MODEL 2260XFA
DUAL LASER TEST SET

INSTRUCTION MANUAL

FIRST EDITION, JANUARY 1989, CAMARILLO, CALIFORNIA
UNITED STATES OF AMERICA

4. APPLICATIONS

4.1 General

This section describes some of the typical applications of the Model 2260XFA dual laser test set. An optical loss test set (OLTS) is to the fiber optics industry, what a digital multimeter is to the electrical industry. In fact the OLTS is the workhorse of the fiber optics telecommunications testing, without which it would be hard to imagine how fiber optic systems could be installed with any degree of confidence.

Although the specific application for the Model 2260XFA is for measuring loss in WDM systems, it may also be used as a test set for conventional systems at 1300nm, and at 1550nm.

4.2 Loss Measurements

There is no single value of attenuation for a fiber; there is simply an attenuation value associated with a specific measurement method. All measurement methods recreate certain conditions (such as launch condition or wavelength) reproducibly, so that repeated measurements on the same fiber with the same method will produce the same value. Users of fiber should recognize, then, that not all attenuation measurement techniques are equivalent. When attempting to correlate in-house measurements with those

REVISIONS

REV	ECN	DESCRIPTION	BY	QA	ENG	MKTG
A	2068	First Edition, JAN-06-89 Release to Production	[illegible]	[illegible]	[illegible]	[illegible]

Caution

THE PERFORMANCE OF THIS INSTRUMENT IS HIGHLY DEPENDENT ON PRESERVING THE ORIGINAL QUALITY OF THE CONNECTOR INTERFACE. OBSERVE THE FOLLOWING THE PRECAUTIONS:

1) THE OPTICAL PORT(S) MUST BE KEPT COVERED AT ALL TIMES WHEN NOT IN USE.

2) ALL DUST PARTICLES AND OTHER CONTAMINANTS MUST BE EXCLUDED FROM THE OPTICAL PORT(S). WE RECOMMEND USING A LINTLESS CLOTH AND ALCOHOL TO CLEAN THE POLISHED END OF THE CONNECTOR.

3) INTERFACES TO THE INSTRUMENT MUST HAVE HIGH QUALITY TERMINATIONS WITH CONNECTORS PERFECTLY COMPATIBLE WITH THE MANUFACTURER'S TYPE AS GIVEN IN THE PHOTODYNE SPECIFICATIONS. THESE ARE HIGHLIGHTED IN THE TABLE BELOW.

NOTE: DAMAGE INCURRED AS A RESULT OF IGNORING THIS **CAUTION** WILL BE AT THE LIABILITY OF THE USER.

SUFFIX	MANUFACUTURER AND TYPE	SINGLE MODE	MULTIMODE
A	AMP SIMPLEX	---	501067-2
B	AMPHENOL 905/906 SMA	---	906-110-XXXX
G	DIAMOND/INTEROPTICS	HMS-3	GFS-3
H	HOLTEK 38000/STRATOS 430	---	38066
J	SEIKO FC/D3	SF-1A/SAP-1	SF-1B/SAP-2
M	DIAMOND/SIEMENS DIN 47256	D-2106	D-236
N	NEC D4	OD-9474	OD-9470
P	SEIKO/NTT FC TYPE PC	SF-1A/SAP-1	SF-1B/SAP-2
R	RADIALL OPTABALL	F714 (VFO)	F710 (PFO)
S	SIRTI BAYONET BICONIC	FC1F-/MB1	FCAF-/MBx
T	AT&T ST	P3020A-C-125	P2020A-C-125
W	AT&T BICONIC	1016A/2016A	1006A

NOTE: FOR REFERENCE PURPOSES, ALL MANUFACTURER'S PART NUMBERS ARE SHOWN FOR 125μM CLADDING DIAMETER FIBER.

FN: CAUTION.ERR REV E 7/88

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Camarillo, California 93010
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805 499-9311 Facsimile
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3M

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NOTE
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No charger other than a 3M Photodyne power charger may be connected to the charger input. Improper use voids the 3M Photodyne warranty.

Table 3.2 Battery Charger Selection Chart

Model	Input AC Power	Country
100E	89 - 110 V AC,50 Hz.	JAPAN
115E	105 - 129 V AC,60 Hz.	USA, CANADA
220E	207 - 253 V AC,50/60 HZ.	EUROPE

Turn the unit off and back on to resume normal operation. If the error repeats itself without logical reason, consult the factory.

Table 3.1 Error Codes

Error Code	Condition
E 01	Display overflow. > 99.99 dB
E 02	CPU error.
E 03	RAM error.

3.10 How to Charge the Battery

The 2260XFA contains a 12V,4Ah sealed lead acid battery. To recharge the internal battery, connect the appropriate 3M Photodyne battery charger to the 'CHARGER' jack on the front panel of the instrument with instrument POWER OFF. Refer to Table 3.2 for correct battery charger selection according to available AC electrical power. A full charge will typically require approximately 14-18 hours. The 2260XFA may be operated while the charger is plugged into the unit. In this case, battery charging will take more time then mentioned above. The charger is designed so that the battery will not overcharge. This is done by providing a constant trickle charge as defined by the battery manufacturer's specifications.

QUICK INSTRUCTIONS

NOTE: Be sure to clean connectors on instrument and your patch cable.

1. Connect patch cable between XMTR and RCVR to make loop.

2. Turn ON 2260XFA,"LOOP" is displayed until the 2260XFA is zeroed out.

3. When "ZERO" is no longer displayed, Turn ON "XMTR".

4. Wait until "-10 dBm" is displayed. (Typically warm up time is approximately 4 minutes.)

5. When "-10 dBm" is displayed.

   YOU ARE NOW READY FOR TESTING

6. If "LOOP" is flashing after 4 minutes, check your Patch cable for breaks or bends.

NOTE: When display reads "LO BAT" you have approximately 30 minutes of use remaining.

3.8 Selecting Absolute Power Units (dBm)

When a laser is OFF, the corresponding measurement window will always be in the dBm mode. When a laser is ON, the 2260XFA allows either dBm units or dB units with a reference power of -10.0 dBm. The "dBm" and "dB" secondary functions allow the user to change between these two possibilities. To select dBm units, use the "dBm" secondary function (Refer Section 3.4). The 2260XFA will select dBm measurement units for both 1300nm and 1550nm windows.

The dBm unit selection is stored as a parameter in the EEPROM. Thus, the user does not have to select dBm units again after turning power OFF and then ON. All 2260XFA's are factory set to measure in the dBm mode.

The resolution of power measurements in this mode is fixed to 0.1 dB over the entire dynamic range of the instrument. Under-range and over-range is indicated by LO and HI respectively.

3.9 Error Codes

The 2260XFA can internally sense certain illegal conditions and errors during its operation. Any such condition is flagged with an error code message and code number. **When an error does occur, note the Error Code and the cause given from the description in Table 3.1.**

instrument. Under-range and over-range is indicated by LO and HI respectively.

All 2260XFA's are factory set to measure in the dBm mode. If dB mode is desired, the user must select the "dB" secondary function. The dB unit selection is also stored in the EEPROM as a parameter. Thus, when the instrument is turned OFF and ON again it will select the dB mode for measurement automatically. When the unit is turned ON again, it will first perform zeroing of both the detectors for about 30 seconds and then **always** go into the dBm mode. In normal opearation, when both the lasers (XMTR1 & 2) are turned ON, then the 2260XFA will first set both lasers to -10.0 dBm. At this point, if the unit has been set for dB operation, it will go into the dB mode and display 0.0 dB on both fields of the display, indicating both incoming and reference values are equal.

When the user selects XMTR1 or XMTR2 secondary function and if the unit has been set for dB operation, then the 2260XFA will select the dB mode, in one of the display field only, depending on which laser is turned ON. Other display field will always remain in the dBm mode during this secondary (XMTR1/XMTR2) function.

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for 1300nm window will always remain in dBm mode during this function, since Laser1 is not turned ON.

3.7 Selecting Relative Power Units (dB)

The dB mode is most commonly used for fiber attenuation measurements and connector/splice loss measurements. Select the "dB" secondary function (Refer Section 3.4) to measure in dB units with a reference power of -10.0 dBm, when the laser(s) are ON. The dB unit selection is dependent on the laser ON/OFF condition. The unit will go into dB mode measurement **only** after the laser(s) are turned ON and automatically adjusted to -10.0 dBm. If only one laser is turned ON, then the 2260XFA will select dB mode in only one of the display fields, depending on which laser is turned ON. When the laser(s) are turned OFF, the unit will return to the dBm mode.

The reference power for the dB measurement is always - 10.0 dBm and it is stored in the computer as a constant value. The incoming light levels of both the 1300nm and 1550nm windows are measured in dBm and have the -10.0 dBm reference power subtracted from them. The resulting dB value is displayed on the LCD.

The resolution of power measurements in this mode is fixed to 0.1 dB over the entire dynamic range of the

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patch cable from the XMTR port to the RCVR port. During the adjustment, the bottom half of the display will be blanked out. The top half of display will show "LOOP" and blink the **XMTR1** annunciator. "LOOP" is displayed to remind the user that there must be a loop-back cable from the XMTR port to the RCVR port. The adjustment will take from 1.5 to 3 minutes. Once the adjustment is complete, "LOOP" will disappear, and the 2260XFA will resume normal power measurement. The power reading will be -10.0 ± 0.2 dBm. At this point, if the unit has been set for dB operation, it will go into the dB mode and display 0.0 dB only on the top field of the display. The bottom field of display (1550nm window) will still remain in dBm mode since Laser2 is not turned ON. If it has been set for dBm operation, then it will stay in the dBm mode and display -10.0 dBm on the top field of the display. To turn the laser OFF, simply press **[XMTR]** again.

3.6 Turn ON XMTR2 [Laser2(1550nm)] Only

Select XMTR2 secondary function (Refer Section 3.4) to turn ON Laser2 (1550nm). The function operation is exactly similar to the XMTR1 function operation. In this mode, during the power adjustment the top half of display will be blanked out and the bottom half of the display will show LOOP, XMTR2 and ON annunciators. Power measurement readings in dBm or dB will be displayed in the bottom field of the display. Top field of display

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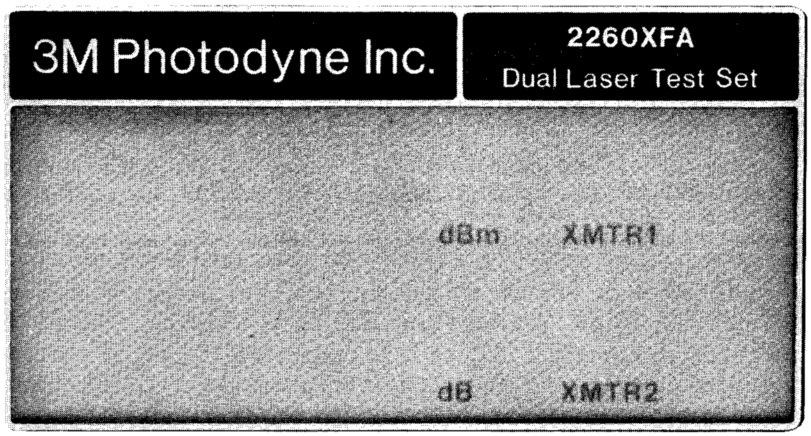

Figure 3.7 LCD Display during secondary function selection.

3.5 Turn ON XMTR1 [Laser1(1300nm)] Only

Select XMTR1 secondary function (Refer Section 3.4). Laser1 (1300nm) will be turned ON. The ON state is indicated by the XMTR1 annunciator on the display. The actual laser ON status is displayed by an **ON** annunciator next to the XMTR1 annunciator. When the laser is turned ON, the 2260XFA automatically adjust its output power to -10.0 ± 0.2 dBm. In order for this adjustment to occur, there must be a loop-back cable from the XMTR port to the RCVR port of the 2260XFA.

Thus, before selecting this function, connect a fiber

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dBm as shown in Figure 3.7. The first secondary function annunciator (XMTR1) will be blinking. XMTR1 will continue to blink for approximately 3 seconds and then XMTR2 will blink, then dB and then dBm.

2. To select the function, release the key when desired secondary function is blinking.

If the key is still held down after the last secondary function (dBm) has been blinking for 3 seconds, then the unit will leave the secondary function selection mode, and resume normal operation.

Secondary Function	**Result**
XMTR1	Turns ON XMTR1 (1300nm laser) only.
XMTR2	Turns ON XMTR2 (1550nm laser) only.
dB	Unit will go into dB mode after laser(s) are turned on.
dBm	Unit will stay in dBm mode even after laser(s) are turned on.

When the unit is first turned ON, it will first perform zeroing of both the detectors for about 30 seconds and then **always** go into the dBm mode. When both the lasers are turned ON, the unit will automatically adjust both lasers power level to -10.0 dBm. At this point, if the unit has been set for dB operation, it will go into the dB mode and display 0.0 dB on both fields of the display. If it has been set for dBm operation, then it will stay in the dBm mode and display -10.0 dBm on both fields of the display.

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Thus, before pressing **[XMTR]** connect a fiber patch cable from the XMTR port to the RCVR port. Once **[XMTR]** is pressed, the 2260XFA will turn on the lasers and begin adjusting them to -10.0 dBm. During the adjustment, the display will show "LOOP" and blink the **XMTR1** and **XMTR2** annunciators. "LOOP" is displayed to remind the user that there must be a loop-back cable from the XMTR port to the RCVR port. The adjustment will take from 1.5 to 3 minutes. Once the adjustment is complete, "LOOP" will disappear, and the 2260XFA will resume normal power measurement. The power reading will be -10.0 ± 0.2 dBm. At this point, if the unit has been set for dB operation, it will go into the dB mode and display 0.0 dB on both fields of the display. If it has been set for dBm operation, then it will stay in the dBm mode and display -10.0 dBm on both fields of the display.

To turn the lasers OFF, simply press **[XMTR]** again.

3.4 Secondary Function Selection

The XMTR ON/OFF key is used for accessing the secondary functions. To access any secondary function, perform the following.

1. Press and hold down the XMTR key for approx. 5 seconds until the display is blanked and only the secondary function annunciators are shown. The 2260XFA will display four secondary function annunciators XMTR1,XMTR2,dB and

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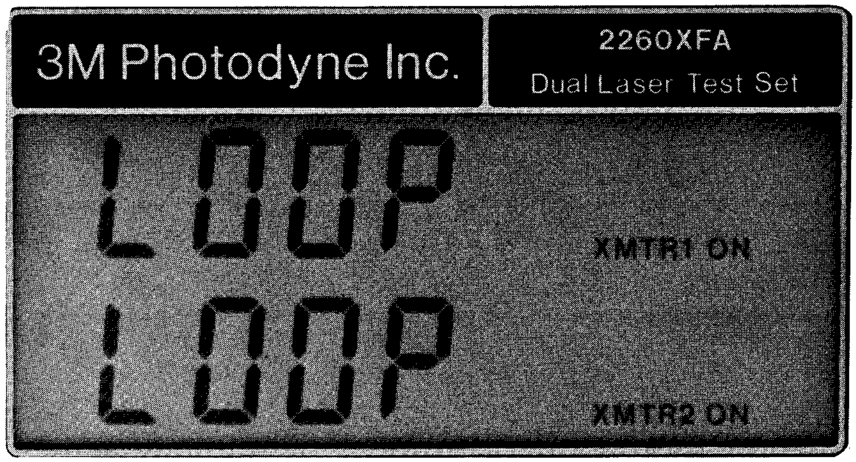

Figure 3.5 LCD Display during Laser Power Adjustment.

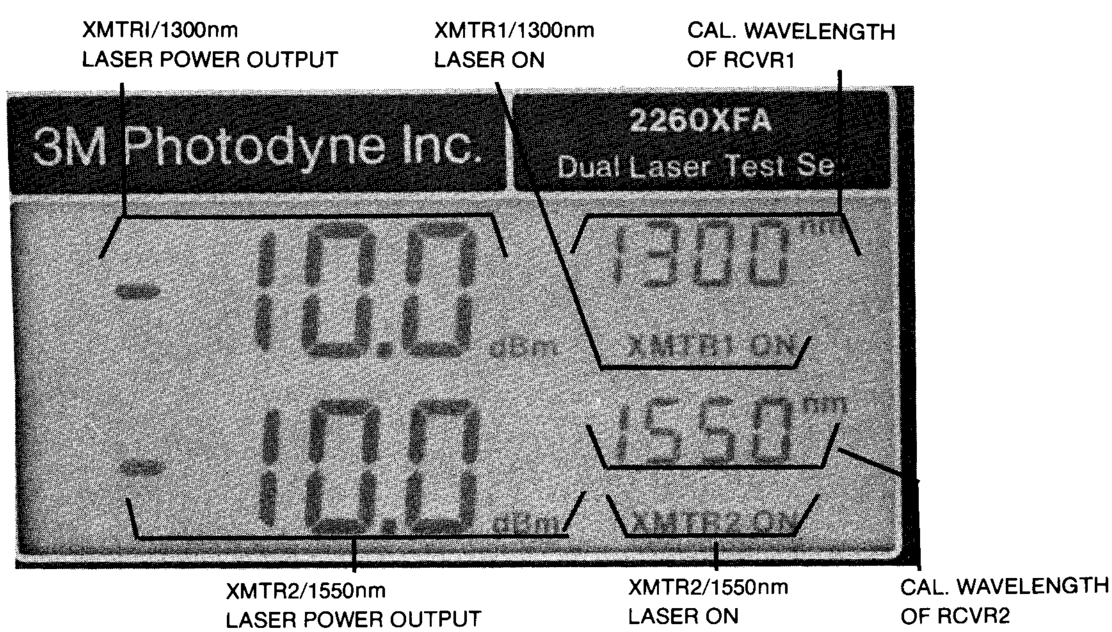

Figure 3.6 LCD Display after Laser Power Adjustment.

1. GENERAL INFORMATION

1.1 Introduction

3M Photodyne's Model 2260XFA, Dual Laser Test Set is specifically designed for testing single mode trunk lines at 1300nm and 1550nm operating wavelengths. This test set allows the user to do testing at both wavelengths simultaneously, which reduces both measurement time and inaccuracies of measurements due to interfacing problems.

The model 2260XFA is a portable, light weight instrument and is housed in a heavy duty militarized enclosure. A custom membrane switch front panel provides reliable operation and resistance to dirt and other contaminants. Internally sealed lead acid batteries provide extended, portable operation.

The 2260XFA contains dual thermoelectrically cooled singlemode C.W. laser sources (1300nm and 1550nm). Both laser sources are internally coupled through a wave length division multiplexed (WDM) coupler. A connectorized output port of this WDM coupler is brought to the front panel as a XMTR output port. The user needs to connect a test fiber to the XMTR port to launch light from the lasers into the system. Automatic receiver zeroing is done when the unit is turned on. In addition, the 2260XFA will automatically adjust the lasers to

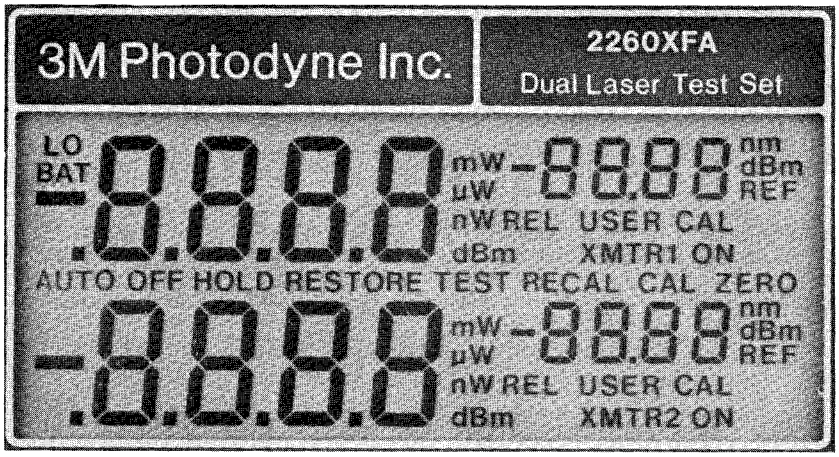

Figure 3.4 Detailed Photograph of LCD showing all active segments and annunciators.

3.3 <u>Turn ON/OFF XMTR (1300nm & 1550nm Laser Sources)</u>

This key controls ON/OFF of both 1300 and 1550 nm lasers. Momentarily pressing **[XMTR]** will change the output of the XMTR from ON to OFF or from OFF to ON depending upon its previous state. The ON state is indicated by the **XMTR1** and **XMTR2** annunciators on the display. The actual laser ON status is displayed by an **ON** annunciator next to the **XMTR** annunciators.

When the lasers are turned on, the 2260XFA automatically adjusts their output power to -10.0 ±0.2 dBm. In order for this adjustment to occur, there must be a loop-back cable from the XMTR port to the RCVR port of the 2260XFA.

- 10.0 dBm as soon as the lasers are turned on.

The 2260XFA has the unique capability of measuring input light power at 1300 and 1550 nm simultaneously. The user just needs to connect a test fiber containing both wavelengths of light to the RCVR input port of the 2260XFA. The receiver section is comprised of dual InGaAs detectors and dichroic filters. The input light from the receiver port is collimated and diverted to these two detectors by the dichroic filters. One of these two detectors measures input light for 1300 nm and another detector measures input light for 1550nm. This receiver arrangement demands a fixed connector interface for precise power measurement.

Model 2260XFA utilizes dual single chip microcomputer technology to allow simultaneous measurement, and provides extremely simple two key operation. To add to the 2260XFA's simplicity, the power readings are always in dBm units with a displayed resolution of 0.1 dBm.

A 16-digit custom liquid crystal display allows simultaneous readout of power and wavelength plus additional annunciators for ease of operation. One part of the display is dedicated to 1300 nm power measurements and the second part of the display is dedicated to 1550nm power measurements. Both power measurements are independent and simultaneously made.

the 2260XFA will go into its normal power measurement mode (most likely displaying "LO dBm" indicating little or no input light).

Momentarily press Power [ON/OFF] again to turn OFF the unit.

****
*** NOTE ***
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In prolonged operation, power measurement accuracy is affected by the detector's dark current and amplifier offset. If the 2260XFA is used to measure power below - 50.0 dBm, it is recommended that the user re-zero the detectors, by turning the unit OFF and back ON with the RCVR port darkened, at regular intervals.

****
*** NOTE ***
****

If the RCVR port is not completely darkened, the 2260XFA will not be properly zeroed and will not measure power correctly. "LOOP" may be continuously displayed, even after 20 seconds, indicating the input power level is too high and the RCVR can not be zeroed. The unit must be turned OFF and back ON to repeat the automatic zeroing with no light input.

HIGHLIGHTS

* DUAL THERMOELECTRICALLY COOLED SINGLE MODE C.W. LASER SOURCES (1300nm AND 1550nm).

* DUAL InGaAs DETECTORS

* SIMULTANEOUS POWER MEASUREMENTS AT BOTH 1300 AND 1550nm WAVELENGTHS.

* AUTOMATIC -10.0 dBm LASER POWER ADJUSTMENT.

* AUTOMATIC RECEIVER OFFSET ZEROING.

* DYNAMIC RANGE OF POWER MEASUREMENTS FOR BOTH WAVELENGTHS: 0 TO -65 dBm

* 16 DIGIT CUSTOM LCD DISPLAY.

* RUGGEDIZED SELF CONTAINED FIELD CASE.

APPLICATIONS

* SINGLE MODE WDM SYSTEM MEASUREMENTS AND MAINTENANCE.

* ATTENUATION AND SPLICE MEASUREMENTS

* Q.C. OF FIBER OPTIC CABLE AND COMPONENTS (WDM COUPLERS,OPTICAL SWITCHES ETC.)

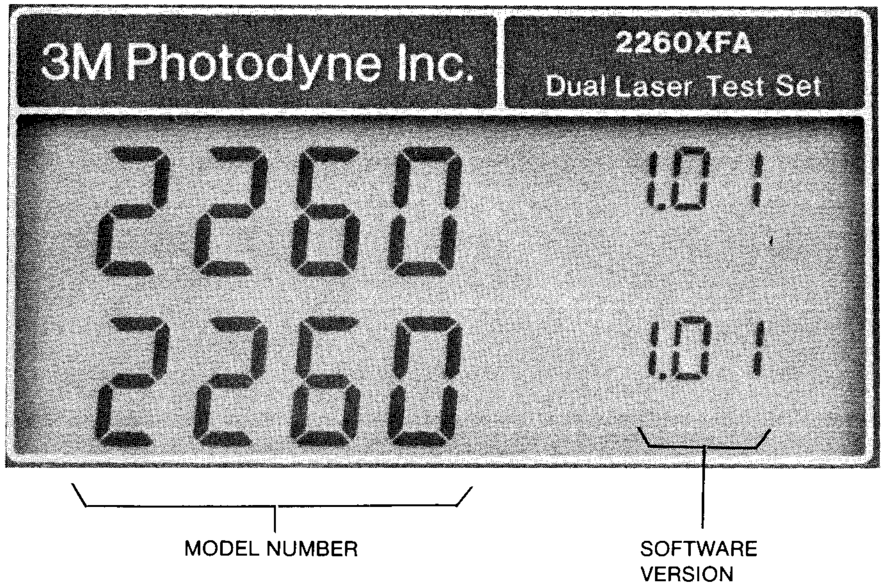

Figure 3.2 Photograph of POWER ON Display

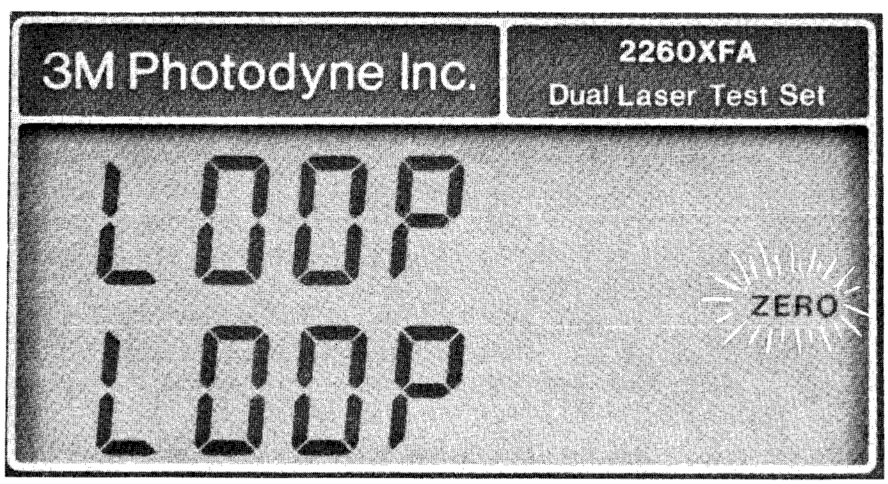

Figure 3.3 LCD Display while zeroing.

1.2 SPECIFICATIONS

SPECIFICATIONS AT 18° TO 25°C:

	MODEL 2260XFA	
	XMTR	
1	FIBER INTERFACE	S.M. 9/125 μm, 0.11 N.A., S.I.
2	CONNECTOR INTERFACE *	J, P, W
3	XMTR1 & XMTR2 TYPE	T.E. COOLED LASER
4	CENTRAL WAVELENGTH XMTR1 XMTR2	 1300 nm ±10 nm 1550 nm ±20 nm
5	RMS SPECTRAL WIDTH XMTR1 XMTR2	 < 3 nm (typ.) 5 nm (max.) < 3 nm (typ.) 5 nm (max.)
6	POWER OUTPUT (MODULATED AT 2KHz SQ.) XMTR1 XMTR2	(BOTH LASER POWER OUTPUT - ARE AUTOMATICALLY ADJUSTED) -10.0 dBm -10.0 dBm
7	STABILITY (XMTR1 & XMTR2) 1 hour 24 hours	 <± 0.05 dB <± 0.2 dB
8	REPEATABILITY	0.5 dB typical
9	LASER ON INDICATION	XMTR1 ON and XMTR2 ON Annunciator displayed on LCD
10	WARM-UP TIME	15 min.
11	LASER SAFETY CLASSIFICATION	CDRH, CLASS I, 21CFR Subchapter J

3.2 Instrument Power ON/OFF

When the 2260XFA is first turned ON, it will perform an internal self test of the CPU, computer memories, and electronics. This self test takes approximately 30 seconds. Immediately after the self test, the 2260XFA will perform an automatic zeroing of the receiver to null out any dark state offset current coming from the detectors. The zeroing must be performed with no light coming into the unit.

Thus, before turning ON the unit, connect a cable from the XMTR port to the RCVR port of the 2260XFA, or just cover the RCVR port with its dust cap.

Momentarily press Power **[ON/OFF]** to turn the instrument ON. The 2260XFA will display "2260" and the software version number, i.e. "1.02". It will then perform its Self Test. Immediately after the Self Test, the 2260XFA will display "LOOP" and begin the automatic zeroing. "LOOP" is displayed to remind the user that the zeroing requires a loop-back cable from the XMTR port to the RCVR port (or covering the RCVR port with its dust cap) in order to block all light from the RCVR. During automatic zeroing, "LOOP" will continuously be displayed, and the **ZERO** annunciator will blink. The zeroing will take from 1 to 30 seconds to complete. When zeroing is complete, "LOOP" and the **ZERO** annunciator will disappear, and

SPECIFICATIONS AT 18° TO 25°C:

	RECEIVER		
12	SENSOR TYPE	Dual InGaAs Photodiodes	
13	SENSOR SIZE	3 mm dia. (Both Sensor)	
14	MAXIMUM N.A.	0.11	
15	WAVELENGTH ISOLATION	≤ - 40 dB	
16	DISPLAY RESOLUTION	LOG: 0.1 dB	
17	ABSOLUTE CALIBRATION WAVELENGTHS, nm	1300 nm	1550 nm
18	ABSOLUTE CALIBRATION ACCURACY at -20 dBm	±0.3 dB	±0.3 dB
19	DYNAMIC RANGE	0 to -65 dBm	0 to -65 dBm
20	MEASUREMENT RANGE (of the Test Set)	52 dB	52 dB
21	MAX. RELATIVE POWER MEASUREMENT ERROR +0.00 to -39.99 dBm -40.00 to -49.99 dBm -50.00 to -59.99 dBm -60.00 to -62.00 dBm	 ±0.4 dB ±0.6 dB ±0.8 dB ±1.0 dB	 ±0.4 dB ±0.6 dB ±0.8 dB ±1.0 dB
22	MEASUREMENT REPEATABILITY	0.2 dB	
23	OPTICAL INPUT CONNECTOR INTERFACE *	J, P, W	
24	OPTICAL CALIBRATION TRACEABILITY	NATIONAL INSTITUTE OF SCIENCE AND TECHNOLOGY - U.S.A. & NATIONAL PHYSICAL LABORATORY -U.K.	
25	RECALIBRATION PERIOD	1 YEAR	
26	WARM UP TIME	5 minutes	

3. FRONT PANEL OPERATION

3.1 Introduction

This section includes operating instructions and front panel control descriptions. For the 2260XFA front panel illustration refer to Figure 3.1. For references to the Model 2260XFA custom LCD, refer to Figure 3.4 showing all segments and annunciators.

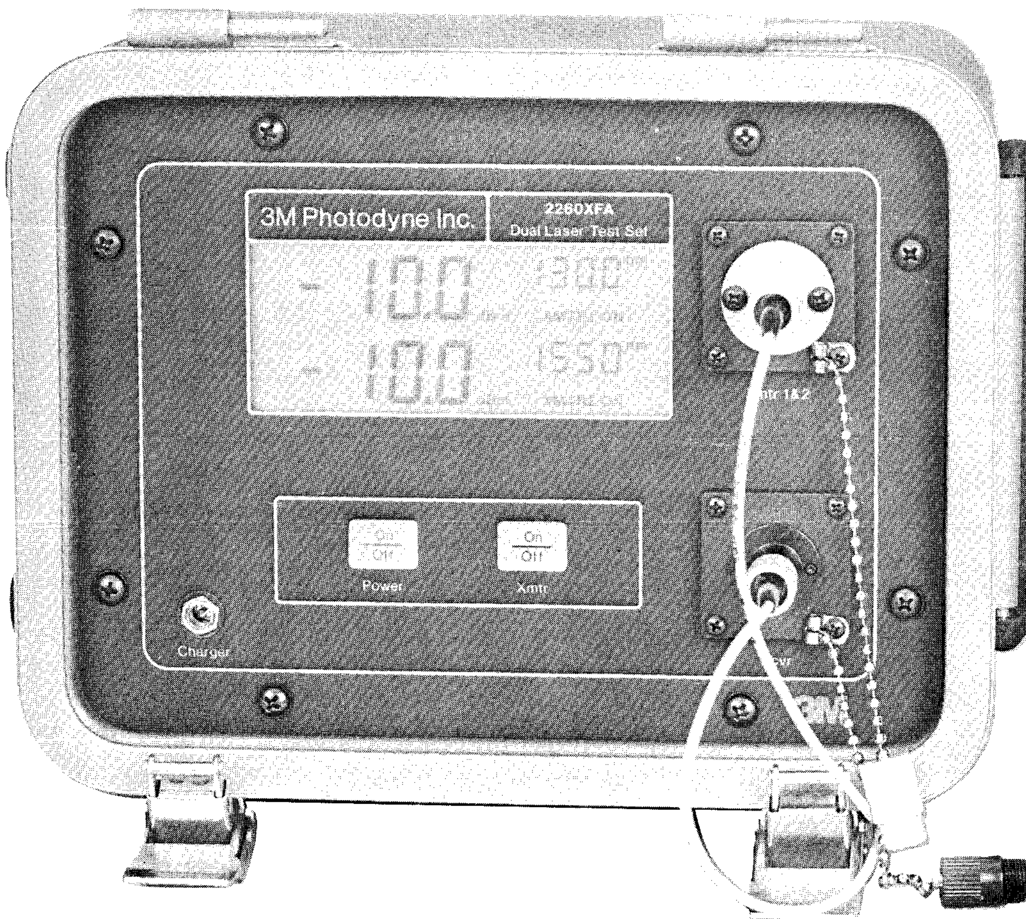

FIGURE 3.1 Front Panel View of Model 2260XFA

SPECIFICATIONS AT 18° TO 25°C:

27	DISPLAY TYPE UNITS ANNUNCIATORS	 Custom Dual 8 Digit Liquid Crystal Display (LCD) dBm,nm. TEST,XMTR1,ON,XMTR2,ON, ZERO,LO BAT.
28	MEASUREMENT MODE OTHER FUNCTIONS	dBm,dB. XMTR 1 & 2 (ON/OFF)
29	POWER BATTERY: BATTERY LIFE: BATTERY CHARGER: MODEL 100E MODEL 115E MODEL 220E	 12V,4Ah,sealed lead acid, rechargeable 7 hrs. (typical) INPUT POWER: 89 -110 VAC,50Hz INPUT POWER: 105 -129 VAC,60Hz INPUT POWER: 207 - 253 VAC, 50/60Hz
30	ENVIRONMENTAL OPERATING TEMPERATURE STORAGE TEMPERATURE HUMIDITY	 0 to +40°C (+32 to +104°F) -15 to +70°C (+ 5 to +158°F) 0-95%, NON -CONDENSING

SPECIFICATIONS AT 18° TO 25°C:

31	DIMENSIONS , cm (in.)	Height X Width X Depth
	INSTRUMENT WITH LID ON:	26.03 X 25.04 X 20.95 cm (10.25 X 10.00 X 8.25 in)
	TRANSIT CASE:	34.79 X 27.94 X 33.02 cm (13.70 X 11.00 X 13.00 in.)
	SHIPPING CASE:	38.73 X 32.68 X 38.25 cm (15.25 X 12.87 X 15.06 in.)
32	WEIGHT , kg (lbs., oz.)	
	INSTRUMENT WITH LID ON & INCLUDING CHARGER:	6.35 kg (14 lbs)
	TRANSIT CASE:	5.22 kg (11.5 lbs)
	SHIPPING CASE:	1.81 kg (4 lbs)

* Connector option codes:

Same connector option applies to both XMTR1 &2 optical Power output and RCVR optical input interface.

J = Seiko/ NTT Type FCN/D3 S.M. connector interface.

P = Seiko/ NTT PC S.M. connector interface.

W = Dorran S.M. Biconic connector interface.

Specifications subject to change without notice.

2.5 Preparation for use

The 2260XFA Dual Laser Test Set is shipped ready for use. The instrument is powered from the internal rechargeable battery pack or the external power supply/charger (Model 100E, 115E, or 220E). Before operating instrument for the first time, read Section 3 and familiarize yourself with the operational instructions of the instrument.

1.3 Specification Definition

1. **FIBER INTERFACE:** This specification lists the type of fiber that can be used with this instrument and with which the instrument will meet or exceed the published specifications.

   Symbols:

   S.M. = Single Mode

   9/125 = Fiber size in μm core/cladding.

   N.A. = Numerical Aperture

   S.I. = Step Index Fiber

2. **CONNECTOR INTERFACE:** This field lists the connector options available on this instrument.

3. **TYPE OF EMITTER:** This field lists the type of the emitter used for source.

   T.E. COOLED LASER = Thermo Electrically Cooled LASER source with a photodiode to monitor back facet emission.

4. **CENTRAL WAVELENGTH:** The Central wavelength is defined as the first moment of the wavelength from the power versus wavelength distribution. It can be calculated as follows:

   $$CW = (1/P_o) \sum_{i=1}^{n} P_i \lambda_i$$

   Where:

   CW = Central wavelength

   $P_o = \Sigma P_i$ = Total Power

2.4 Contents

1 Model 2260XFA Dual Laser Test Set

1 Data Package (Plastic Bag) containing following items:
- 1- Instruction Manual
- 1- Calibration Certificate
- 1- Metrology Report
- 1- Spectral plot of 1300 nm Laser
- 1- Spectral plot of 1550nm Laser
- 1- Warranty registration card (Mail immediately after checking out the unit.)

1 Battery Charger (specific model as ordered)
- Model 100E : 90 - 110 VAC, 50Hz
- Model 115E : 104 - 126 VAC, 60Hz
- Model 220E : 198 - 242 VAC, 50/60Hz

Figure 2.1 Contents of the Model 2260XFA.

P_i = Power of the i-th longitudinal mode.

λ_i = Wavelength of the i-th longitudinal mode.

5. **RMS SPECTRAL WIDTH:** The spectral width is defined as the root-mean-square (RMS) deviation of the wavelength from the wavelength versus power distribution. It can be calculated as follows:

$SW = [[(1/P_o)\ P_i\ \lambda_i^2] - (CW)^2]^{(1/2)}$

Where:

SW = RMS Spectral Width

CW = Central Wavelength

$P_o = \Sigma P_i$ = Total Power

P_i = Power of the i-th longitudinal mode.

λ_i = Wavelength of the i-th longitudinal mode.

6. **POWER OUTPUT:** This specification defines the optical power launched into the test fiber. The launched power is specified for any compatible fiber type with the same numerical aperture. The user's connector must be terminated to the manufacturers specification.
Modulation: Both laser sources are always continuously modulated at 2 kHz square wave internally.

7. **STABILITY:** Short term stability is the maximum deviation within one hour after 15 minute warm-up period at a constant temperature deviating no more than ± 2°C.
Long term stability is the maximum deviation within 24

2. INITIAL PREPARATION

2.1 Introduction

This section provides information needed for incoming inspection and preparation for use.

2.2 Unpacking and Inspection

The unit was carefully inspected, both mechanically and electrically before shipment. When received, the shipping carton should contain the following items listed below. Account for and inspect each item before the carton is discarded. In the event of a damaged instrument, write or call your local 3M PHOTODYNE Representative or contact 3M PHOTODYNE Headquarters in Camarillo, California. Please retain the shipping carton in case re-shipment is required for any reason.

2.3 Damaged in Shipment

All instruments are insured when shipped by 3M Photodyne. If you receive a damaged instrument you should:

1) Report the damage to your shipper immediately.
2) Inform your local 3M Photodyne Representative or 3M Photodyne directly.
3) Save all shipping cartons.

Failure to follow this procedure may affect your claim for compensation.

hours after the 15 minute warm-up period at a constant temperature deviating no more than ±4°C.

8. **REPEATABILITY:** This specification defines the repeatability of power coupling into the fiber at the XMTR port. It is defined as the standard deviation of the ten insertions of the same connector into the XMTR port. The connector must be terminated to the manufacturer's specifications.

9. **LASER ON INDICATION:** The ON state of the laser is indicated by the XMTR1 and XMTR2 annunciators on the display. The actual laser on status is displayed by an **ON** annunciator next to the XMTR annunciators.

10. **WARM-UP TIME:** This specifies the time XMTR1&2 must be warmed up after turning on laser(s) in order to conform to the specifications.

11. **LASER SAFETY CLASSIFICATION:** Both laser sources (1300nm and 1550nm) conform to the regulations of CDRH (Center for Devices and Radiological Health) - United States of America (U.S.A.). Both Lasers are CLASS I.

12. **SENSOR TYPE:** This field provides information on the type of photo detector used at the front end of the instrument for optical power detection.

13. **SENSOR SIZE:** This is the physical size and shape of the sensor chip.

14. **MAXIMUM N.A.:** This specification defines the maximum fiber Numerical Aperture (N.A.). which can be used for power measurement without loss of accuracy.

15. **WAVELENGTH ISOLATION:** This specification defines the crosstalk or isolation between the RCVR1 and RCVR2 channels at specified wavelengths.

16. **DISPLAY RESOLUTION:** This specification defines the smallest power change the power meter can display during the power measurement.

17. **ABSOLUTE CALIBRATION WAVELENGTHS:** This field provides a list of wavelengths for which absolute calibration is provided and these absolute calibrations are traceable to the National Institute of Science and Technology (N.I.S.T.) -U.S.A. or National Physical Laboratory (N.P.L.) - U.K. calibration standard.

    Absolute calibration: Currently absolute calibration data provided by the N.I.S.T. (U.S.A.) and N.P.L.(U.K.) is only for 820,850,1300 and 1550nm. An absolute power reading calibration of the power meter is performed using a source of specific wavelength (e.g. 820,850,1300,1550 nm) and using a working transfer standard. The 2260XFA power reading is adjusted to match the power reading of through equipment which is calibrated at planned intervals by comparison to certified standards.

The instrument should have its calibration checked annually in order to maintain specifications. This provides the basis for an effective quality assurance/standards program. These services are available for 3M PHOTODYNE products for a nominal fee.

1.6 Change Notice

Improvements or changes to the instrument not incorporated into the manual will be explained on a yellow Change Notice attached to the inside back cover of the manual.

the working transfer standard. This provides absolute calibration of these wavelengths which is directly traceable to the N.I.S.T. - U.S.A. or N.P.L. - U.K. standard.

18. **ABSOLUTE CALIBRATION ACCURACY:** This is the total uncertainty of the transfer calibration process. Specific power level, source wavelength and temperature are specified as qualifiers so that the user can verify this specification.

19. **DYNAMIC RANGE:** This defines the range between noise level and upper level of the power meter. The noise level is defined as the highest power reading displayed within a 3 minute interval, after performing the zero procedure. The power measurement range is considered 3 dB (or at least two times) above the noise floor. The upper level is a highest power level which can be detected by the power meter. The dynamic range is specified at 1300 and 1550nm.

20. **MEASUREMENT RANGE (of the Test Set):** The measurement range of the test set is defined as the maximum power range, expressed in dB, over which measurement can be made. The dynamic range is the difference between the amount of power that can be coupled in to the fiberoptic system and the sensitivity of the detector. The maximum

3M PHOTODYNE representative, or contact 3M PHOTODYNE Headquarters in Camarillo, California. You will be given prompt assistance and return instructions. Send the instrument, transportation prepaid, to the indicated service facility. Repairs will be made and the instrument returned, transportation prepaid. Repaired products are warranted for the balance of the original warranty period, or at least 90 days.

Limitation of Warranty

This warranty does not apply to defects resulting from unauthorized modification or misuse of any product or part. This warranty also does not apply to fuses or AC line cords.

This warranty is in lieu of all other warranties, expressed or implied, including any implied warranty of merchantability of fitness for a particular use. 3M PHOTODYNE, INC. shall not be liable for any indirect, special or consequential damages.

1.5 Statement of Calibration

This instrument has been inspected and tested in accordance with specifications published by 3M PHOTODYNE, INC. The accuracy and calibration of this instrument is traceable to the U.S. National Bureau of Standards distance over which the Test Set can be used is dependent not only on its dynamic range, but also on the optical loss of the system being measured.

21. **RELATIVE POWER MEASUREMENT ERROR:** This specification defines the linearity of the power meter. This is the error in relative power measurement with respect to -20 dBm reference power level.

22. **MEASUREMENT REPEATABILITY:** This specification defines the repeatability of the same power measurement at the RCVR port. It is defined as the standard deviation of the ten insertions of the same connector into the RCVR port. Connector must be terminated to the manufacturer's specifications.

23. **OPTICAL INPUT INTERFACE:** This field provides information on the available type of connector interfaces (fixed connector) listed by connector codes. Connector codes are explained at the end of the specifications.

24. **OPTICAL CALIBRATION TRACEABILITY:** The detector absolute calibration data is directly traceable to NIST - U.S.A. (National Institute of Science and Technology - U.S.A.) and N.P.L.-U.K. (National Physical Laboratory - U.K.) .

25. **RECALIBRATION PERIOD:** This is the recommended time period in between instrument and/or detector calibrations in order to maintain the accuracy specifications.

safely stored in the OFF condition in this temperature range. It is required that the instrument be brought back to within the operating temperature range before it is turned ON.

HUMIDITY: The relative non-condensing humidity levels allowed in the operating temperature range.

31. **DIMENSIONS:** All dimensions (Height x Width x Depth) in cm. and inches of following is listed in the specifications.
    1. Instrument with Lid on.
    2. Transit case or carrying case.
    3. Shipping case.

32. **WEIGHT:** Weights in kg/grams and lbs/oz. of following is listed in this field.
    1. Instrument with charger and Lid on.
    2. Transit case / Carrying case only.
    3. Shipping case only.

1.4 Warranty Information

3M PHOTODYNE, INC. warrants this product to be free from defects in material and workmanship for a period of 1 year from date of shipment. During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your local

26. **WARM UP TIME:** The instrument must be left on for this time interval in order to conform to all Receiver specifications.

27. **DISPLAY:** The size and type of display is defined in this field. In general every power meter display is a custom made LCD display. All annunciators and units of measurements are also described in this field.

28. **MEASUREMENT MODES AND OTHER FUNCTIONS:** All possible measurement modes and all functions are listed in this field.

29. **POWER:** This specification defines the power requirements necessary to operate the instrument. The type and size of the battery and the typical battery life time is defined in this field. Typical battery life time is determined in the most common mode of operation (with both lasers ON). Charger information is also provided in this field.

30. **ENVIRONMENTAL:**

    OPERATING TEMPERATURE: This is the temperature range in which the instrument will work flawlessly after the specified warm up time.

    STORAGE TEMPERATURE: Without any damage to the instrument or any loss of specification, the instrument can be

4. APPLICATIONS

4.1 General

This section describes some of the typical applications of the Model 2260XFA dual laser test set. An optical loss test set (OLTS) is to the fiber optics industry, what a digital multimeter is to the electrical industry. In fact the OLTS is the workhorse of the fiber optics telecommunications testing, without which it would be hard to imagine how fiber optic systems could be installed with any degree of confidence.

Although the specific application for the Model 2260XFA is for measuring loss in WDM systems, it may also be used as a test set for conventional systems at 1300nm, and at 1550nm.

4.2 Loss Measurements

There is no single value of attenuation for a fiber; there is simply an attenuation value associated with a specific measurement method. All measurement methods recreate certain conditions (such as launch condition or wavelength) reproducibly, so that repeated measurements on the same fiber with the same method will produce the same value. Users of fiber should recognize, then, that not all attenuation measurement techniques are equivalent. When attempting to correlate in-house measurements with those

9.10 Spectral Calibration at 3M Photodyne

The procedure for optical calibration at 3M Photodyne uses a Photodyne Model 7160XF laser source, and a National Institute of Science and Technology -U.S.A. certified transfer standard power meter, to precisely determine the response of the detectors for their particular wavelengths (1300, or 1550 nm).

At 3M Photodyne, once the calibration values are determined, they are permanently burned into PROM computer memory. This memory is not re-programmable, thus the user can not change (re-calibrate) these spectral calibrations. 3M Photodyne recommends that a performance verification be done once a year. If the unit does not pass the verification, then the user can use the Linearity test chart as a correction chart to be carried with the unit, or the unit should be sent to 3M Photodyne for factory re-calibration.

of the fiber manufacturer, it is necessary to test with the same attenuation method.

A few more conditions must be correct before proper measurements can be made. In single mode fibers, one should take care that only the fundamental mode propagates. Therefore, the measurement wavelength should be larger than the cutoff-wavelength. At a smaller than cutoff-wavelength, higher order modes also propagate. These modes have much stronger attenuation, which will result in length dependent attenuation numbers. A mode filter should be implemented in these cases. A 50 mm or 2 inch diameter loop in the launch fiber/cable constitute a mode filter. Usually the launch cable will not be in a perfectly straight position; therefore, the existing curvature will act as a mode filter, and a separate 50mm (2 in) diameter loop may not be required.

If the fiber coating has an index lower than that of the cladding, cladding mode strippers must be placed both after the source and ahead of the detector. Most single mode fibers have cladding mode-stripper built in. If a mode filter is used, the input cladding mode-stripper shall be placed in series following the mode filter.

The 2260XFA, Dual laser test set, is far more convenient to use than most conventional test sets. To make the

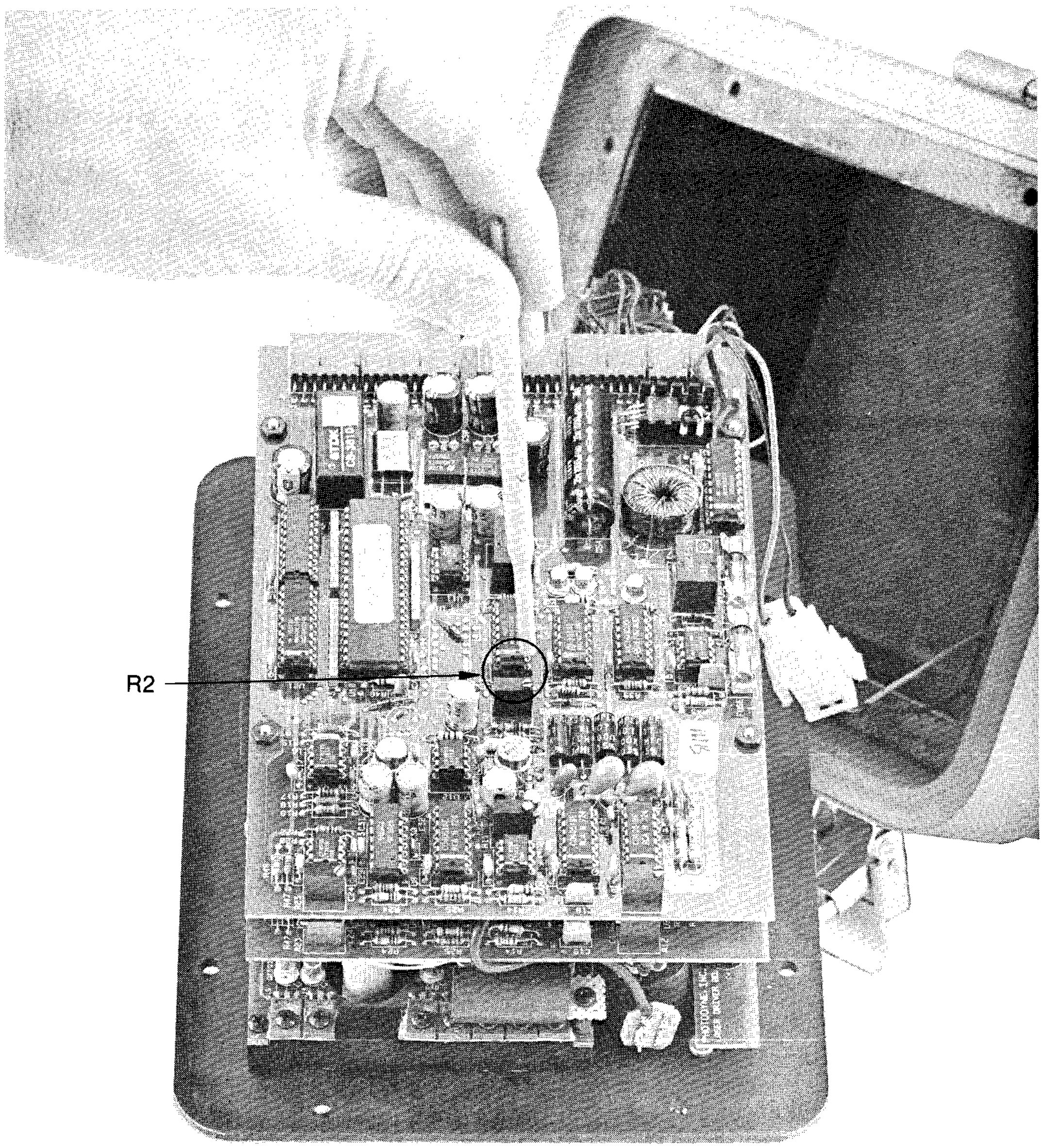

Figure 9.5 Zero Adjustment

9.9 Spectral Calibration

If all procedures have checked out to this point, re-assemble instrument and follow the Performance Verification instructions of Section 8.

attenuation measurement on any test set, the user must measure XMTR output in order to set an accurate reference power level. Thus user must have an equivalent test set at each end or bring the XMTR and power meter together for setting the reference power level. The reference power level has to be set for each wavelength to be measured. The 2260XFA simplifies this operation and takes out most of the operator interaction from the measurement. The operator has to simply loop the light source (XMTR) to the sensor (RCVR) and turn ON the instrument. The 2260XFA does automatic zeroing of both detectors. When lasers are turned ON, the 2260XFA sets both laser outputs automatically to a pre-defined reference power level of -10.0 dBm. The 2260XFA makes power measurements at both wavelengths and displays them simultaneously. Thus reduces the measurement time and inaccuracies of measurements due to interfacing problems.

4.3 Why Measure the Fiber Link From Each End ?

Good practice dictates that the loss in a fiber link should be measured in both directions and that the losses be averaged out. For most telcos and installers this is routine and the averaged loss is an accurate measure of the actual fiber loss.

Why should a link be measured from each end? There are several good reasons. An optical phenomena, although

The 2260XFA has two triplex display drivers and thus two separate contrast control trim pots (R1 & R2 on Display/Laser board). The contrast is set by adjusting R1 or R2 until all "OFF" segments and annunciators are clearly off. R1 & R2 should be set just past this visual threshold point under normal lighting.

When this procedure is completed, switch power supply OFF.

9.8 Detector Zero Calibration

The 2260XFA has both a hardware and a software zero mechanism. The hardware zero is done by a computer controlled D/A converter. Once the detector current is brought anywhere close to 0.0 nA, the D/A will be able to completely zero the current. The 2260XFA is initially brought close to 0.0 nA by adjusting trimpot R2 on each receiver board. To perform this adjustment, completely darken the 2260XFA RCVR port. Then adjust R2 until the reading is between -66.9 and -70.0 dBm. (See figure 9.5).

small, can sometimes yield an unbalanced loss in either direction. This could be extremely significant if fibers of different core diameters or different numerical apertures (NA) are joined, or if there are any optical components, splitters, couplers or attenuators, on the line.

Another significant reason for the two way measurement is the complete elimination of the absolute calibration error of the power meters used. In very long links, fibers are measured using two test sets. Each test set having an accurate calibration of within ± 5%. Clearly, if each meter has drifted to the opposite extreme we can have a measurement error of up to 10%, the equivalent of 0.5dB. This would equal the loss of more than one kilometer in a singlemode fiber.

Let's look what happens with this calibration error when the fiber is measured twice with different power meters from opposite direction. Before each measurement the power launched into the fiber is measured with the Test Set's own power meter (P_L).

Loss =

$$\frac{[(P_{L1} + E_1) - (P_{R2} + E_2)] + [(P_{L2} + E_2) - (P_{R1} + E_1)]}{2}$$

9.5 <u>Environmental Conditions</u>

Maintenance should be performed under laboratory conditions having an ambient temperature range of 18 to 25^{o}C and a relative humidity of less than 50%. Be sure that the instrument has been fully charged before beginning these procedures. Turn ON the instrument and allow it to warm up for 15 minutes. If the instrument has been subjected to temperatures outside the specified range, or to higher humidity, allow additional time for the instrument to stabilize before beginning test procedures.

9.6 <u>LO BAT Indicator</u>

Connect power supply to the battery cable coming off CPU Board #2 as shown in Figure 9.3. Turn power ON and set output to +12Vdc. Press **[ON/OFF]** on the 2260XFA front panel to energize system. Adjust power supply output over the range 10 to 12 volts. Verify that the "LO BAT" indicator appears for voltages less than about 11.3 volts. The "LO BAT" is controlled by fixed resistors, so no adjustment is possible. Reset power supply to 12 volts and turn OFF. Leave the power supply hookup as it is required for the rest of this section.

where;

P_{L1}, P_{L2} : Launch Power at station 1 and station 2.

P_{R1}, P_{R2} : Received Power at station 1 and station 2.

E_1, E_2 : Absolute Calibration Error of Power Meters.

After resolving the above formula one can see that the two power meter errors E_1 and E_2 cancel out. If the fiber is not measured twice, then the calibration difference of the power meters, light sources, connectors, and other components would be a part of the measurement result. The sum of the errors, while small individually, could be significant in its totality of the measurement. In actual practice all that is necessary is to note both readings and calculate the average loss from;

$$P_L = \frac{P_{R1} + P_{R2}}{2}$$

However, it should be noted that if the measurement is performed in both directions, with only one test set, then this error would not be of significance to begin with. But having fiber links as long as 40km to 70km long, measurements are usually performed by separate crews at each end of the link, each with its own test set.

9.3 Maintenance Interval

Maintenance checks should be performed every 12 months, or if the performance verification procedures in Section 8 show that the Test Set is out of specification. If any of the calibration procedures in this section cannot be performed properly, contact your 3M Photodyne representative or the factory for repair information.

9.4 Recommended Test Equipment

Recommended test equipment for calibration is listed in Table 9.1. Alternate test equipment may be used. However, the accuracy of the alternate test equipment must at least be equal to the specifications in Table 9.1.

Table 9.1
Recommended Calibration Equipment

EQUIPMENT	SPECIFICATIONS
Keithley 175 Digital Multimeter	2Vdc range: ±(0.03 + 1 count) 20Vdc range: ±(0.03% + 1 count)
Hewlett-Packard 6214B DC Power Supply	0-12 Vdc, 0-1.2 A

4.4 Bi-directional WDM Link Measurements

The following procedure describes how to make end-to-end measurements at 1300 and 1550nm simultaneously. Two Model 2260XFA test sets are used and the measurement is bi-directional,from A to B, and from B to A. The Model 2260XFA has only two control keys - [Power **ON/OFF**], and [XMTR **ON/OFF**]. The power level of both lasers is automatically set, at -10.0 dBm, through a software procedure. No operator interaction is required.

There are two basic steps;

1). Calibrating both test sets.

2). Making the measurement.

Step 1. Calibrate the test sets.

A. Loop a patch cable from the XMTR port to the RCVR port.

B. Press Power **[ON/OFF]** key to turn ON instrument.

C. Press XMTR **[ON/OFF]** key to turn ON lasers. If all is correct a steady display will read "LOOP". Wait until both LCDs (on each test set) show -10.0 dBm or 0.0 dB. Instruments are now calibrated.

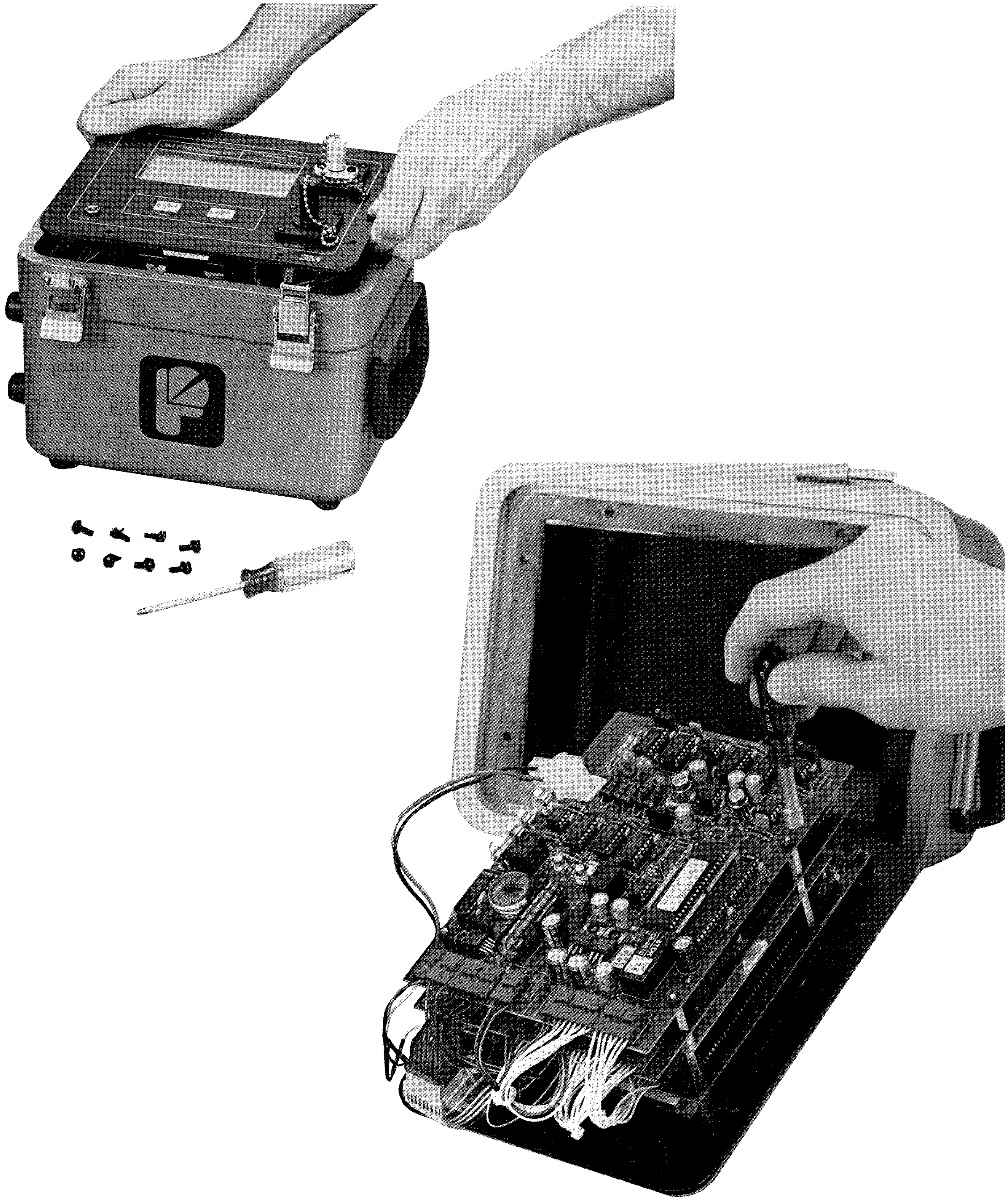

Figure 9.2 How to Remove/Install Main Board Assembly

******
NOTE
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If "LOOP" is flashing it means that there is an error, do not attempt to proceed with test. Check your patch cable and connector interfaces. When you have a steady display proceed to step 2.

******
NOTE
******

When a 2260XFA is first received from the factory, it is set to measure in dBm units. If user wants to make measurement in dB units, then "dB" secondary function must be selected (Refer Section 3.7). This function selection needs to be done only once.

Step 2. Making End-to-End Measurements (WDM Systems): Two Test Sets are used in this procedure, one at each end of the link.

Using patch cords, connect the XMTR port of #1 test set, and the RCVR port of #2 set, into the fiber patch panel. While making a patch cable to patch panel connection, the user must not disconnect or disturb the patch cord

Figure 9.1 Removing Top Cover of Test Set

connection at the XMTR port. The connector from the RCVR port must be disconnected and then connected to the fiber patch panel. This ensures that connector repeatability error at the XMTR port will not be a part of the measurement. Take and write down the loss readings (both wavelengths) from set #2 (L1 dBm or dB at 1300nm and L2 dBm or dB at 1550nm). Reverse this set up, and again take the readings, this time on set #1 (L3 dBm or dB at 1300nm and L4 dBm or dB at 1550nm). Four readings have now been obtained ,two at 1300nm, and two at 1550nm. The overall span loss is the average reading of the bi-directional measurements at each wavelength calculated from:

1300nm Loss (dB)

$$= \frac{[L_1 \text{ dBm} - (-10.0 \text{ dBm})] + [L_3 \text{ dBm} - (-10.0 \text{ dBm})]}{2}$$

1550nm Loss (dB)

$$= \frac{[L_2 \text{ dBm} - (-10.0 \text{ dBm})] + [L_4 \text{ dBm} - (-10.0 \text{ dBm})]}{2}$$

If L1 to L4 measurements are done in dB mode then the overall span loss is the average reading of both bi-directional measurements at each wavelength calculated from:

9. MAINTENANCE

9.1 General

This section contains information necessary to maintain the Model 2260XFA Dual Laser Test Set. Included are disassembly procedures, low battery circuit testing, LCD contrast adjustment, automatic zero circuit adjustment, and a description of the Spectral Calibration Procedure at 3M Photodyne.

9.2 Disassembly

The calibration procedures given in this section require the removal of the internal circuit assembly as described here. First, open the instrument case and remove hinged cover as shown in Figure 9.1. Next, remove circuit board assembly from instrument case as shown in Figure 9.2. Disconnect power cable (3C - from Display/Laser Board) from battery. The main circuit board assembly has now been removed from the instrument enclosure.

$$1300 \text{ nm loss (dB)} = \frac{L_1 \text{ dB} + L_3 \text{ dB}}{2}$$

$$1550 \text{ nm loss (dB)} = \frac{L_2 \text{ dB} + L_4 \text{ dB}}{2}$$

4.5 Bi-directional Measurements - Single Wavelength

The versatility of the 2260XFA is such that it may be used not only for loss measurements in WDM systems but also in conventional one-wavelength systems operating at 1300nm and at 1550nm. In addition the 2260XFA will also talk with other test sets which are calibrated at either or both 1300nm and 1550nm.

As in WDM applications, there are two basic steps to the measurement of single wavelength systems, 1) calibrate the test sets, and 2) make the measurements.

Normally when the instrument is turned on and the [XMTR] key is pressed, both lasers come on. In order to activate the 1300nm laser only, select XMTR1 secondary function (refer Section 3.6). If the 1550 nm laser is required, select XMTR2 secondary function (Refer Section 3.7).

Step 1. Calibrate the test sets.

A. Loop a patch cable from the XMTR port to the RCVR port.

B. Press [ON/OFF] key to turn on instrument.

C. Now,select XMTR1 (1300nm) or XMTR2 (1550nm) secondary function to turn on desired laser. If all is correct a steady display will read; "LOOP". Wait until the LCD (on each test set) shows -10.0 dBm or 0.0 dB.

******
NOTE
******

If "LOOP" is flashing it means that there is an error, do not attempt to proceed with test. Check your patch cable and connector interfaces. When you have a steady display proceed to step 2.

******
NOTE
******

When a 2260XFA is first received from the factory, it is set to measure in dBm units. If user wants to make measurement in dB units, then "dB" secondary function must be selected (Refer Section 3.7). This function selection needs to be done only once.

Table 8.3 2260XFA Linearity Test Chart

1975XQ dB Setting	Transfer Standard dBm Reading	2260XFA dBm Reading	dB Deviation (Step 9)	Tolerances (dB)
- 0.00	__-10.00 dBm___	___________	___0.0 dB___	±0.4
- 5.00	___________	___________	___________	±0.4
- 10.00	___________	___________	___________	±0.4
- 15.00	___________	___________	___________	±0.4
- 20.00	___________	___________	___________	±0.4
- 25.00	___________	___________	___________	±0.4
-30.00	___________	___________	___________	±0.6
-35.00	___________	___________	___________	±0.6
-40.00	___________	___________	___________	±0.8
-45.00	___________	___________	___________	±0.8
-50.00	___________	___________	___________	±1.0
-51.00	___________	___________	___________	±1.0
- 52.00	___________	___________	___________	±1.0

8.9 Verifying XMTR Operation

To verify the XMTR operation perform the following:

1. Connect a patch cable between the XMTR and RCVR ports of the 2260XFA.

2. Turn on the 2260XFA and press **[XMTR]**. The 2260XFA will go through an auto test and auto zero. It will then adjust the lasers output to -10.0 dBm. This should take approximately 2 to 3 minutes, at the end of which the display should read -10.0 dBm (±0.2 dB).

******
NOTE
******

"dB" unit will be selected only in the top field of the display when XMTR1(1300nm laser) is turned ON and adjusted to - 10.0 dBm. The bottom field of the display (1550nm window) will still measure power in the dBm mode. If the XMTR2(1550nm laser) is turned ON dB unit will be selected in the bottom field and top field of the display (1300nm window) will still measure power in the dBm mode.

Instruments are now calibrated.

Step 2. Making End-to-End Measurements (Single Wavelength):
Two Test Sets are used in this procedure, 1 at each end of the link.

Using patch cords, connect the XMTR port of #1 test set, and the RCVR port of #2 set, into the fiber patch panel. Take and write down the loss readings from set #2 (PR1 dBm or dB at 1300 or1550nm). Reverse this set up, and again take the readings, this time on set #1 (PR2 dBm or dB at 1300 or 1550 nm). The overall span loss is the average reading of the bi-directional measurements dB setting of Step 3 within ±0.30 dB.

7. Use the Model 1975XQ UP function to sequence through each 5 dB step again. Record the power meter readings in column 3 of Table 8.3.

8. Calculate the OFFSET at zero by subtracting the two readings at -0.00 attenuation (1975XQ). For Example,

-10.00 dBm	-	-10.10 dBm	=	+0.10 dB
Transfer Standard		2260XFA		OFFSET

9. Calculate the deviation by computing the results for column 4. For each attenuator setting, compute the following result:

Transfer Std	**minus**	**2260XFA**	**plus**	**OFFSET**
(Col 2)		(Col 3)		

To verify proper operation within specifications, the results of column 4 should fall within the ranges of column 5.

calculated from;

$$PL\ (dB) = \frac{[PR1\ dBm - (-10.0dBm)] + [PR2\ dBm - (-10.0dBm)]}{2}$$

Where:

PL = Loss in dB
PR1 = Received power at station 1 in dBm.
PR2 = Received power at station 2 in dBm.

If the dB unit was selected for measurements then PR1 and PR2 readings will be in dB. The overall span loss is the average reading of the bi-directional measurements calculated from;

$$PL\ (dB) = \frac{PR1\ dB + PR2\ dB}{2}$$

Where:

PL = Loss in dB
PR1 = Received power at station 1 in dB.
PR2 = Received power at station 2 in dB.

6. Disconnect the fiber optic cable from the Transfer Standard and connect it to the optical input of the 2260XFA. The Test Set should produce a stable reading within ±0.30 dBm.

7. Reconnect the patch cord to the Transfer Standard. The reading should still read 10.00 microwatts (-20 dBm) to within a few percent due to bending of the cable and repeatability of the connector. If not, repeat the test.

8.8 Verifying Linearity

This procedure assumes the user has just completed Section 8.7 - Verifying Calibration Accuracy so that the equipment has warmed up and the power meters have been zeroed. Proceed as follows to check the linearity of the Model 2260XFA:

1. Press **[RESET]** on the Model 1975XQ to reset the attenuation to -0.00 dB. The cal wavelength should still read 1300 nm.

2. Set the 1975XQ **UP/DOWN STEP** parameter to 5.00 dB. This will make it easy to step through the linearity test using the STEP function.

3. To verify proper linear operation of the 2260XFA over its dynamic range requires 1 mW (0.0 dBm) of optical power as measured by the Transfer Standard. If less than 1 mW is available the user will have to derate the dB range of this verification test by that difference and correct the tolerances. Set the ADJ control on the 7160XF until a reading of -10.00 dBm is obtained. Higher power level setting may not be possible due to insertion loss of the 1975XQ.

4. Use the Model 1975XQ UP function to sequence through each 5 dB step. Record the Transfer Standard readings (in dBm units) to column 2 of Table 8.3.

5. Re-zero the 2260XFA by darkening the RCVR port and turning the unit OFF and back ON.

6. Disconnect the fiber optic cable from the Transfer Standard and connect to the RCVR port of the 2260XFA. The meter should read the same value as observed at the 0.00

5. THEORY OF OPERATION

5.1 Introduction

This section contains an overall functional description of the Model 2260XFA. Detailed schematics and component layout drawings can be obtained by contacting the factory.

5.2 Functional Description

Basically, the Model 2260XFA is two separate Fiber Optic Test Sets with the two laser outputs combined together into a single fiber output, and the single optical input separated into its two (1300 and 1550) components. There are two identical CPU boards, one for the 1300nm laser and receiver, one for the 1550nm laser and receiver. Each laser is a thermoelectrically cooled single mode C.W. laser.

Each receiver is a high performance, low noise InGaAs photodiode. Each photodiode is calibrated for its specific wavelength (1300 or 1550). The responsivity (Amps/Watt) data is stored in the internal computer associated with the particular receiver (photodiode). In simplest terms, the photodiode generates a photocurrent. This photocurrent is turned into a voltage, the voltage is then converted to a frequency, and the CPU reads this frequency to determine the power input. This power input must be corrected for each wavelength, since the

Table 8.2 2260XFA Connector Repeatability Chart

INSERTION #	2260XFA Reading (dB)	dB DEVIATION (Step 9)	Tolerances (dB)
1	________	________	±0.2
2	________	________	±0.2
3	________	________	±0.2
4	________	________	±0.2
5	________	________	±0.2
6	________	________	±0.2
7	________	________	±0.2
8	________	________	±0.2
9	________	________	±0.2
10	________	________	±0.2

8.7 Verifying Calibration Accuracy

Proceed as follows to check the calibration accuracy of the Model 2260XFA:

1. Cover the 2260XFA RCVR port with its dust cap. Turn ON the 2260XFA and allow it to perform its automatic zeroing. Then turn ON the 7160XF and the 1975XQ.

2. Set the Model 1975XQ to the proper cal wavelength (1300 nm). Following this step, the instrument will RESET and display -0.00 dB.

3. Turn ON the Transfer standard and connect the patch cable to it.

4. Set the front panel controls of the 7160XF to ADJ and CW. Allow the laser to warm-up and stabilize for 5 minutes. Then, with the model 3018 Adjustment Tool (or a small jeweler's screwdriver), set the ADJ trimpot on the 7160XF for the maximum reading on the Transfer Standard.

5. Use the **UP/DOWN** and **dB** functions of the 1975XQ to obtain a 10.00 microwatt (-20.00 dBm) reading on the Transfer Standard.

photodiode responds differently to each wavelength. This is the responsivity of the photodiodes in Amps/Watt. Responsivity tells how much photocurrent is produced for each unit of power incident on the photodiode. The result is the absolute optical power as shown in the equation below:

$$\text{Absolute Power (watts)} = F * V/F * I/V * \frac{1}{R\ (\lambda)}$$

where F = Frequency input to the CPU.
V/F = Voltage to Frequency constant.
I/V = Current to Voltage constant.
R (λ) = Responsivity in Amps/Watt for a particular wavelength.

The model 2260XFA electronics is divided among three circuit boards - Display/Laser, and two CPU boards. There is also a separate board which holds the WDM coupler. A simplified block diagram showing the internal optics and electronics is shown in Figure 5.1. This section briefly describes the basic operation of each optic and electronic sub-assembly.

connector is the one which is alternated between the 2260XFA and the Transfer Standard. Proceed as follows to check the repeatability of this connector with the 2260XFA connector interface.

1. Thoroughly clean the patch cable connector and the 2260XFA RCVR connector interface.

2. Connect the patch cable to the 2260XFA RCVR port. Tape the patch cable down to the table, to keep fiber bending and movement to a minimum.

3. Turn ON the 2260XFA and allow it to perform its automatic zeroing. Then turn ON the 7160XF and the 1975XQ.

4. Set the front panel controls of the 7160XF to ADJ and CW. Allow the laser to warm-up and stabilize for 5 minutes. Then, with the model 3018 Adjustment Tool (or a small jeweler's screwdriver), set the ADJ trimpot on the 7160XF for the maximum reading on the 2260XFA top display (the 1300 window). This is recorded as the dBm reference value.

5. Completely remove the connector from the 2260XFA, then reinsert.

6. Take the current reading and subtract the dBm reference reading from it. Record this value in column 2 of the Connector Repeatability Chart (Table 8.2).

7. Repeat Steps 5 & 6 nine more times, for a total of ten insertions.

9. Add all the readings together and divide by 10. This is the average power. Subtract this average from each reading, placing the result in column 3 (dB Deviation).

10. Check that each of the dB Deviations (Column 3) are within the allowed limits. If they are not, then repeat this test with another patch cord. It may be that this particular patch cord has been scratched or damaged. If the readings are still out of specification with a different patch cord, contact your local 3M Photodyne representative or the factory to determine the action to be taken.

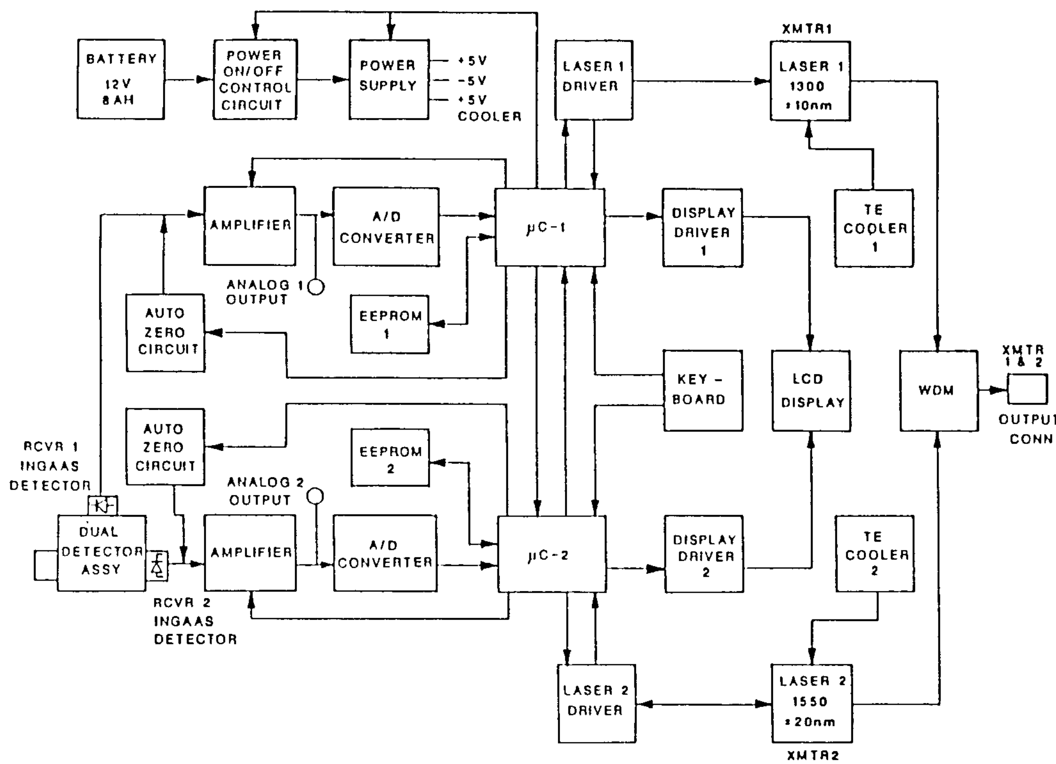

Figure 5.1 Block Diagram of Model 2260XFA Electronics.

of the Model 1975XQ. The remaining end will be connected alternately between the Transfer Standard and the 2260XFA RCVR port.

CMS = Cladding Mode Stripper,
or 1 km of optical fiber

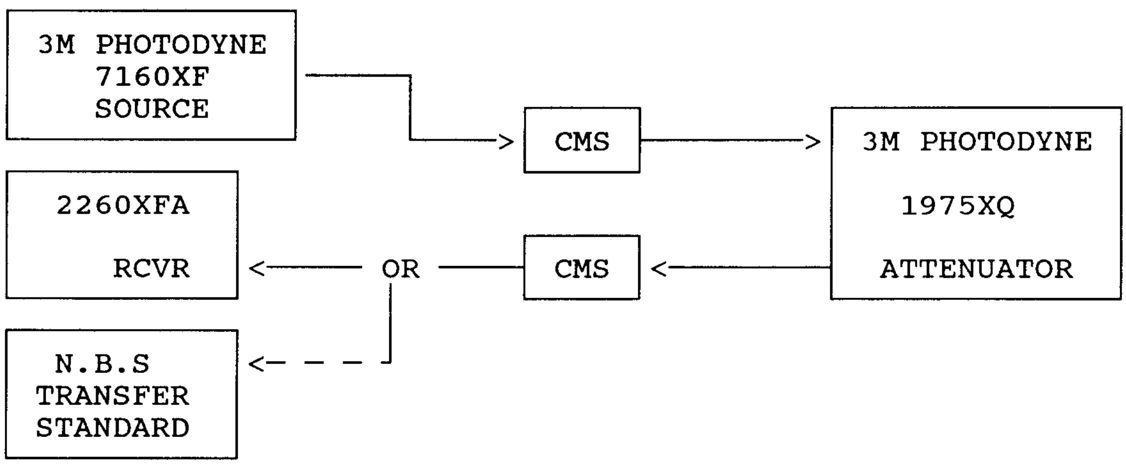

Figure 8.1. Diagram of Equipment Setup for Calibration

8.6 <u>Verifying Connector Repeatability</u>

It is particular important to have repeatable connectors (including fiber optic patch cables) while verifying calibration or linearity. If a connector is not repeatable then the verifications will produce erroneous results. A bad connector or a bad or dirty patch cable can often lead to a Test Set performing as if it is out of spec. Also especially residual matching gel will cause bad coupling. In the verification tests, the crucial

5.2.1 CPU Board

The CPU board centers around a single chip microcomputer. It is an 8-bit microprocessor with 4k PROM memory and 128 bytes of RAM, all on a single chip. There is also 64 bytes of serial EEPROM, accessed through one of the CPU I/O ports, for parameter storage.

The CPU board also contains circuitry required for the first stage DC amplifier and a voltage-to-frequency converter.

DC Amplifier

The first stage of the amplifier is a transimpedance amplifier used to convert detector current to voltage. This first stage of the amplifier has seven programmable decades of gain. The output of this amplifier is passed through an inverting gain amplifier and then passed to the voltage-to-frequency converter.

Voltage-to-Frequency Converter

The V/F (Voltage-to-Frequency) converter, is used to convert the analog voltage into a digital form so the computer can process it. The voltage coming into the V/F converter is directly proportional to the receiver photocurrent, thus the frequency coming out of the V/F converter is also directly proportional to the receiver photocurrent. Once the CPU knows the receiver photocurrent, and the internal wavelength calibration

Table 8.1 Recommended Test Equipment

EQUIPMENT	SPECIFICATIONS
N.I.S.T. - U.S.A. Secondary Transfer Standard for Optical Fiber Power (STSOFPM) Measurements	Accuracy: ±4% at 1300 nm
3M Photodyne Model 1230-010W Cables (Qty. 2)	SM cable assembly terminated with AT&T 1016A connectors on both ends Core/Cladding dia: 9/125 um
3M Photodyne Model 1975XQ-010W SM Optical Attenuator	SM Optical Attenuator with AT&T 1016A connectors on optical ports Accuracy: Greater of ±0.20dB or ±2% Max. insertion loss: 5 dB
3M Photodyne Model 7160XF-10W Laser Source	Single-mode laser source with AT&T 1016A Biconic Termination. Peak wavelength at 1300 nm.
3M Photodyne Model 2017 Biconic Adaptor	Sensor adaptor for AT&T Biconic Connector

8.4 Initial Conditions

If the instrument has been subject to temperatures below 18°C (64°F) or above 25°C (77°F), allow sufficient time for the instrument to reach temperatures within this range. Generally, it takes one hour to stabilize an instrument that is ±10°C (50°F) outside of this range.

8.5 Equipment Set-Up

Figure 8.1 shows how the equipment should be hooked together. Connect the output of the 7160XF to the input of the Model 1975XQ using one of the patch cables. Connect one end of the second patch cable to the output factor, it can calculate the absolute input power.

5.2.2 Display Circuit

The custom LCD (liquid crystal display), display drivers, LCD backlight, and front panel keyboard decoder are all located on the Display/Laser Board. In operation, each microprocessor outputs display data to the board which is processed by two display encoders (U3 and U4) to drive the tri-plexed LCD. The front panel keys are scanned and decoded by the keyboard decoder and then read by each microprocessor.

5.2.3 Laser Circuit

The laser circuit consists of two high power lasers each with TE-coolers, two microprocessor controlled laser drivers, and a WDM coupler. The lasers have optical feedback monitoring to provide stabilized output over the operating temperature range of 0 to 40 degrees Celsius. In addition, the laser drivers are microprocessor controllable, so that the 2260XFA can automatically adjust the output power to -10.0 dBm. The WDM coupler is a singlemode passive fused-fiber optical device with greater than 20 dB isolation, with minimum coupling loss, and low back reflection. The coupler is terminated in a single connector (XMTR Port) at the front panel of the instrument.

8.3 Recommended Test Equipment

The procedures described in this section are for verifying the performance of a Model 2260XFA at 1300 nm. The recommended equipment list is given in Table 8.1. For verifying the calibrations for other wavelengths you will just use a different source. You may substitute for the other test equipment but be sure that the equipment accuracy is at least as good as the specifications listed in Table 8.1.

Basically, the test set-up requires a stable source, a precision optical attenuator, and reference standard such as a calibrated radiometer or photodiode. The source must be a highly stable laser source or a broadband source/monochromator combination with equal stability, accuracy (±2 nm), resolution (0.1 nm), and narrow bandwidth (2-10 nm). A precision optical attenuator is required to verify spectral and electrical linearity of the test set. The reference standard should be one provided by your country's national standards laboratory (such as National Institute of Science and Technology - U.S.A.) or a commercial calibration lab providing similar services.

8. PERFORMANCE VERIFICATION

8.1 General

This section contains the information necessary to verify that the Model 2260XFA Dual Laser Test Set is performing within the published specifications. Ideally, performance verification should be checked when the instrument is first received to ensure that no damage or change in calibration has occurred during shipment. The verification procedure may also be performed whenever instrument accuracy is suspect or following calibration.

NOTE

If the instrument does not meet specifications and is still under warranty (less than 12 months since date of shipment), contact your local 3M Photodyne representative or the factory to determine the action to be taken.

8.2 Environmental Conditions

All measurements should be made at an ambient temperature between 18°C and 25°C (64° to 77°F) with a relative humidity less than 70%.

6. ACCESSORIES

6.1 General

The Model 2260XFA is supplied with an instruction manual, optical metrology report, and an AC charging module. Unless otherwise specified, the unit is shipped with a Model 115E Battery Charger (or 100E or 220E for other AC line environments, if requested). The following optional 3M PHOTODYNE accessories are available - making the 2260XFA a truly universal Single Mode WDM Test Set.

6.2 Battery Chargers

100E	Input:	89 - 110 VAC, 50Hz, Wall plug-in module with standard U.S. 3-prong plug.
115E	Input:	105 - 129 VAC, 60Hz, Wall plug-in module with standard U.S. 3 -prong plug.
220E	Input:	207 - 253 VAC, 50/60Hz, Desk top module with AC line cord terminated with European VDE/SEMKO-approved Schuko (3-prong) plug.

6.3 Bare Fiber Adapters

2038-125G	Bare Fiber to Interoptics/Diamond GFS-3 Adapter (125 OD)
2038-125J	Bare Fiber to NTT Type FCN/D3 Adapter (125 OD)
2038-125M	Bare Fiber to Siemens DIN Adapter (125 OD)
2038-125N	Bare Fiber to NEC OD-9470/D4 Adapter (125 OD)
2038-125T	Bare Fiber to AT&T ST Adapter (125 OD)
2038-125W	Bare Fiber to AT&T 1006A Biconic Adapter (125 OD)

Figure 6.2 Photograph of Fiber Optic Tool Kit

6.5 <u>Transit Case (Model 4006)</u>

A Transit Case is available as an option for the Model 2260XFA. This enclosure is heavily padded and cushioned. It is designed to be used as a shipping container when the Test Set is being shipped or transported between sites. The transit case affords the extra protection required when the Test Sets are exposed to excessive shock and vibration which may damage the instrument.

LASER SAFETY DATA SHEET FOR MODEL 2260XFA-X

Model No.: 2260XFA - ______

Serial No. of Model 2260XFA - X : ______________

Dual laser assy. Serial No.: __________________

Date: ________________________________

Laser diode 1 serial No.: ______________________

Date: ________________________________

Peak Wavelength : ____________________________

Laser diode 2 serial No.: _____________________

Date: ________________________________

Peak Wavelength: ____________________________

Operator: ______________________________________

Verify that both ID and certification labels are attached to the instrument.

Laser Emission Calibration:

Average Output Power laser1 ___________ μw (< 155 μW)

Average Output Power laser2 ___________ μw (< 630 μW)

Accept: _____________

Reject: _____________

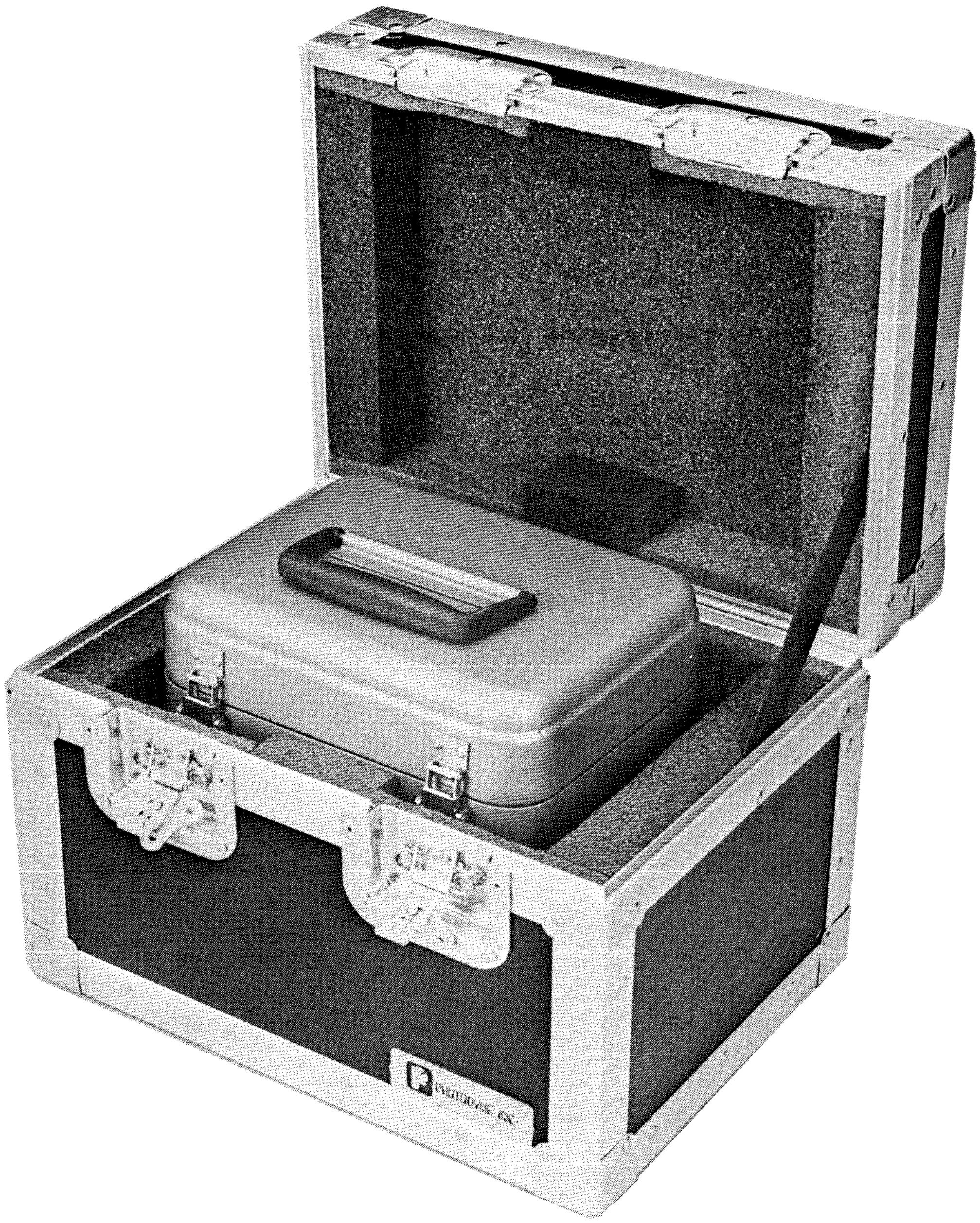

Figure 6.3 Photograph of 2260XFA Transit Case Model 4006

Figure 7.2 ID/Certification Label

Figure 7.3 ID/Certification Label Location

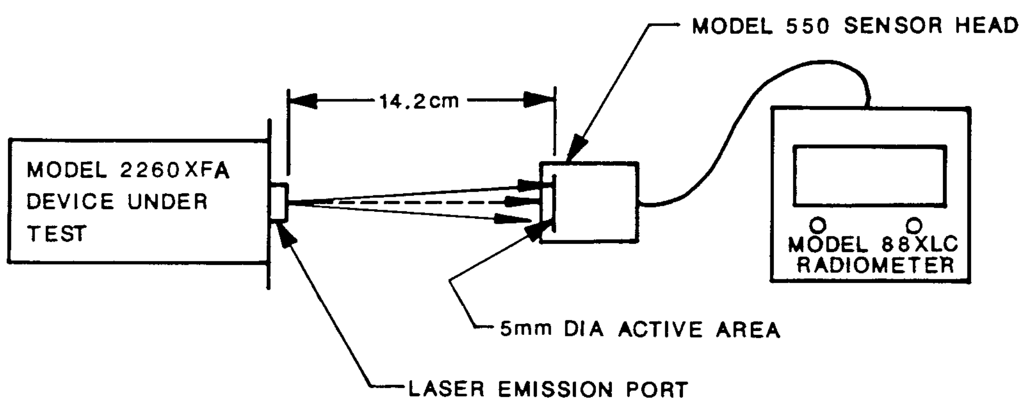

Figure 7.1 Measurement Setup

7. SAFETY CONSIDERATIONS

7.1 General

Operator safety has been a prime concern in the design of model 2260XFA - Dual Laser Test Set. Safety standards established by the U.S. Government and other governments have been carefully adhered to.

7.2 Laser Safety

All laser products sold in the United States must conform to performance and safety regulations established by the Center for Devices and Radiological Health (CDRH). The 2260XFA conforms to the applicable requirements of 21CFR sub chapter J at date of manufacture. The 2260XFA is a Class I laser product. Following the procedures described in the manual, the instrument can be operated safely.

CAUTION - The use of optical instruments with this product will increase eye hazard.

The above warning refers especially to viewing optics, open patch cords, eye loupes, and other magnifying optics (or glasses) which will collect optical energy with an aperture larger than that of the human eye.

7.3 Acceptance test procedure for lasers and laser drivers on the 2260XFA, Dual Laser Test Set.

1. Equipment Required:

   3M Photodyne 88XLC Radiometer

   3M Photodyne Model 550 Sensor Head

   3M Photodyne Model 3001 Extension Cable for Sensor

   Mechanical fixture defining a 5mm diameter measuring aperture, 14.2cm from the fiber optic connector output.

2. Procedure - Fiber/Connector output calibration

   a.) Setup the equipment as shown in Figure 7.1.

   b.) Turn ON the power to the 88XLC.

   c.) Turn ON power to the device under test.

   d.) Record value of power output on the Laser Safety Data Sheet.

   f.) Reject unit if the optical power emitted from Model 2260XFA- X under test exceeds the power levels stated on the Laser Safety Data Sheet.

3. Procedure - data sheet for calibration results

   3M Photodyne maintains a data sheet on file of calibration data taken in step 3 above for each Model 2260XFA -X.

4. Procedure - label verification

   Verify that the following label (Figure 7.2) is securely affixed at the bottom of the instrument.