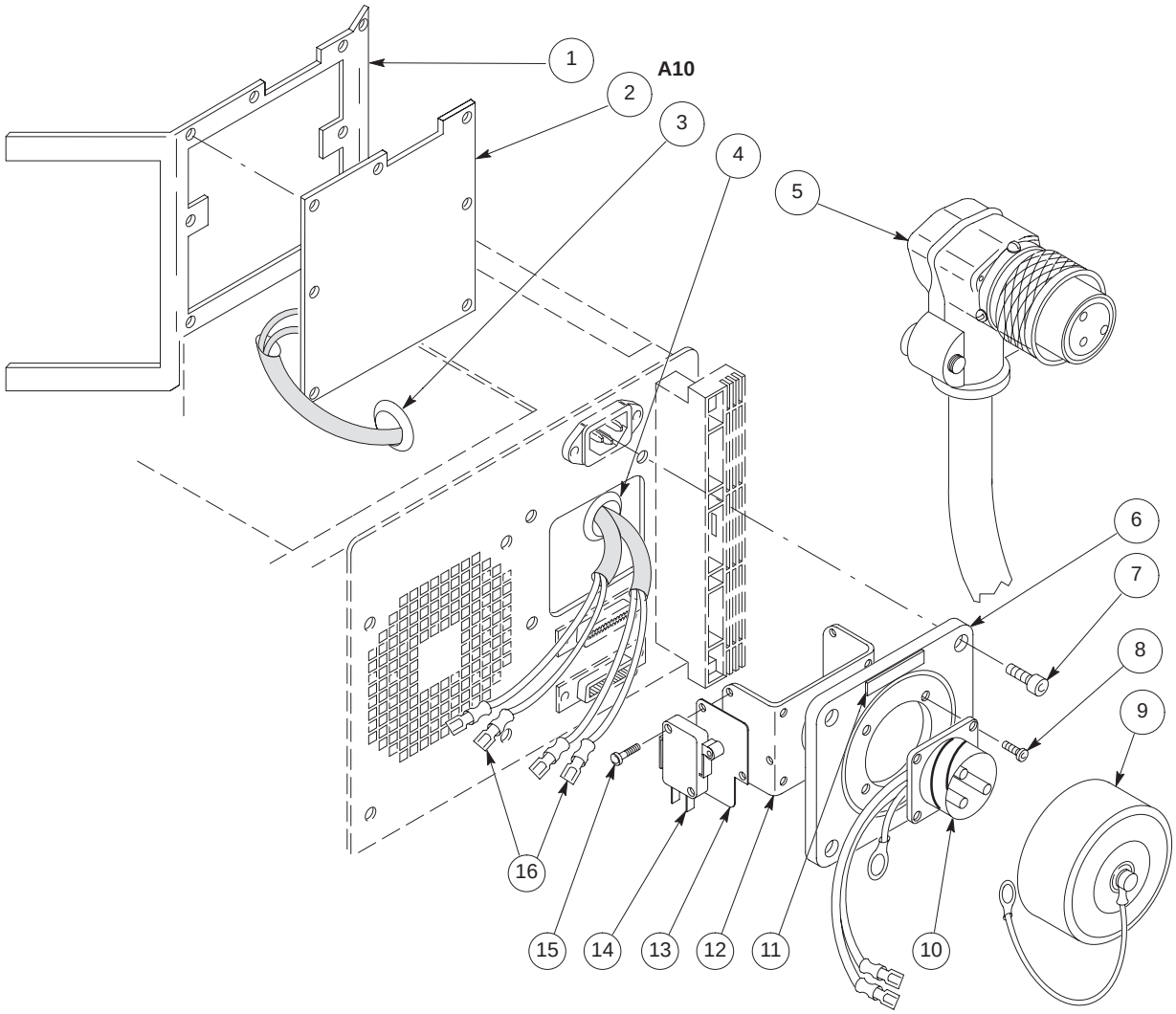


Figure 5-12. DC Power: Option 17 (B079999 and Below)

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5–13		B080000			DC POWER – OPTION 17 (B080000 and Beyond)		
–1	210–0586–00			2	. NUT,PL,ASSEM WA:4–40 X 0.25	0KB01	ORD BY DESCR
–2	——— ———			1	. DC POWER SUPPLY:SEE A3 REPL		
–3	334–8329–00			1	. MARKER,IDENT:MKD DC SUPPLY FUSE	0J4Z2	334–8329–00
–4	334–2332–00			1	. MARKER,IDENT:DANGER,VOLTAGE IN THIS AREA	22670	ORD BY DESCR
–5	334–8361–00			1	. MARKER,IDENT:MKD DC OPTION	0J4Z2	334–8361–00
–6	348–0005–00	B080000	B082787		. GROMMET,RUBBER:BLACK, ROUND,0.375 ID, TFP2A	70485	230X–36017
	348–0006–00	B082787			. GROMMET,RUBBER:BLACK, ROUND,0.562 ID, TFP2A	70485	1720–26006
	348–0005–00	B080000	B080594		. GROMMET,RUBBER:BLACK, ROUND,0.375 ID, TFP2A/M	70485	230X–36017
	348–0006–00	B080595			. GROMMET,RUBBER:BLACK, ROUND,0.562 ID, TFP2A/M	70485	1720–26006
–7	161–0280–00	B080000	B082703	1	. CABLE ASSY,PWR:2,10 AWG,DC OPTION,TFP2A	TK2231	161–0280–00
	161–0280–01	B082704		1	. CABLE ASSY,PWR:2,10 AWG,DC OPTION,TFP2A	TK2231	161–0280–01
–7	161–0280–00	B080000	B080592	1	. CABLE ASSY,PWR:2,10 AWG,DC OPTION,TFP2AM	TK2231	161–0280–00
	161–0280–01	B080593		1	. CABLE ASSY,PWR:2,10 AWG,DC OPTION,TFP2AM	TK2231	161–0280–01
–8	200–4053–01			1	. CAP ASSEMBLY:DC OPTION	80009	200–4053–01
–9	334–8330–01			1	. MARKER,IDENT:MKD 10–16 VDC,200VA MAX	80009	334–8330–01
–10	103–0320–00			1	. ADAPTER,CONN:DC OPTION	TK2496	103–0320–00
–11	212–0193–00			4	. SCREW,EXT RLV:8–32 X 0.375 BUTTON HD,HEX,SS,BLK	0KB01	212–0193–00
–12	198–5858–00	B080000	B082703	1	. WIRE SET,ELEC:DESCRETE,DC POWER, TFP2A	0J7N9	198–5858–00
	198–5858–01	B082704	B082786	1	. WIRE SET,ELEC:DESCRETE,DC POWER, TFP2A	0J7N9	198–5858–01
	198–5858–02	B082787		1	. WIRE SET,ELEC:DESCRETE,DC POWER, TFP2A	0J7N9	198–5858–02
	198–5858–00	B080000	B080592	1	. WIRE SET,ELEC:DESCRETE,DC POWER, TFP2A/M	0J7N9	198–5858–00
	198–5858–01	B080593	B080594	1	. WIRE SET,ELEC:DESCRETE,DC POWER, TFP2A/M	0J7N9	198–5858–01
	198–5858–02	B080595		1	. WIRE SET,ELEC:DESCRETE,DC POWER, TFP2A/M	0J7N9	198–5858–02
–13	211–0014–00			4	. SCREW,MACH:4–40 X 0.5,PNH,POZ	93907	ORD BY DESCR
–14	407–3407–00			1	. BRACKET,SWITCH:ALUMINUM	0J9P4	407–3407–00
–15	342–0959–00			2	. INSULATOR:FISHPAPER	2K262	342–0959–00
–16	260–2572–00			2	. SWITCH,SENS:SPNO,11A,125VAC	91929	V3L–141–D8
–17	211–0152–00			4	. SCR,ASSEM WSHR:4–40 X 0.625,PNH,POZ	TK0435	ORD BY DESCR
–18	212–0102–00			3	. SCREW,EXT RLV:8–32 X 2.0,PNH,POZ	0KB01	ORD BY DESCR

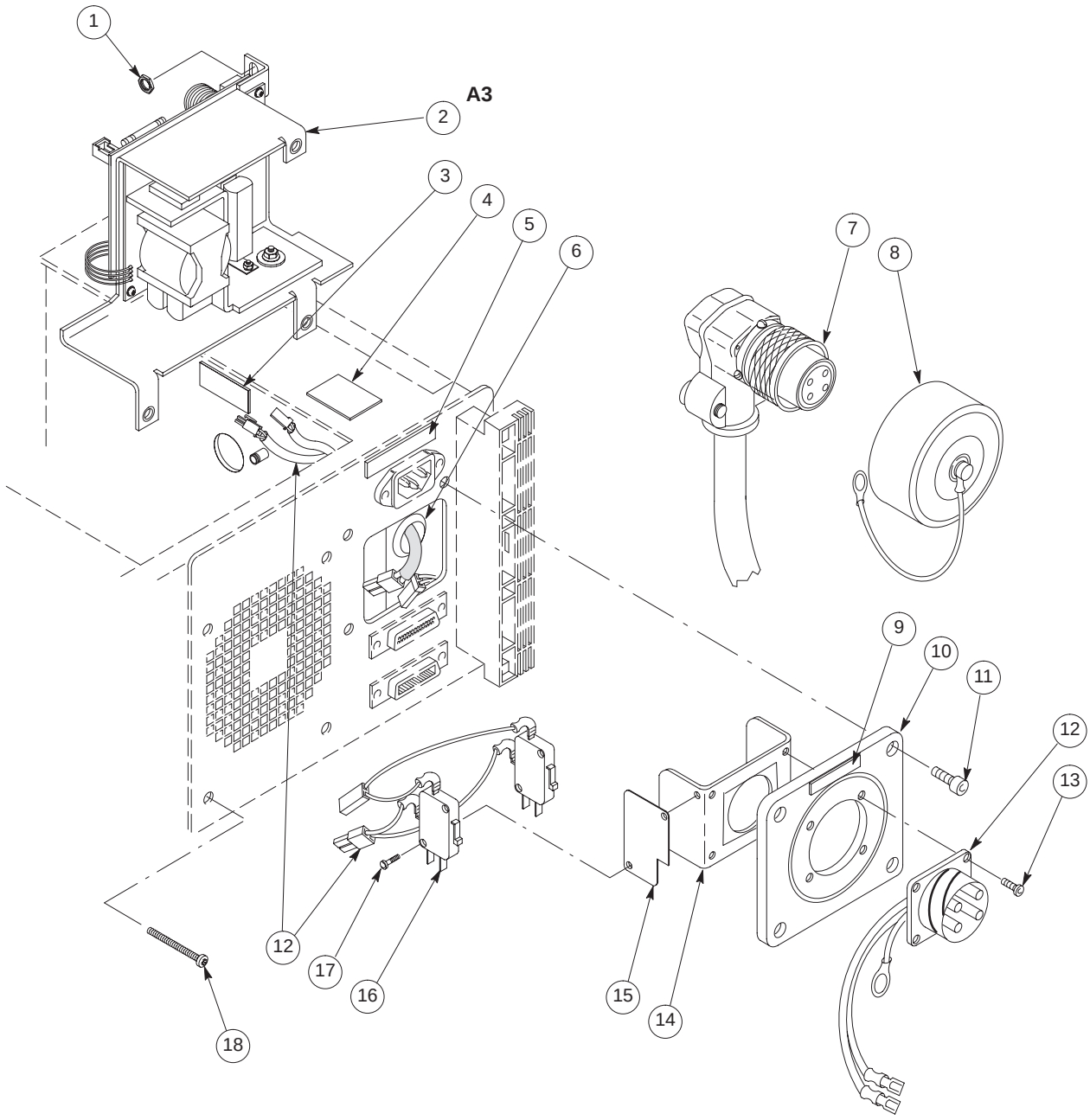


Figure 5-13. DC Power: Option 17 (B080000 and Beyond)

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Serial No. Dscont	Qty	Name & Description	Mfr. Code	Mfr. Part No.
FIG 5-14					DISC DRIVE ASSY		
–1	——— ———				DISC DRIVE:FLOPPY (SEE A8 REPL)		
–2	174–1513–01	B070000	B082732	1	. CA ASSY,SP:2,22 AWG,5.5 L,TFP2A	0J7N9	174–1513–01
	174–1513–01	B070000	B080594	1	. CA ASSY,SP:2,22 AWG,5.5 L,TFP2A/M	0J7N9	174–1513–01
	174–1513–02	B082733		1	. CA ASSY,SP:2,22 AWG,5.5 L,TFP2A	0J7N9	174–1513–02
	174–1513–02	B082595		1	. CA ASSY,SP:2,22 AWG,5.5 L,TFP2A/M	0J7N9	174–1513–02
–3	174–3423–00	B070000	B082732	1	. CA ASSY,SP:IDC,34,28 AWG,9.0 L,GPIB,RIBBON,TFP2A	0J7N9	174–3423–00
	174–3423–00	B070000	B080594	1	. CA ASSY,SP:IDC,34,28 AWG,9.0 L,GPIB,RIBBON,TFP2A/M	0J7N9	174–3423–00
	174–3423–01	B082733		1	. CA ASSY,SP:IDC,34,28 AWG,9.0 L,GPIB,RIBBON,TFP2A	0J7N9	174–3423–01
	174–3423–01	B082595		1	. CA ASSY,SP:IDC,34,28 AWG,9.0 L,GPIB,RIBBON,TFP2A/M	0J7N9	174–3423–01
–4	131–3199–00	B070000	B082732	4	. CONN,SHUNT:FEMALE,STR,1 X 2, TFP2A	22526	68786–202
	131–3199–00	B070000	B080594	4	. CONN,SHUNT:FEMALE,STR,1 X 2, TFP2A/M	22526	68786–202
	119–3910–00			1	. FLOPPY DISK:3.5” DOULBESIDE,BLANK,1.44 MEG	TK2237	ORD BY DESCR

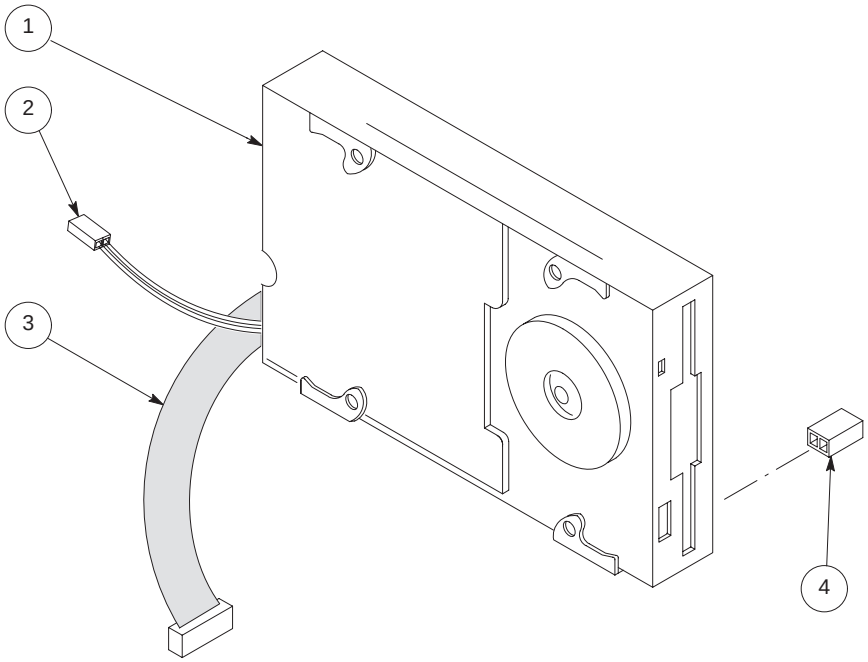
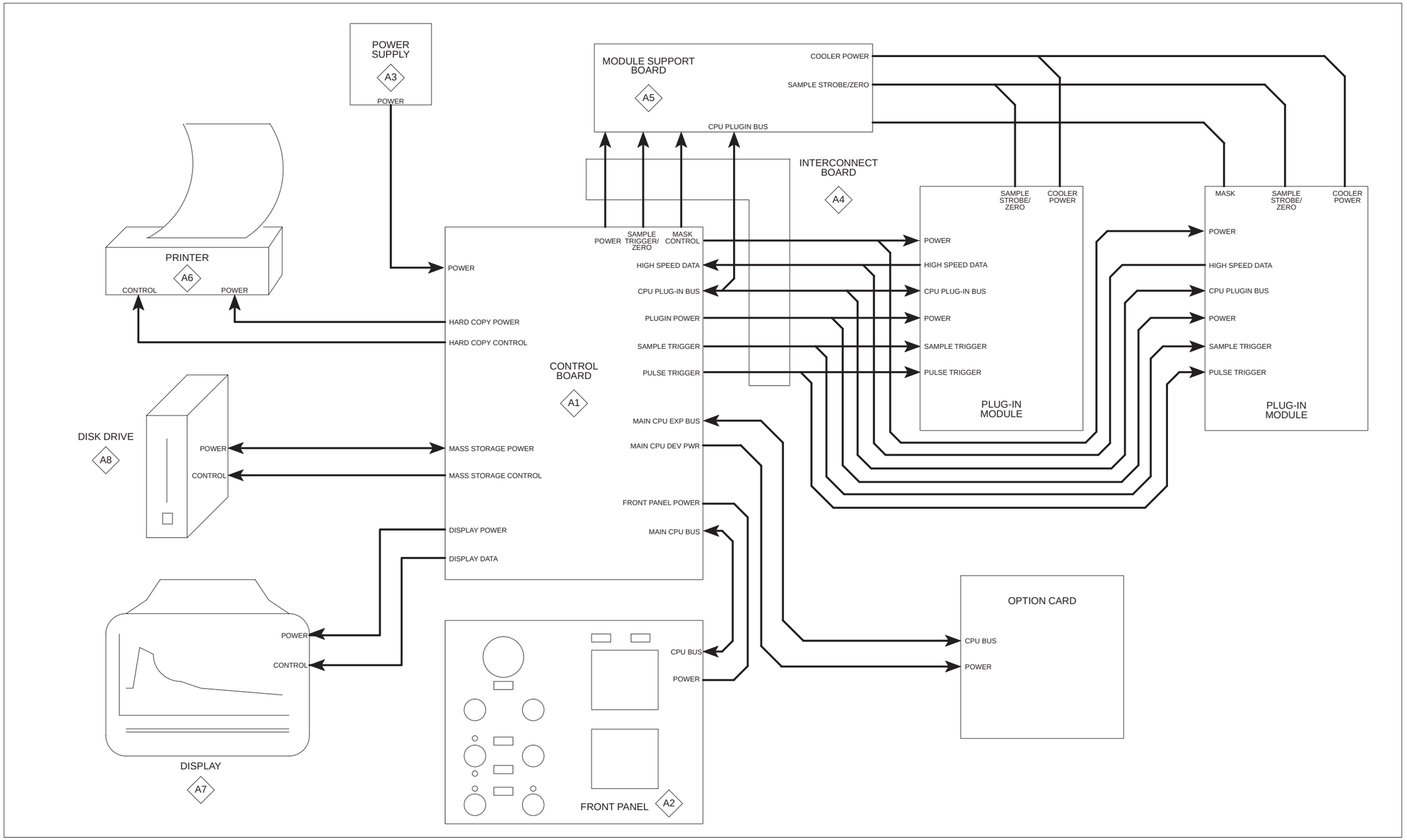


Figure 5-14. Disc Drive Assy


POWER SUPPLY
A3
POWER
MODULE SUPPORT BOARD
A5
COOLER POWER
SAMPLE STROBE/ZERO
CPU PLUGIN BUS
INTERCONNECT BOARD
A4
PRINTER
A6
CONTROL
POWER
POWER
SAMPLE TRIGGER/ ZERO
MASK CONTROL
HIGH SPEED DATA
CPU PLUG-IN BUS
PLUGIN POWER
SAMPLE TRIGGER
PULSE TRIGGER
HARD COPY POWER
HARD COPY CONTROL
CONTROL BOARD
A1
SAMPLE STROBE/ ZERO
COOLER POWER
POWER
HIGH SPEED DATA
CPU PLUG-IN BUS
POWER
SAMPLE TRIGGER
PULSE TRIGGER
PLUG-IN MODULE
MASK
SAMPLE STROBE/ ZERO
COOLER POWER
POWER
HIGH SPEED DATA
CPU PLUGIN BUS
POWER
SAMPLE TRIGGER
PULSE TRIGGER
PLUG-IN MODULE
DISK DRIVE
A8
POWER
CONTROL
MASS STORAGE POWER
MASS STORAGE CONTROL
MAIN CPU EXP BUS
MAIN CPU DEV PWR
FRONT PANEL POWER
MAIN CPU BUS
DISPLAY POWER
DISPLAY DATA
OPTION CARD
CPU BUS
POWER
POWER
CONTROL
DISPLAY
A7
CPU BUS
POWER
FRONT PANEL
A2

A Performance Verification Data Sheets

Use the data sheets on the following pages to record the results of performance checks given in chapter 4, *Maintenance*. (You may want to photocopy these data sheets, in case the instrument requires performance verification at another time.)

Optical Test Summary Data Sheet—FS1315 Singlemode

Serial Number:	
Date:	

Front Panel Loss	**1310 nm:**	
	1550 nm:	

Optical Power	**1310 nm:**	
	1550 nm:	

	1310 nm				1550 nm			
PW/ Range	**5 mHR/ 10 km**	**20 m/ 10 km**	**100 m 50 km**	**1 km/ 200 km**	**5 mHR/ 10 km**	**20 m/ 10 km**	**100 m/ 50 km**	**1 km/ 200 km**
Dyn R. DZ-Loss DZ-Evnt	**12.0 dB 15 m 7 m**	**18.5 dB 40 m 25 m**	**22.0 dB 140 m 110 m**	**29.5 dB 1080 m 1050 m**	**9.0 dB 18 m 7 m**	**15.5 dB 40 m 25 m**	**19.0 dB 140 m 110 m**	**26.5 dB 1080 m 1050 m**
Noise (1 σ)								
Two-Pt. Loss								
Dyn R. (SNR=1)								
DZ Loss								
DZ Event								

Optical Test Summary Data Sheet—FG1315 Singlemode

Serial Number:	
Date:	

Front Panel Loss	**1310 nm:**	
	1550 nm:	

Optical Power	**1310 nm:**	
	1550 nm:	

	1310 nm				1550 nm			
PW/ Range	**5 mHR/ 10 km**	**20 m/ 10 km**	**100 m 50 km**	**1 km/ 200 km**	**5 mHR/ 10 km**	**20 m/ 10 km**	**100 m/ 50 km**	**1 km/ 200 km**
Dyn R. DZ-Loss DZ-Evnt	**13.5 dB 30 m 7 m**	**19.5 dB 55 m 25 m**	**24.0 dB 150 m 110 m**	**31.0 dB 1150 m 1150 m**	**11.5 dB/ 35 m 7 m**	**17.5 dB 60 m 25 m**	**22.0 dB 150 m 110 m**	**29.0 dB 1150 m 1150 m**
Noise (1 σ)								
Two-Pt. Loss								
Dyn R. (SNR=1)								
DZ Loss								
DZ Event								

Optical Test Summary Data Sheet—FL1315 Singlemode

Serial Number:	
Date:	

Front Panel Loss	**1310 nm:**	
	1550 nm:	

Optical Power	**1310 nm:**	
	1550 nm:	

	1310 nm							
PW/Range	**10m 10 km**	**20m 10 km**	**50m 10 km**	**100m 50 km**	**200m 50 km**	**400m 200 km**	**1 km/ 200 km**	**2 km/ 200 km**
Dyn. R DZ-Loss DZ-Evnt	**24.0 dB 125 m 25 m**	**25.5 dB 125 m 35 m**	**27.5 dB 150 m 60 m**	**29.5 dB 280 m 120 m**	**31.0 dB 395 m 220 m**	**33.5 dB 670 m 440 m**	**36.0 dB 1270 m 1050 m**	**37.5 dB 2375 m 2100 m**
Noise (1 σ)								
Noise (mean)								
Two-Pt. Loss								
Dyn R. (SNR=1)								
DZ Loss								
DZ Event								

	1550 nm							
PW/Range	**10m 10 km**	**20m 10 km**	**50m 10 km**	**100m 50 km**	**200m 50 km**	**400m 200 km**	**1 km/ 200 km**	**2 km/ 200 km**
Dyn R. DZ-Loss DZ-Evnt	**23.0 dB 170 m 25 m**	**25.0 dB 195 m 35 m**	**27.0 dB 150 m 60 m**	**29.0 dB 280 m 120 m**	**30.5 dB 395 m 220 m**	**33.0 dB 670 m 440 m**	**35.0 dB 1270 m 1050 m**	**37.0 dB 2375 m 2100 m**
Noise (1 σ)								
Noise (mean)								
Two-Pt. Loss								
Dyn R. (SNR=1)								
DZ Loss								
DZ Event								

Optical Test Summary Data Sheet—FM8513 Multimode

Serial Number:	
Date:	

Front Panel Loss	**850 nm:**	
	1300 nm:	

Optical Power	**850 nm:**	
	1300 nm:	

	850 nm		**1300 nm**		
PW/Range	**80 cm/ 4 km**	**10 m/ 20 km**	**5 mHR/ 10 km**	**20 m/ 25 km**	**100 m 100 km**
Dyn R. DZ-Loss DZ-Event	**20.5 dB 4.5 m 1.0 m**	**27.0 dB 13 m 10.5 m**	**15.0 dB 20 m 7 m**	**21.5 dB 35 m 25 m**	**26.5 dB 125 m 110 m**
Noise (1 σ)					
Two-Point Loss					
Dyn. Range (SNR=1)					
Dead Zone Loss					
Dead Zone Event					

B GPIB and RS-232 Connections

Connection tables for the GPIB and RS-232 connectors are shown below. The RS-232 connection requires an insulation displacement ribbon cable assembly. The connector aligns to a standard RS-232 arrangement. The connections are set up as a DCE device and must be cabled accordingly.

Table B-1. GPIB Connections

Signal	Connector (J40102)	External GPIB
DIO1	1	1
DIO2	3	2
DIO3	5	3
DIO4	7	4
DIO5	2	13
DIO6	4	14
DIO7	6	15
DIO8	8	16
EOI	9	5
DAV	11	6
NRFD	13	7
NDAC	15	8
IFC	17	9
SRQ	19	10
ATN	21	11
REN	10	17
GND	23,12,14,16	12,18,19,20
	18,20,22,24	21,22,23,24

Table B-2. RS-232 Connections (DCE)

Signal	Connector (J40104)	External RS232
GND	1,13	1,7
TxD	3	2
RxD	5	3
RTS	7	4
CTS	9	5
DSR	11	6
RSD	15	8
DTR	14	20

Signal	Connector (J30101)
GND	1,6
Send Data	2
Receive Data	3
Receive Control	4
Send Control	5

C Firmware Features

FiberMaster firmware is periodically updated to add new features and enhancements. This user information in this manual applies to the firmware version noted on the title page of the manual, but can also be used with all TFP2A/TFP2 instruments with any prior firmware version. The differences in the user interface consist of the features and enhancements that are added to each successive firmware version.

You can identify your firmware version on the start-up screen. The version number appears in the upper right-hand corner, as shown below.

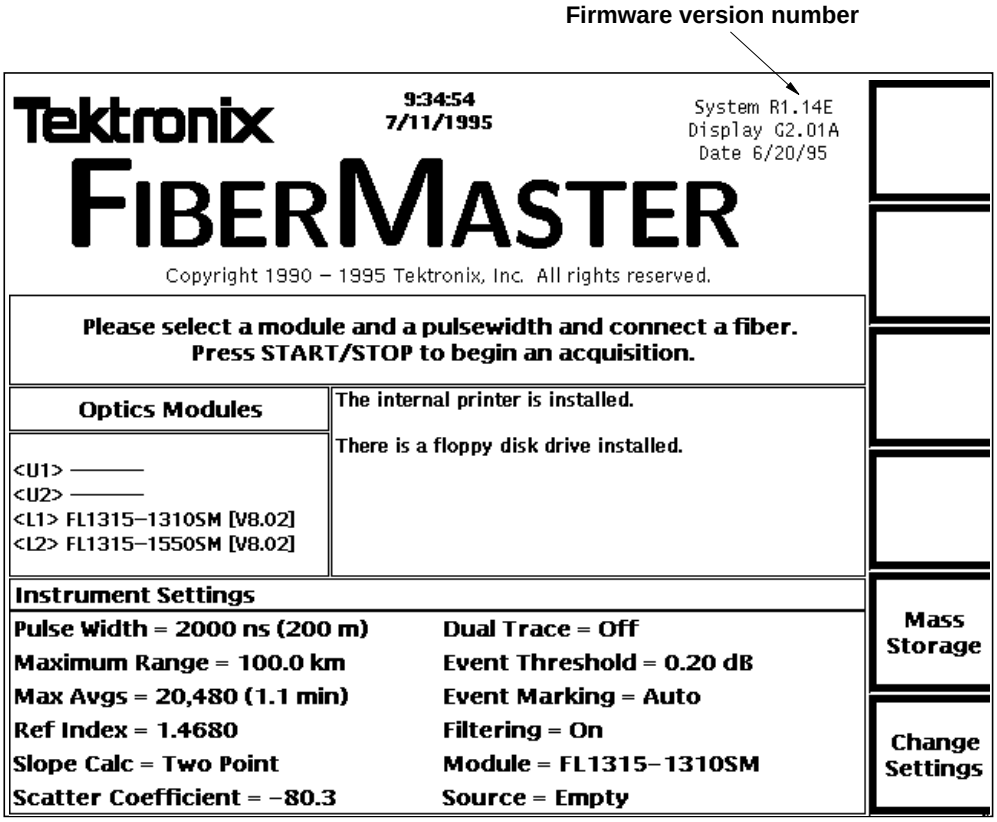


Figure C-1. Firmware Version Number on the Start-Up Screen

The table below lists the major firmware version releases, and the significant features added with each release. If your firmware is not the most current version, your instrument does not include the features listed in the table as having been added with later versions. **The sections of the user manual and the user information in this manual that cover the features added in firmware versions later than the one installed in your instrument do not apply to the operation of your instrument**.

Table C-1: Firmware Versions and Features

Firmware Version	Major Features Added
2.00	Initial TFP2 release
3.00	Link Return Loss and Event Return Loss measurement modes, scattering coefficient parameter
4.00	Event Marking, event threshold and event marking parameters, units parameter moved from Waveform Settings to System Settings menu, GPIB expansion window commands, batch copy mass-storage function, support for foreign language help
8.00	Module parameter information expanded, support for FL-series optical modules and non-standard core diameter modules, 2-km pulse width, quick load and quick save mass-storage functions, GPIB commands EVNTAUTOMARK and IPRNEVENTS, maximum averages default changed to 20,480
9.00	RS-232 remote control, mass-storage filename extensions; ASCII versions of PUT_SET, PUT_WFM, GET_SET?, and GET_WMF? remote-control commands and queries; FILHIGH, FILNORM, FILSET remote-control commands; DIRECTORY? and TYPEFILE? remote-control queries. Final TFP2 release.
1.00	Initial TFP2A release. Language and file format parameters added to the System Settings menu and to remote control instruction set (MSFORMAT and MSFORMAT?). Firmware upgrade via floppy disk. Quick start. Extended long range for FL modules.
1.20	Software filtering parameter for FL modules.

Upgrading Firmware

The TFP2A FiberMaster is shipped with firmware installed. You can upgrade your instrument's firmware when necessary via floppy disk. Contact your local Tek representative, or in the U.S. and Canada, call 1-800-835-9433 for information about TFP2A firmware releases.

To install the firmware into the instrument follow the steps given below. First the instrument checks the firmware disks then the firmware is loaded into the instrument, so you must insert each disk twice during this process.

1. With the power turned off to the instrument, insert TFP2A Firmware disk 1 into the floppy-disk drive.
2. Press **POWER** to turn on the instrument. The power-on diagnostics are performed.
3. The TFP2A displays the following prompts:

   To load from Floppy press the LOAD button
   To start the instrument press the START button

   Softkey 4 (the fourth softkey from the top) is labeled **LOAD**, and softkey 5 is labeled **START**.

   To start the process that loads the firmware from the floppy disk to the TFP2A's flash ROM (where the firmware resides in the instrument), press the **LOAD** softkey.

   To bypass loading the firmware from the floppy disk and start the instrument using the firmware already resident in the flash ROM, press the **START** softkey.
4. After you press the **LOAD** softkey, the instrument starts checking the floppy disk. Information is displayed about the disk (number of disks, languages being loaded, part number, firmware version, and date and time). When the instrument is finished checking the first disk, this prompt appears:

   Insert Disk 2
5. Remove disk 1 from the floppy-disk drive and insert disk 2. Disk 2 is checked, and the same information is displayed. When the disk check is complete, this prompt appears:

   Insert Disk 1
6. Remove disk 2 from the drive, and insert disk 1. The firmware on disk 1 is copied to the instrument. After the file is copied, the following prompt appears:

   Insert Disk 2
7. Remove disk 1 from the drive, and insert disk 2. The firmware on disk 2 is copied to the instrument. When the load procedure is complete, the flash ROM is checked and the instrument starts. The start-up screen displays.
8. Remove disk 2 from the disk drive, and store the firmware disk set in a safe place.

NOTES

Do not interrupt the load process. If you stop the load process before it is complete, firmware can be partially copied to flash ROM. This can cause the instrument to function improperly, or not at all. If this happens, restart the load process from the beginning.

If the load process causes errors and does not complete as expected, contact your local Tek representative for assistance or in the U.S. and Canada call 1-800-835-9433. Error messages that might occur while loading firmware are displayed on the instrument's screen. These messages appear on the screen in English only. For languages other than English, check appendix d, Error Codes*, in your local language version of this manual for translated error codes.*

D Error Codes

This appendix lists file system error codes that may appear on the TFP2A display. If there is a problem with your instrument that you cannot resolve, call our toll-free help line at 1-800-835-9433.

File System Error Codes

The following file system errors may occur during the process of loading new software into the TFP2A.

Table D-1: File System Error Codes

Error Code	Description
FS-1	Unable to allocate memory for file system
FS-2	File name invalid or file does not exist
FS-3	Invalid pathname
FS-4	Too many files open
FS-5	Incompatible file access, or file is not open for access
FS-6	Invalid file handle
FS-12	Invalid access mode
FS-13	Recovered error in data
FS-14	Unrecovered error in data
FS-15	Invalid device
FS-17	Incorrect device for this operation
FS-18	No more directory entries satisfy request
FS-19	Invalid file truncation
FS-20	Device or media write protected
FS-21	Invalid directory of FAT table
FS-22	Hardware error on device

Table D-1: File System Error Codes (cont.)

Error Code	Description
FS-23	Directory already exists
FS-24	Directory full
FS-25	Directory to be deleted not empty
FS-26	Invalid disk label
FS-27	Disk full
FS-28	Duplicate file/directory name
FS-29	Invalid operation on current path
FS-30	Disk I/O error abort
FS-31	Timeout on disk I/O
FS-34	Disk not formatted
FS-66	Ambiguous file name
FS-90	Permanent disk error
FS-280	Access denied
FS-281	File not found
FS-282	Invalid operation current path
FS-283	Different device numbers
FS-284	Directory not empty
FS-285	Name already exists
FS-286	File name already exists
FS-287	Invalid label
FS-288	Invalid directory path
FS-289	File truncation
FS-290	No disk to format
FS-350	Device error
FS-500	Disk removed after customer abort
FS-501	Abort after archive disk mount request
FS-607	Device abort
FS-608	Directory full
FS-609	Too many files open

Table D-1: File System Error Codes (cont.)

Error Code	Description
FS-745	Disk retry
FS-903	Disk change detected
FS-906	Mount floppy disk
FS-907	Permanent error on device X
FS-908	Restore error on file X
FS-909	Skip restoring file X
FS-910	Timeout error on device X
FS-917	Disk change detected

Flash Memory Error Codes

The following flash memory errors may occur during the process of loading new software into the TFP2A.

Table D-2: Flash Memory Error Codes

Error Code	Description
FM-2	Clear status failed for part(s) <part number list>
FM-3	VPP low detected for part(s) <part number list>
FM-4	Device timed out on write for part(s) <part number list> Device timed out on erase for part(s) <part number list>
FM-5	Data verify failed for part(s) <part number list>
FM-6	Byte write error for part(s) <part number list>
FM-7	Block erase error for part(s) <part number list>
FM-8	Erase sequence error for part(s) <part number list>
FM-9	Parallel data failure for part(s) <part number list>
FM-10	Checksum failed
FM-11	Invalid block number parameter
FM-12	Write-enable failed
FM-13	Write-disable failed
FM-14	Unexpected error

Power-On Diagnostic Error Codes

During the first phase of power-on diagnostics, the front-panel LEDs indicate which part of the test sequence is running. The LED code is flashed just prior to starting the specific test, so if the instrument halts, the pattern displayed reflects the test that failed. The pattern codes are as follows:

Table D-3: LED Error Codes

REMOTE LED	REFERENCE LED	CURRENT LED	WINDOW LED	Error Condition
Off	Off	Off	Off	Self test complete
Off	Off	Off	On	LED bus error test
Off	Off	On	Off	Unused
Off	On	On	Off	Parallel port test
Off	Off	On	On	Core RAM test
Off	On	Off	Off	Shared RAM test
Off	On	Off	On	Display processor test
Off	On	On	On	Comprehensive RAM test
On	Off	Off	Off	Floating point coprocessor test
On	Off	Off	On	Serial port test
On	Off	On	Off	Serial port test complete
On	Off	On	On	Unused
On	On	Off	Off	Status register bus error test
On	On	Off	On	Unused
On	On	On	Off	Unused
On	On	On	On	Initial LED write/read verify test
Off	Off	On	Off	Normal power-up/init complete

The following is a list of additional possible error conditions that can be reported during phase 1 power-on diagnostics.

Table D-4: Phase 1 Error Codes

Error Code	Description
D1-0001	Front-panel button bus error test failed
D1-0002	LED bus error test failed
D1-0004	LED error test failed
D1-0008	Simple core RAM test failed
D1-0010	Simple core RAM test failed (vector area)
D1-0020	Shared RAM test failed
D1-0040	Not an error. Indicates display interface untested.
D1-0080	Display interface error
D1-0100	Extended RAM test error
D1-0200	Extended RAM test refresh error
D1-0400	Extended RAM test moving inversion error
D1-0800	FPU bus error test failed
D1-1000	DUART bus error test failed
D1-2000	Parallel interface bus error test failed
D1-4000	System status register bus error test failed
D1-8000	Bus error occurred for reasons unknown

The following is a list of possible error conditions that can be reported during phase 2 power-on diagnostics.

Table D-5: Phase 2 Error Codes

Error Code	Description
D2-00001	Front-panel controller register pattern test failed
D2-00002	Printer controller registers reset value
D2-00004	Printer controller does not count down
D2-00008	Printer controller counts down when it should not
D2-00010	Serial controller register reset value
D2-00020	Serial controller loop-back error - bad data received

Table D-5: Phase 2 Error Codes (cont.)

Error Code	Description
D2-00040	Serial controller does not transmit character
D2-00080	Serial controller counter does not count down
D2-00100	Floppy controller register read error
D2-00200	Real-time clock time updates not OK
D2-00400	GPIB controller soft reset command failed [fatal]
D2-00800	Printer controller register write-read failed
D2-01000	Floppy controller drive reset interrupt
D2-02000	Serial controller loop-back error - timeout
D2-04000	Serial controller counter error - no interrupts [fatal]
D2-08000	NV memory checksum error
D2-10000	NV memory read/write error [fatal]

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