

# **DSP-FOM**

## **Fiber Optic Meter**

*Service Information Sheet for Serial Numbers < 79370000*

### **Introduction**

This *Service Information Sheet* provides the following service information for the DSP Fiber Optic Meter (hereafter referred to as the FOM) with serial numbers < 79370000.

- Parts and warranty service information
- Specifications
- Theory of operation
- Cleaning procedures
- Required equipment
- Performance tests
- Procedures for disassembling and reassembling the FOM
- Calibration adjustments
- Parts and accessories lists
- Schematic
- Diagram showing calibration measurement and adjustment points

For operating instructions, refer to the *DSP-FOM/DSP-FTK Fiber Optic Accessory Instruction Sheet*.

### **Parts and Warranty Service**

The FOM is warranted to be free from defects in material and workmanship for one year, while under normal use. Parts and repairs are warranted for 90 days.

Refer to the *Instruction Sheet* for the complete warranty statement.

To order parts, or for warranty service, contact Fluke as follows:

U.S.A.: 1-888-993-5853

Canada: 1-800-363-5853

Europe: +31-402-675-200

Japan: +81-3-3434-0181

Singapore: +65-738-5655

Anywhere in the world: +1-425-446-4519

For operating assistance in the USA, call 1-800-283-5853.

Visit the Fluke Networks web site at [www.flukenetworks.com](http://www.flukenetworks.com).

## Specifications

Accuracy is specified for a period of one year after calibration, at 18 °C to 28 °C (64 °F to 82 °F) with relative humidity to 90%. Specifications are shown in Table 1.

**Table 1. Specifications**

<b>Calibrated Wavelengths</b>	850 nm, 1300 nm, and 1550 nm
<b>Measurement Range</b>	+3 dBm to -50 dBm
<b>Measurement Accuracy*</b>	±0.25 dB at -10.0 dBm and 25 °C (77 °F)
<b>Resolution</b>	0.1 dB (1 mV)
<b>Display Resolution</b>	0.01 dB (0.001 µW)
<b>Detector Type</b>	1 mm (0.04 in) Germanium
<b>Conformance</b>	IEC 1010-1
<b>Optical Adapter</b>	ST
<b>I/O Connector</b>	RJ45 8-pin with ground shield
<b>Output Voltage</b>	Dynamic Range: -0.02 V to +0.55 V
<b>Operating Temperature</b>	0 °C to +40 °C (32 °F to 104 °F)
<b>Storage Temperature</b>	-20 °C to +70 °C (-4 °F to 158 °F)
<b>Dimensions</b>	11.4 cm x 6.4 cm x 3.8 cm (4.5 in x 2.5 in x 1.5 in)
<b>Weight</b>	141.7 g (5 oz)
<b>Battery Type</b>	9 V Alkaline
<b>Battery Life</b>	90 hours typical

\* For field strengths between 1 V/m and 3 V/m add 6 dB.

## Theory of Operation

This section provides theory of operation for the FOM. Refer to the schematic in Figure 1.

### General Description

The FOM is an optical power to voltage converter designed to interface with a DSP CableMeter™ and CableAnalyzer™ test tool. The FOM is calibrated to convert optical power to voltage at wavelengths of 850 nm, 1300 nm, and 1550 nm.

A slide switch on the face of the FOM enables the unit and selects the calibration for one of the three wavelengths. A ST optical connector couples the

light to be measured into the FOM. The RJ45 connector outputs a calibrated voltage via a cable to the host CableMeter test tool. Other signals present at the RJ45 connector are analog levels indicating the selected wavelength and a full-scale voltage reference for determining the battery status.

### Switch Positions and I/O

Slide switch SW1 is a 2-pole switch. One pole (pin 5) applies the battery voltage to the voltage regulator U3. Battery voltage is also applied to one of the voltage dividers R23/R24, R25/R26, or R19/R20. Each of these dividers generates an analog level of 0 V to 0.53 V (referenced to analog ground), which is proportional to the battery voltage. This analog level, which appears at pin 4, 3, or 2 of connector J4, indicates which wavelength has been selected. J4 provides output to the CableMeter test tool.

The other pole of SW1 (pin 6) applies the 5 V regulator output to the appropriate potentiometer (R1, R2, or R3) controlling the wavelength-specific reference current. Photo diode PD1 is the optical input interface.

### Power Supply and Low Battery Detection

When power is enabled with SW1, the battery voltage (minus a diode drop) appears at pin 5 of voltage regulator U3. U3 generates a 5 V output on pin 4 and a 2.5 V output on pin 6, which is used as a rail-splitting analog ground.

A low battery condition is indicated when the voltage from the selected divider R23/R24, R25/R26, or R19/R20 drops below 0.26 V relative to analog ground (battery voltage of 6.2 V). The full-scale voltage reference of 0.53 V is generated by divider R21/R16 between the 5 V supply and the 2.5 V analog ground. U2A buffers this reference.

### Optical Receivers and A/D Measurements

The logarithmic optical power to voltage circuit is comprised of Q1, U1, PD1, and associated resistors and capacitors. Q1B, part of a dual, bipolar transistor, receives a reference current from one of three potentiometers. Q1A receives the signal current from PD1. The output at U1B, pin 7, is proportional to the logarithm of the difference

between the reference current and the signal current; therefore, the output is a linear function of the optical power received by the photo detector. A typical output at U1, pin 7 is 23 mV per dB of optical power, plus a 69 mV offset

The reference current adjustment potentiometers R1, R2, and R3 control the zero offset for the three calibrated wavelengths. Potentiometer R10 trims the final output slope to 10 mV per dB. The output of U1B is buffered by U2B. R7 provides temperature compensation to null some of the thermal drift of Q1A and Q1B.

## Cleaning the Optical Connector

Most problems with optical power meters result from contaminated connectors. Therefore, always clean the connector before troubleshooting or calibration.

To clean the FOM ST connector, wipe it gently with an optical-grade tissue or swab dampened with optical-grade alcohol. To remove loose dirt and dust from the connector, use filtered, compressed air.

Always cover the connector with a dust cap when the unit is not in use.

## Required Equipment

The following equipment is required for servicing the FOM:

- 0-10 V power supply
- Fluke 187 digital multimeter or equivalent
- Optical power meter calibrated at 850 nm, 1300 nm, and 1550 nm traceable to NIST Standards
- 850 nm laser source;  $P_o = -10$  dBm
- 1300 nm laser source;  $P_o = -10$  dBm
- 1550 nm laser source;  $P_o = -10$  dBm
- Variable MM optical attenuator
- Variable SM optical attenuator
- Fluke DSP CableMeter test tool
- 1 m fiber optic patch cables, 2 required
- 2 m UTP patch cable (supplied with the CableMeter test tool)

## Performance Tests

Use the performance tests to confirm that the FOM is working properly. If the FOM fails any of these tests, clean the fiber connectors, verify that the connections are solid, then retest the FOM. If the FOM still fails a test, it needs calibration adjustments or repair.

### DSP-FOM Detection

1. Turn the CableMeter test tool knob to **SETUP**. Use the arrow keys to select **TEST STANDARD, CABLE TYPE**; then press . Use   (and Page Up/Page Down softkeys if necessary) to select the applicable standard for the DSP-FOM; then press . Use the arrow keys to select **Multimode** as the cable type; then press .
2. With the FOM not connected to the CableMeter test tool, turn the test tool knob to **SINGLE TEST**; then press . Verify that the test tool displays the following message: **WARNING THE DSP-FOM IS NOT CONNECTED**. Press  to continue.
3. With the FOM switch in the **OFF** position, use the 2-meter UTP patch cable to connect the FOM to the CableMeter test tool. Press the test tool  key. Verify that the test tool displays the following message: **WARNING THE DSP-FOM IS TURNED OFF**. Press  to continue.

### DSP-FOM -10 dBm Checkout

1. Turn on the FOM and the three light sources. Verify that the FOM power LED is on. Allow the FOM and the sources to warm up for 10 minutes.

Perform the remaining steps using the light sources in the following order: (1) 850 nm, (2) 1550 nm, and (3) 1300 nm.

2. Use a fiber optic patch cable to connect the light source to the reference power meter.
3. Verify that the reference power meter is configured to measure the wavelength of the light source. Adjust the output of the source for a reading of  $-10.00$  dBm  $\pm 0.05$  dBm. Record the power reading for later use.

4. Set the FOM switch to the wavelength position being tested. Press **TEST** on the CableMeter test tool; then verify that the second line of the test tool message displays the following:  
**Multimode** (wavelength setting) **nm A-B**.
5. Use the patch cable from step 2 to connect the FOM to the light source. Press **3 Power**. Allow a few seconds for the reading to stabilize; then verify that the reading shows the power level recorded in step 3  $\pm 0.25$  dB.
6. Press **EXIT** on the CableMeter test tool. Disconnect the light source from the FOM.

### **DSP-FOM -50 dBm Checkout**

1. Connect the 1300 nm light source to the optical attenuator. Use a second fiber optic patch cable to connect the optical attenuator to the reference power meter.
2. Verify that the reference power meter is configured to measure the wavelength of the light source. Adjust the optical attenuator for a reading of  $-50.00$  dBm  $\pm 0.05$  dBm. Record the power reading for later use.
3. Use the patch cable connected to the reference power meter to connect the FOM to the optical attenuator.
4. On the CableMeter test tool, press **3 Power**. Allow a few seconds for the reading to stabilize; then verify that the reading shows the power level recorded in step 2  $\pm 0.4$  dBm.

Turn off the test tool, FOM, and the light sources. Disconnect the FOM and 2-meter UTP patch cable from the test tool. Disconnect the fiber optic patch cables from the attenuator, source, and FOM.

### **Disassembling and Reassembling the FOM**

#### **⚠ Caution**

**While servicing the FOM, always follow guidelines for preventing electrostatic discharge (ESD). Otherwise, ESD can damage sensitive components, causing immediate or delayed failure of the FOM.**

A Phillips-head screwdriver is required for disassembling and reassembling the FOM. To disassemble the FOM, proceed as follows:

1. Set the FOM switch to OFF.
2. Remove the battery door; then disconnect the battery.
3. Remove the two Phillips screws found under the battery door; then separate the top and bottom cases.
4. To remove the pca, remove the Phillips screw near SW1; then lift out the pca.

To reassemble the FOM, proceed as follows:

1. Reinsert the pca; then replace the screw that holds the pca.
2. Tuck the battery wires into the notch at the side of the battery compartment.
3. Tuck the battery wires down against the pca so they will not interfere with SW1.
4. Set SW1 to the off position.
5. Set the slide switch actuator on the top case to the OFF position.
6. Put the top and bottom cases together; then replace the two screws under the battery door.

### **Calibration Adjustments**

To ensure that the FOM performs to specifications, calibrate it annually using the procedure that follows.

Always perform the complete calibration adjustment procedure.

#### **Step 1: Preparing for Calibration**

To prepare for calibration, proceed as follows:

- 1-1. Remove the dust cap from the DSP-FOM.
- 1-2. Connect a voltage supply of 8 V dc  $\pm 1.0$  V dc to the FOM battery strap.
- 1-3. Set the FOM switch to the 1300 nm position. Allow the unit to warm up for 10 minutes.
- 1-4. Connect the 1300 nm light source to the attenuator input.
- 1-5. Turn on the 1300 nm light source. Allow the unit to warm up for 10 minutes.

### Step 2: Coarse Calibration Adjustment

Refer to the schematic in Figure 1 and the drawing in Figure 2 for the locations of measurements and components.

- 2-1. Connect the attenuator output to the reference power meter.

*Note*

*For the remaining calibration adjustments, use the cable used in step 2-1 for connecting the attenuator output to the reference power meter or the FOM.*

- 2-2. Set the attenuator to 0 dBm. Set the 1300 nm light source to -10 dBm  $\pm$ 0.05 dBm. Record the level shown on the reference power meter as  $P_{in}$  (power in) for use in step 2-6.
- 2-3. Connect the attenuator output to the FOM.
- 2-4. Measure  $V_{det}$  between U1 pin 7 and the analog ground reference at U1 Pin 4. Adjust R2 for 0.3 V  $\pm$ 0.01 V dc.
- 2-5. Measure  $V_{ref}$  between U2 pin 1 and the analog ground reference at U1 Pin 4. Record this value for use in the transfer function calculations.
- 2-6. Use the following transfer function to calculate  $V_o$ :

$$V_o = \left( \frac{V_{ref}}{53 \text{ dBm}} \right) \times (-(P_{in}) + 3 \text{ dBm})$$

- 2-7. Measure between DBout at U2 pin 7 and the analog ground reference at U1 Pin 4. Adjust R10 for  $V_o$  (as calculated in step 2-6)  $\pm$ 0.0005 V.

### Step 3: 1300 nm Fine Calibration Adjustment

- 3-1. Connect the attenuator output to the reference power meter. Set the attenuator output to -45 dBm  $\pm$ 0.1 dBm. Record the value shown on the reference power meter as  $P_{in}$  for step 3-3.
- 3-2. Connect the attenuator output to the FOM.

- 3-3. Use  $P_{in}$  from step 3-1,  $V_{ref}$  from step 2-5, and the transfer function below to calculate  $V_o$ :

$$V_o = \left( \frac{V_{ref}}{53 \text{ dBm}} \right) \times (-(P_{in}) + 3 \text{ dBm})$$

- 3-4. Measure between DBout at U2 pin 7 and the analog ground reference at U1 Pin 4. Use the formula below to calculate  $V_n$ :

$$V_n = \frac{DBout - V_o \text{ (from step 3-3)}}{2}$$

- 3-5. Adjust R10 for  $V_n \pm$ 0.0005 V at DBout.
- 3-6. Connect the attenuator output to the reference power meter. Set the attenuator for a power meter reading of -10 dBm  $\pm$ 0.1 dBm.
- 3-7. Connect the attenuator output to the FOM. Adjust R2 for  $V_o \pm$ 0.0005 V (as calculated in step 2-6) at DBout.
- 3-8. Repeat steps 3-1 through 3-7 until the FOM's -10 dBm and -45 dBm readings are within specifications.

### Step 4: 850 nm Fine Calibration Adjustment

- 4-1. Set the switch on the FOM to the 850 nm position.
- 4-2. Set the 850 nm light source to -10 dBm  $\pm$ 0.05 dBm. Use the reference power meter to measure the source output power level. Record this level as  $P_{in}$  for use in step 4-4.
- 4-3. Connect the 850 nm light source to the FOM.
- 4-4. Use  $P_{in}$  from step 4-2,  $V_{ref}$  from step 2-5, and the transfer function below to calculate  $V_o$ :

$$V_o = \left( \frac{V_{ref}}{53 \text{ dBm}} \right) \times (-(P_{in}) + 3 \text{ dBm})$$

- 4-5. Measure between DBout at U2 pin 7 and the analog ground reference at U1 Pin 4. Adjust R1 for  $V_o$  (as calculated in step 4-4)  $\pm$ 0.0005 V.

**Step 5: 1550 nm Fine Calibration Adjustment**

- 5-1. Set the switch on the FOM to the 1550 nm position.
- 5-2. Set the 1550 nm light source to -10 dBm ±0.05 dBm. Use the reference power meter to measure the source output power level. Record this level as P<sub>in</sub> for use in step 5-4.
- 5-3. Connect the 1550 nm light source to the FOM.
- 5-4. Use P<sub>in</sub> from step 5-2, V<sub>ref</sub> from step 2-5, and the transfer function below to calculate V<sub>o</sub>:

$$V_o = \left( \frac{V_{ref}}{53 \text{ dBm}} \right) \times (-P_{in} + 3 \text{ dBm})$$

- 5-5. Measure between DBout at U2 pin 7 and the analog ground reference at U1 Pin 4. Adjust R3 for V<sub>o</sub> (as calculated in step 5-4) ±0.0005 V.

**Step 6: Verifying Calibration**

- 6-1. Follow the procedures given in the earlier section "Performance Tests".
- 6-2. Apply insulating varnish, such as red GLPT, to R1, R2, R3, and R10.
- 6-3. Reassemble the FOM as described in the earlier section "Disassembling and Reassembling the FOM".

**Parts and Accessories**

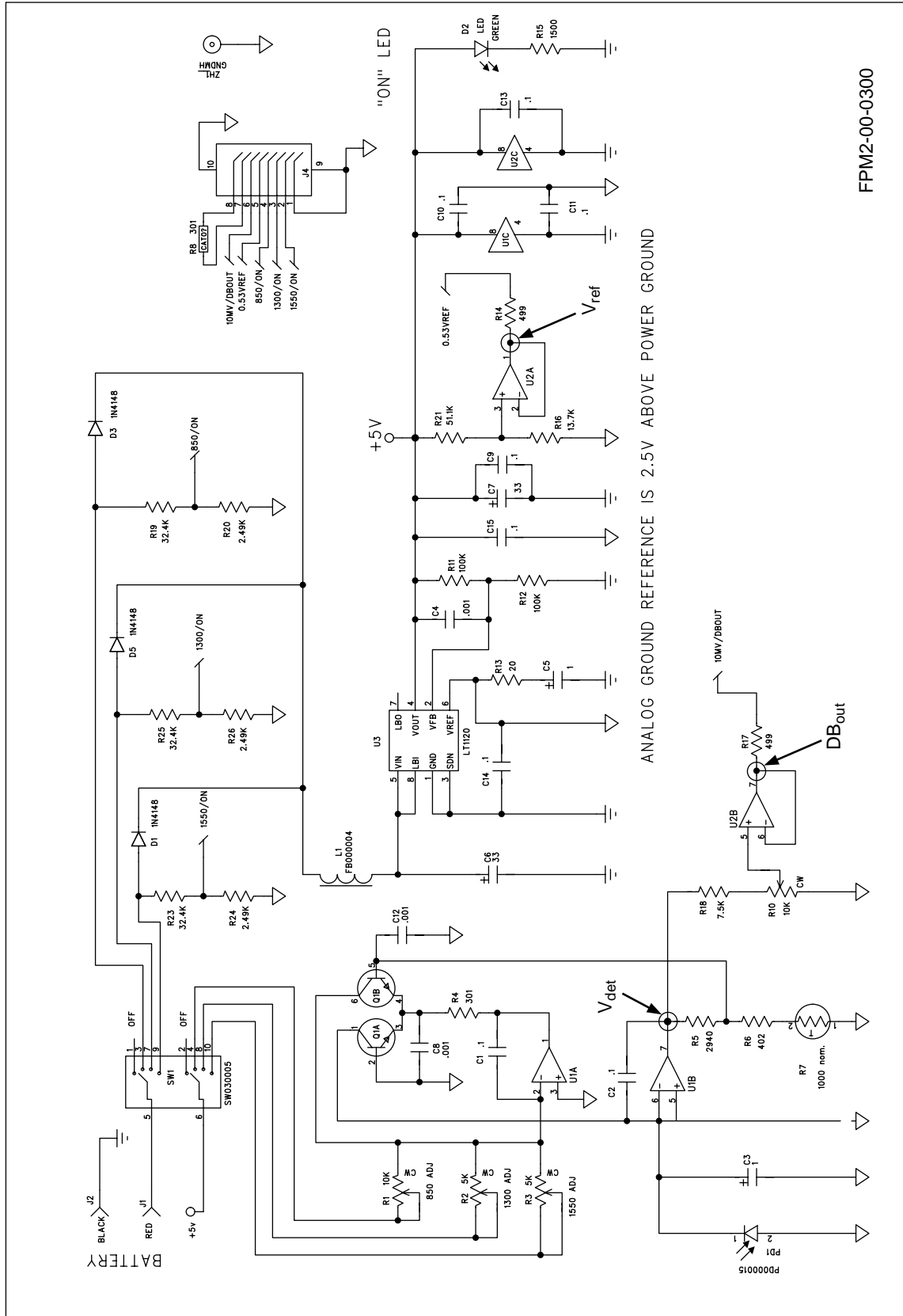
Replacement parts (Table 2) and accessories (Table 3) are available from Fluke.

**Table 2. Fluke Replacement Parts for the DSP-FOM**

Description	Fluke Part Number
DSP-FOM Plastic Case Assembly	616034
Battery Door	200474
PD1: Germanium Photodiode, 1 mm	602778

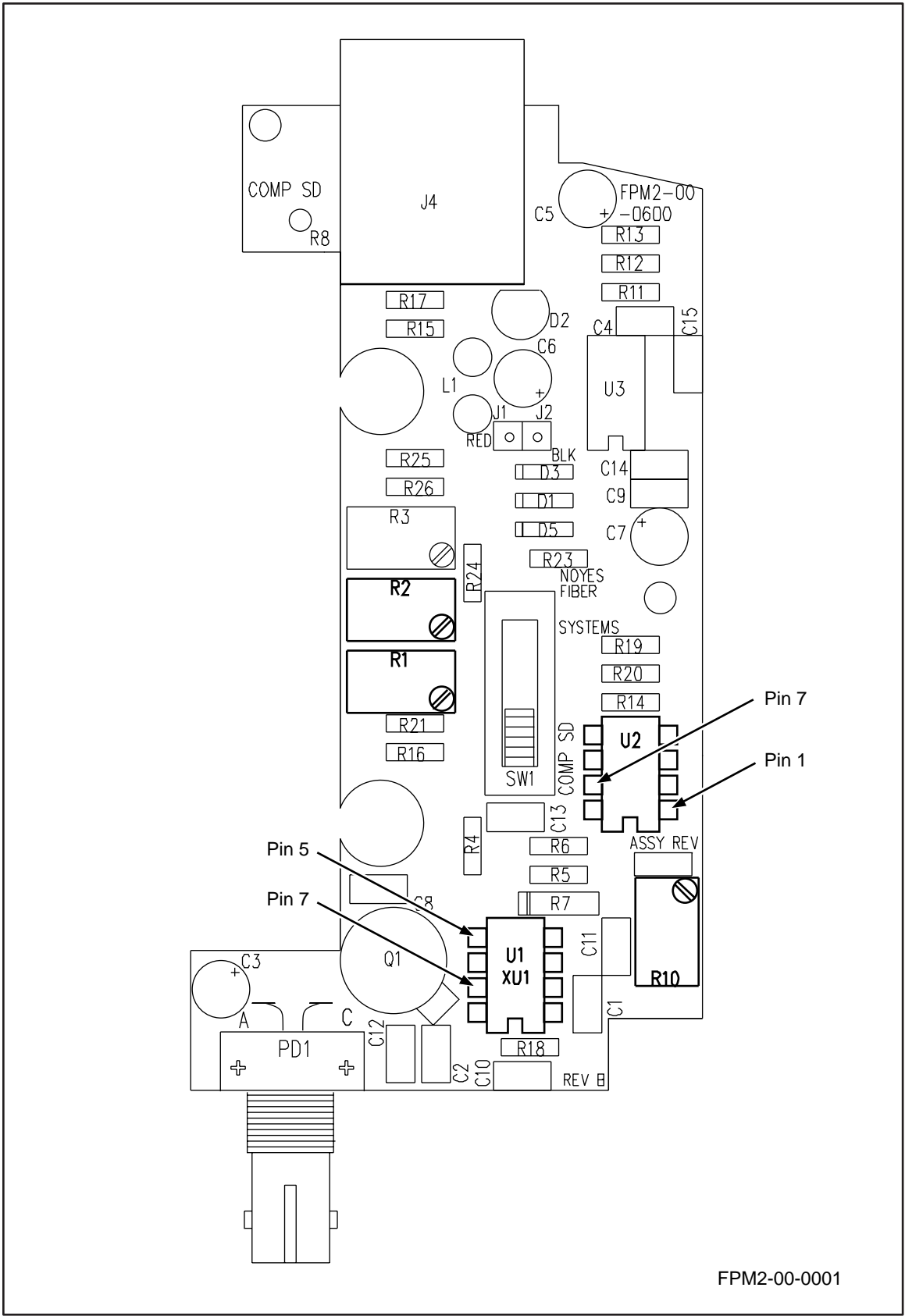
**Table 3. Accessories for the DSP-FOM**

Description	Fluke Part Number
ST to ST Multimode Patch Cable, 1m	617453
ST to ST Cable Adapter	602810
Carrying Case	616091



FPM2-00-0300

Figure 1. Fiber Optic Meter Schematic for SN < 79370000



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Figure 2. Calibration Measurement and Adjustment Points for SN < 79370000