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# OPERATION AND MAINTENANCE MANUAL

# MODEL 144-694-X

# FOL-100 FIBER OPTIC LINK

**Serial Number _____**

**May 5, 2009 Revision A**

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# 1. GENERAL INFORMATION

## 1.1. SCOPE OF MANUAL

This manual contains the information necessary to operate and maintain a Symmetricom Model FOL-100 Fiber Optic Link. There are three versions of the link FOL-100 Fiber Optic Link, differing only by the Factory setting of a selectable frequency filter in the receiver module. The three versions and their frequency selections are:

- 144-694-1 (10 MHz Option) FOL-100
- 144-694-2 (5 MHz Option) FOL-100
- 144-694-3 (1 MHz Option) FOL-100

## 1.2. PURPOSE OF EQUIPMENT

The Model FOL-100 provides a secure, low loss method of interconnecting two pieces of equipment with a sine wave signal. It can be employed wherever a security boundary must be entered, or when protection against lighting strikes is desired, or where the two equipment must be located a long distance apart.

### 1.2.1. Physical Specifications

#### 1.2.1.1. FOL UNITS

| | |
|---|---|
| Form: | Two small enclosures, alodined and painted aluminum. |
| Dimensions: | 4.28”w X 1.50”h X 2.13”d (each) |
| Weight: | Approximately 12 ounces (each) |
| Fiber Length: | 1 to 2000 M (6560 ft.) |

#### 1.2.1.2. Optional Power Supply

| | |
|---|---|
| Form: | Plastic desktop enclosure |
| Dimensions: | 2.96”w X 5.83”l X 1.78”d |
| Weight: | Approximately 1.04 pounds. |

### 1.2.2. Environmental Specifications

#### 1.2.2.1. FOL UNITS

| | |
|---|---|
| Operating Temp: | 0° to +50°C |
| Storage Temp: | -40° to +100°C |
| Humidity: | 95% relative, non-condensing |
| Cooling Mode: | Convection |

#### 1.2.2.2. Optional Power Supply

| | |
|---|---|
| Operating Temp: | -0° to +40°C |
| Storage Temp: | -40° to +70°C |
| Humidity: | 20-90% relative, non-condensing |
| Cooling Mode: | Convection |

### 1.2.3. Power Requirements

#### 1.2.3.1. Transmitter End

| | |
|---|---|
| Voltage: | 12 VDC ±5% (external source) |
| Power: | 3 Watts maximum |

#### 1.2.3.2. Receiver End

| | |
|---|---|
| **Voltage:** | **12 VDC ±5% (external source)** |
| **Power:** | **3 Watts maximum** |

#### 1.2.3.3. Optional Power Supply (for either end)

| | |
|---|---|
| Input Voltage: | 90-265 VAC |
| Output Voltage: | 12 VDC |
| Power: | 30 Watts maximum |

### 1.2.4. Signal Specifications

#### 1.2.4.1. Input (150-703)

| | |
|---|---|
| Type: | Coaxial |
| Amplitude: | 3 Vpp (1 Vrms) ± 5% |
| Impedance: | 50Ω |
| Frequency: | 100 KHz to 11 MHz |

#### 1.2.4.2. Input (150-702)

| | |
|---|---|
| Type: | Optical Fiber, 62.5/125 μM, 850 nM carrier |
| Amplitude: | -16 dbm (typical) - 3db/km fiber length |
| Frequency: | 100 KHz to 11 MHz |

#### 1.2.4.3. Output (150-703)

| | |
|---|---|
| Type: | Optical Fiber, 62.5/125 μM, 850 nM carrier |
| Amplitude: | -16 dbm (typical) |
| Frequency: | 100 KHz to 11 MHz |

#### 1.2.4.4. Output (150-702)

| | |
|---|---|
| Type: | Coaxial |
| Amplitude: | 3Vpp ± 20% (with 10 db loss in fiber) |
| Load Impedance: | 50Ω |
| Frequency: | 100 KHz to 11 MHz |

# 2. INSTALLATION AND OPERATION

## 2.1. INSTALLATION

### 2.1.1. General

The Symmetricom Model FOL-100 Fiber Optic Link requires consideration of certain parameters prior to installation. The simplest installation requires that a suitable length of Optical Fiber be installed between the equipment sites. Mounting the FOL units on a suitable surface, connecting the fibers and the coax cables and installing the power supply and hooking up its power cables completes the installation. **Note that the mounting holes in the mounting flange were designed to mate with any two vertical holes in a standard 19" equipment rack or cabinet.** They may also be used to mount the modules to any flat surface. Be careful to allow enough room for the fibers to make any required bends in a gentle radius. Typically no bend radius should be less than 10X the cable outside diameter. The optical connectors are the "ST" style. See Appendix A for a list of recommended electrical and optical cables and suppliers. Symmetricom may also have supplied cable or cable assemblies as part of the order. Be especially careful when handling the optical fibers to avoid the inclusion of dirt or any other contaminant in the optical fiber connectors since this will have a negative impact on system performance.

### 2.1.2. Method 1

The OPTIONAL power supply is a desktop unit that will accept all world wide power. It is not designed for extreme environmental conditions, and so must be located in a benign location. See Specifications. It comes with a 1M long cable with installed connector for direct connection to either FOL.

### 2.1.3. Method 2

For other than standard conditions, the power supply needs to provide 12 VDC ±5% at the connector to the FOL. $I^2R$ losses in the DC power cable must not reduce the voltage at the FOL below 11.4 VDC worst case. The maximum gauge wire that will fit in the power connector is 20 AWG. Typical 20 AWG wire has a DC resistance of about 10Ω per 1000'. This must be doubled since the current goes both directions. If the FOL is 1000' away, the voltage loss is .25 X 20 = 4V in the power cable. If the power supply must be located more than 50' from the FOL module, we recommend that a remote sensing supply be used with Kelvin sense leads on both the Plus and Minus leads. This should be attached to the current carrying leads right at the FOL module. Please refer to the power supply operating instructions for hook up information. Also found in the instructions are methods that may be required to frequency-compensate the supply and prevent oscillations that may occur in this mode of operation. Another option is to set the power supply voltage higher than nominal to compensate for the line losses. This works because the load is fairly constant and tight regulation is not required. In this case adjust the power supply voltage so that there is 12VDC ±5% measured right at the power connector on the FOL while the FOL is operating.

### 2.1.4. Finish

If not already done, install the source and destination equipment according to their manuals. Install the Transmitter End FOL (150-703) near the source equipment and connect the FOL to the source with the provided coax cable. Install the Receiver End FOL (150-702) near the destination equipment and connect the FOL to the destination with the provided coax cable. Secure the optical cable near the FOL and attach it to the FOL.

## 2.2. OPERATION

Other than insuring that power is applied to the FOLs, there are no other operating instructions. However, if the fiber is a long one you may want to compensate the destination equipment for its length using the standard cable length compensation function of the equipment. The propagation delay of the fiber is roughly the same as the coax that would normally be installed. It is more precisely equal to the speed of light ($2.998 \times 10^8$) divided by the group refractive index of the fiber. For the fiber we recommend, the group refractive index is 1.496 at 850 nM and 1.491 at 1300 nM. Thus, at 850 nM, the correction factor for the recommended optical cable is 1.52 ns per foot. Don't forget to add in any coax between the source equipment and the transmit end FOL and the propagation delay of the FOL modules. The exact delay through the modules (using only 1 M of fiber) is marked on the rear panel of the receiver end FOL.

# 3. THEORY OF OPERATION

## 3.1. GENERAL INFORMATION

This section contains the theory of operation of the FOL-100 Fiber Optic Link. The link is used to provide a secure connection between source and destination equipment for Tempest or other secure facilities. It is also used to provide an extra long link (up to 2 KM), or to provide an EMI immune link in a noisy environment. The FOL can be used to provide a lightning proof link where lightning is a problem.

## 3.2. HARDWARE DESCRIPTION

The FOL-100 Assembly, which consists of two enclosures and a length of fiber optic cable is intended to be used in systems that need the advantages of fiber in transmitting sine wave signals between 100 KHz and 11 MHz. The transmit end serves to send the signal to the receive end by amplitude modulating and launching it into a 62 micron glass optical fiber. The receiver takes the lightwave signal and converts it to an electrical copy which it passes through a limiting amplifier to compensate for fiber and conversion losses. A buffer/filter capable of driving a 50 Ω load follows the limiter section.

# 4. MAINTENANCE AND TROUBLESHOOTING

## 4.1. INTRODUCTION

Effective maintenance and troubleshooting of this equipment requires a thorough understanding of equipment characteristics, and operating procedures. The equipment characteristics, operating procedures and the theory of operation for the system are provided in SECTION ONE through SECTION THREE of this manual. A working knowledge of Fiber Optics theory and connection methods is also required.

## 4.2. PREVENTIVE MAINTENANCE

A systematic preventive maintenance routine can reduce the possibility of a malfunction. This routine should include inspection, qualification and cleaning of the instrument.

## 4.3. Inspection

Exercise care when handling this equipment. It contains sensitive parts that can be damaged by improper handling. Do not touch connector pin surfaces because of the danger of static discharge, also deposits on contact surfaces can cause corrosion, resulting in equipment damage or failure. Inspect the unit for damaged components, loose or frayed connections and corrosion on metal surfaces. If damage is found, correct it immediately. Be especially careful not to get any foreign material into fiber optic connections as it will degrade or destroy the connection. Keep in mind that the active signal path in the fiber is only 62.5 microns in diameter (thinner than a human hair), and so requires only a trace quantity of material to disrupt it.

### 4.3.1. Cleaning

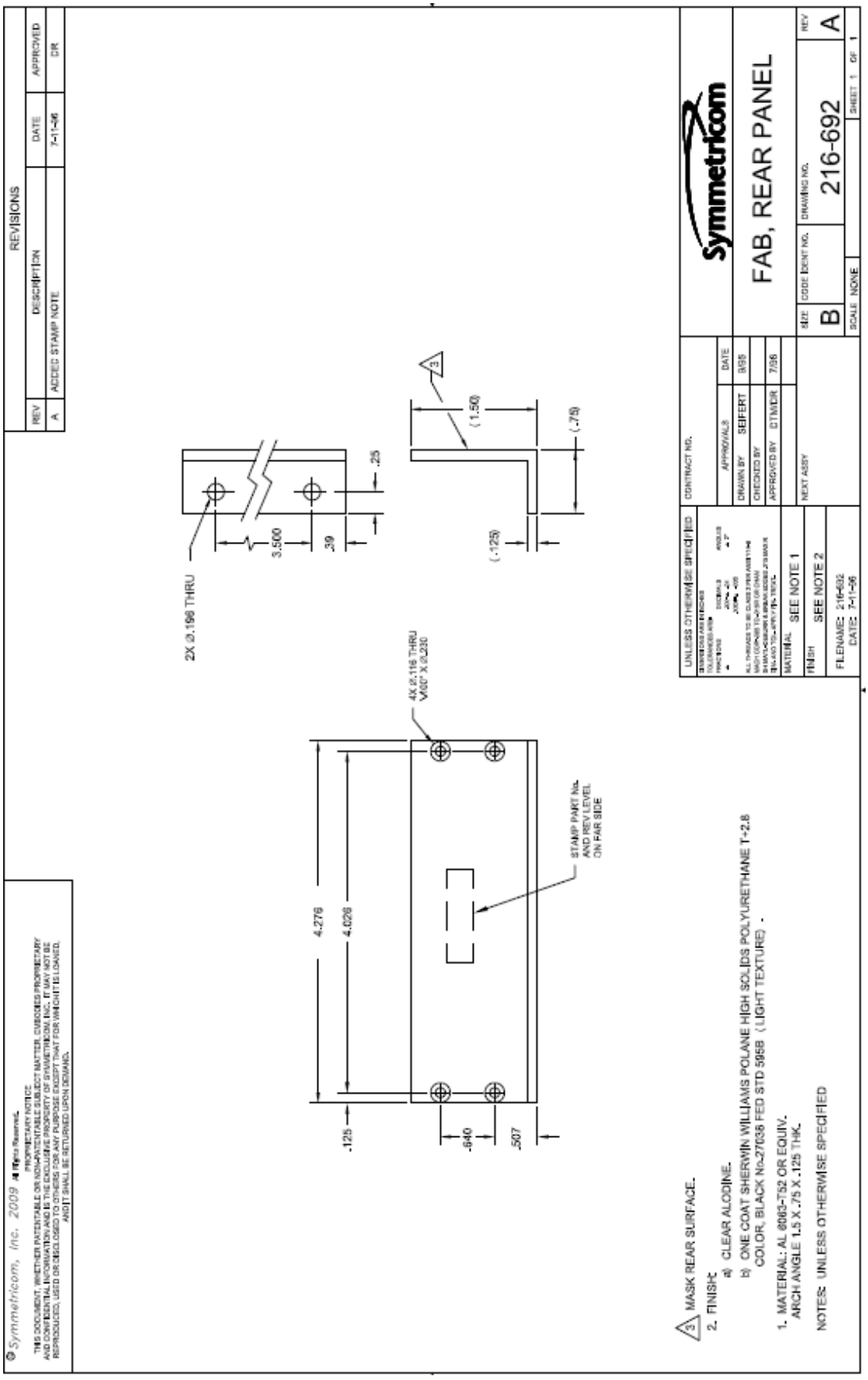
Accumulations of dust and dirt can impair cooling and cause performance degradation. The equipment may be cleaned by the use of a vacuum cleaner or compressed air, and if the problem is bad enough, with a cloth dampened with clean water and a mild detergent. Thoroughly rinse the cloth with clean water after washing, and wipe off washed areas to remove any residue. Be careful not to get water into switches or pots or *Fiber Optic connectors*.. Thoroughly dry the equipment with compressed air, and/or time permitting, by air drying. Circuit cards may be cleaned using the procedure in their manuals. If you suspect that a fiber connector has been fouled, it may be cleaned with *clean* isopropyl alcohol in spray form, followed by a jet of *clean, dry air*. Do not use any form of cloth or tissue to attempt cleaning, as this may only aggravate the problem.

### 4.3.2. Qualification

Verify that the unit meets all of the applicable specifications listed in Section One. Failure to meet a specification is an indication of malfunction and should be corrected immediately.

## 5. DRAWINGS

Mounting hole spacing is 3.5 inches.



# 6. APPENDIX A

## 6.1. RECOMMENDED FIBER OPTIC CABLE

The fiber optic cable recommended for most indoor/outdoor installations is:

**BX002DWLS9KR**

MANUFACTURER IS **OPTICAL CABLE CORPORATION**

This is a riser rated indoor/outdoor tightly buffered breakout cable which is very easy to install compared with any other options. Due to the fact that it is a riser rated cable, it does not require any special handling to run it inside from outside. It is rated for direct burial and aerial installations (with the addition of a suitable messenger). It is also available in an armored version should protection from vermin be required. Where existing fiber cable is used, it must be 62.5/125 micron fiber. The FOL uses 850 nM wavelength optical devices and has a 10DB power budget. All fiber links used must have <=10db loss @ 850 nM. This is a two fiber cable which provides an installed spare.

## 6.2. RECOMMENDED COAX CABLE

Symmetricom normally supplies and recommends: **Belden 8219**

MANUFACTURER IS **BELDEN ELECTRONIC WIRE AND CABLE**

## 6.3. RECOMMENDED OPTICAL CONNECTORS

Symmetricom normally supplies and recommends: **Amp 504034-1**

MANUFACTURER IS **AMP INCORPORATED**

This is a crimp style connector that requires no epoxy or other difficult assembly.

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