# **FIM-108** MATRIX FIBER INTERFACE

# INSTRUCTION MANUAL

FIM-108 Matrix Fiber Interface Instruction Manual


Part Number 810291 Rev. A

Clear-Com Intercom Systems
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U.S.A

# CONTENTS

# OPERATION

## DESCRIPTION

With a Clear-Com FIM-108 System, you can connect Clear-Com intercom stations or interfaces to the central matrix using fiber-optic cables at distances of up to 12 miles (20 km). For added convenience, Clear-Com also provides BNC connectors, so that you can connect FIM-108 units with coaxial cables at distances of up to 1,000 feet (300 meters).

The system consists of one FIM-108 unit at the matrix-frame end and another FIM-108 unit at the matrix-station end. Connecting the pair of interfaces with fiber or coaxial cable, rather than with the standard 4-wire twisted copper, gives you advantages such as increased security from electromagnetic and RF interference, flexibility in equipment placement, ease of maintenance, and often, reduced cost.

*The Clear-Com FIM-108 System links up to eight intercom stations to the central matrix frame over fiber optic or coaxial cable. With fiber-optic cable, you can place the stations at distances of up to 12 miles (20 km) from the central frame.*

Clear-Com provides three versions of of the FIM-108 interface:

- An **FIM-108D** interface pair connects over two single-mode fiber-optic cables —one cable for each direction of the signal flow. You also have the option of connecting the units with two coaxial cables, again one cable for each direction of the signal flow.
- An **FIM-108M** interface pair connects over one multimode fiber-optic cable. The send and receive signals are combined using wave-dimension multiplexing (WDM) so that both directions of the signal flow can transmit over one fiber-optic cable. You also have the option of connecting the units with two coaxial cables, one cable for each direction of the signal flow.
- An **FIM-108S** interface pair connects over one single-mode fiber-optic cable. Like the FIM-108M unit, the FIM-108S unit combines the send and receive signals through wave-dimension multiplexing (WDM), so that both directions of the signal flow can transmit on one fiber-optic cable. As with the other versions, you can optionally connect the units with coaxial cable.

| INTERFACE | # FIBERS | FIBER MODE | FIBER RANGE |
|---|---|---|---|
| **FIM-108D** | 2 | single mode<br>or multimode | 3 miles or 5 km (multimode)<br>12 miles or 20 km (single mode) |
| **FIM-108M** | 1 | multimode | 3 miles (5 km) |
| **FIM-108S** | 1 | single mode | 12 miles (20) km |

*Table 1: Summary of FIM-108 Fiber-Optic Connection Options*

***NOTE:** Throughout this manual the interface will be referred to generally as the "FIM-108 interface." The D, M, and S designations will only be used when it is necessary to distingish between the three versions of the interface. When you see the term "FIM-108 interface," you can assume that the text refers generally to all versions.*

## CONNECTING INTERCOM STATIONS TO THE CENTRAL MATRIX

The Clear-Com FIM-108 system transmits audio and data signals from up to eight intercom units to the matrix frame through the process illustrated in Figure 2. For the purposes of simplification, the illustration shows only one direction of the signal flow, while in reality the opposite direction of signal flow occurs in a a similar fashion and simultaneously, so that the system always transmits in full-duplex mode.

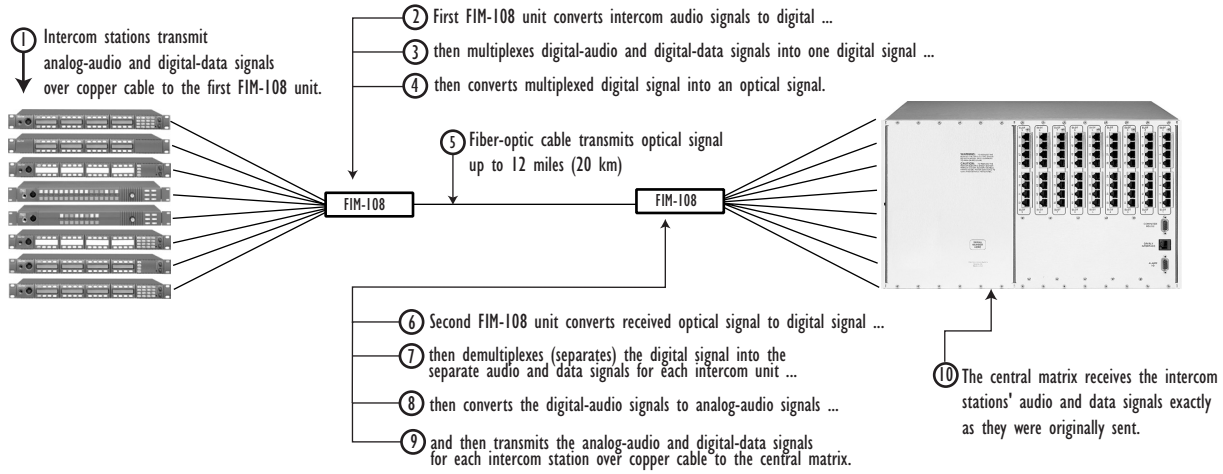



*Figure 1: Connecting Intercom Stations to the Central Matrix*

1. Matrix Plus intercom stations transmit *analog* audio signals and *digital* data signals to the first FIM-108 unit via copper cable terminated with RJ-45 connectors.

2. The first FIM-108 unit converts the analog audio signals to digital audio signals through an analog-to-digital converter (ADC) located on the FIM-108 unit's main circuit board.

3. The first FIM-108 unit then multiplexes (combines) the digital audio signals with the already digital data signals.

4. The first FIM-108 unit then converts the multiplexed digital signal into an optical signal.

5. The first FIM-108 unit then transmits the optical signal over up to 12 miles (20 km) of fiber-optic cable (or 1,000 ft. of coaxial cable) to the second FIM-108 unit, where a similar but reverse process occurs to convert the signal back to its original format.

6. The second FIM-108 unit converts the received optical signal to a digital signal.

7. The second FIM-108 unit then "demultiplexes" (separates) the digital signal back into its separate audio and data signals for each intercom unit.

8. The second FIM-108 unit then converts the *digital* audio signals for each intercom station to *analog* audio signals by sending the signals through a digital-to-analog converter (DAC) located on the FIM-108 unit's main circuit board.

9. The second FIM-108 unit then transmits the analog audio and digital data signals for each intercom station to the central matrix over copper cable terminated with RJ-45 connectors.

10. The central matrix receives the intercom stations' audio and data signals in the same format in which they were originally sent by the Matrix Plus 3 intercom stations.

***NOTE**: There is a one-to-one correspondence between inputs and outputs at opposite ends of the system. Audio inputs and outputs are on separate sets of eight RJ-45 connectors located on the rear panel of each IMS-108 unit. See "Rear Panel Connectors" later in this chapter for more information.*

Table 1 lists the main circuits on the FIM-108's circuit board.

| CIRCUIT | DESCRIPTION |
|---|---|
| Analog-to-Digital (A/D) Converters | High speed analog-to-digital converters for each audio channel. |
| Multiplexer | Sequentially presents eight RS-422 digital inputs and eight digitized audio signals from the A/D converters to the optical output driver. |
| Demultiplexer | Takes sequential digital signals from the *pin* diode and separates them into 20 separate lines: eight to the D/A converters, eight to the RS-422 transmitters and four for overhead. |
| Digital-to-Analog (D/A) Converters | High speed digital-to-analog converters for each audio channel convert the digitized audio signal back to analog audio. |

*Table 2: Circuits in the FIM-108 System*

***WARNING**: Always use extreme caution with fiber-optic equipment. Never look directly into the light port or into the end of the optical fiber while either FIM-108 unit is operating. Even if you do not see visible light, eye damage is possible.*

## CONNECTING INTERFACE MODULES TO THE CENTRAL MATRIX

With a pair of FIM-108 units you can also remotely connect Clear-Com interface modules to the central matrix. For example, using a Clear-Com CCI-22 dual party-line interface at one end, you can connect two independent, external 2-wire party line systems to the central matrix from a distance of up to 12 miles (20 km). Or, with a Clear-Com TEL-14 Telephone Interface Module, you can send telephone audio to the central matrix over a secured, interference-free fiber optic line.

Figure 2 shows a system with connected interface modules.

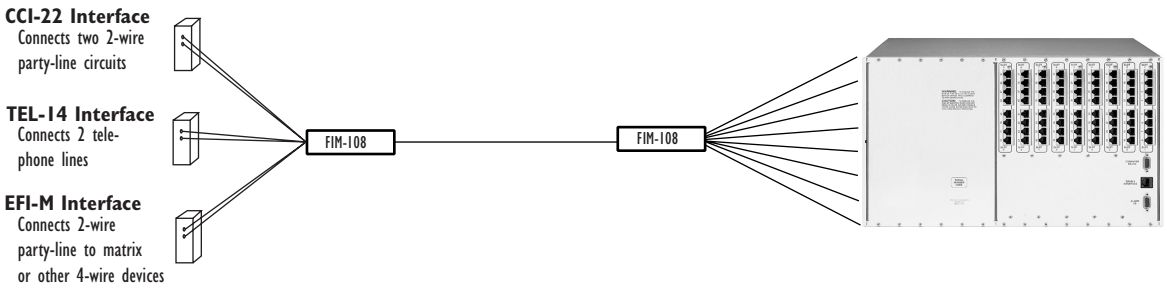



*Figure 2: Connecting Interface Modules to the Central Matrix*

# ONE-FIBER AND TWO-FIBER CONFIGURATIONS

## FIM-108D Two-Fiber Configuration

In a standard two-fiber system, identical FIM-108D units are used at each location. The units both transmit at 300 nm on ST connector A and receive the 300 nm signal on ST connector B. They are connected by the two fibers so that the optical output of each box is connected to the optical input of the other. In both one- and two-fiber systems, the input of channel 1 on one unit becomes the ouput of channel 1 on the other unit, and vice versa.

The two FIM-108 units in the two-fiber version are identical, so the units are interchangeable.

## FIM-108M and FIM-108S One-Fiber Configurations

In a one-fiber system, the two FIM-108 units are *not identical* and are configured before shipment. They must be used as a pair. The units are connected by a single fiber that is wavelength division multiplexed (WDM). One unit transmits from the "A" ST connector at a wavelength of 1300 nm and also receives at 1550 nm on the same connector. The other unit transmits from the "A" ST connector at 1550 nm and similarly receives at 1300 nm on the same connector.

The two FIM-108 units in the one-fiber versions are not identical, so if a replacement unit is needed, the unit type must be specified.

Figure 4 illustrates the three configurations of the Clear-Com FIM-108 System.

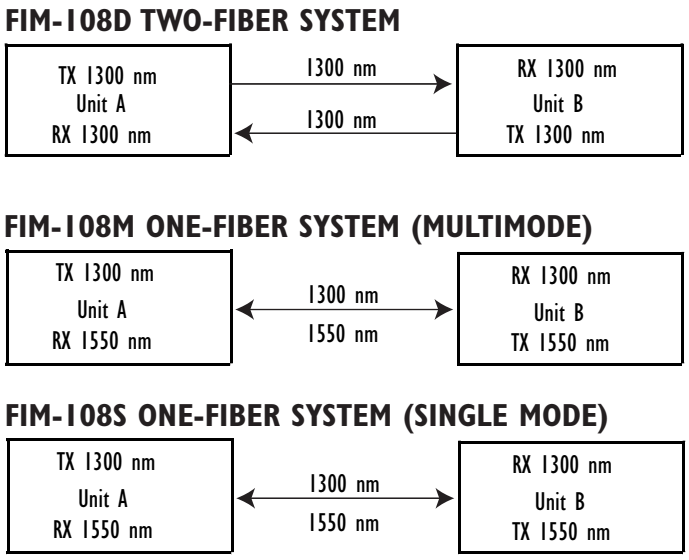



*Figure 3: Possible Optical Configurations*

# FIM-108 FRONT PANEL CONTROLS AND LIGHTS

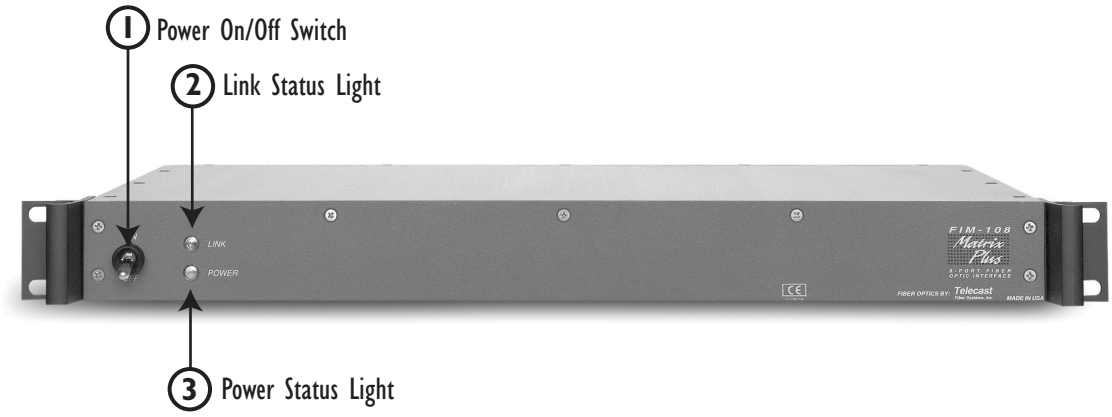



*Figure 4: Front Panel of an FIM-108 Unit*

## 1 Power On/Off Switch

The power on/off switch locks to prevent inadvertent power turn off. To unlock the switch, pull it towards you until the lock disengages. Do not try to move the switch without first unlocking it.

## 2 Link Status Light

The link status light illuminates only when the fiber-optic link is not properly attached, or when the the system units are not communicating properly. This light is meaningful only if the green power light is on.

## 3 Power Status Light

The power status light illuminates when an external power supply of between 12 and 24 VDC is connected.

# FIM-108 REAR PANEL CONNECTORS

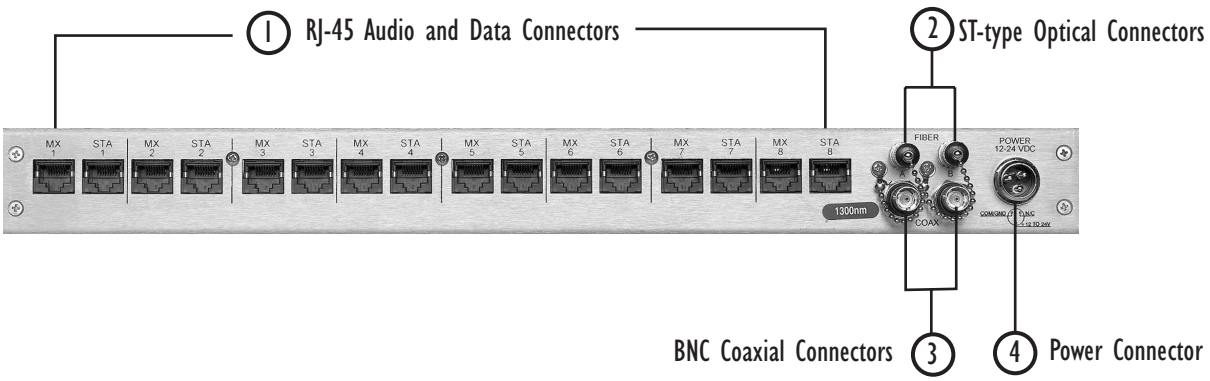



*Figure 5: Rear Panel of an FIM-108 Unit*

## 1 Audio and Data Connectors

Eight separate pairs of RJ-45 connectors are located on an FIM-108 unit's rear panel as shown in Figure 5. Each pair of RJ-45 connectors attaches an audio/data input and an audio/data ouput to the FIM-108 unit.

## 2 Optical Connectors

A high-powered LED coupled to an optical fiber generates the FIM-108 unit's optical output. A bulkhead-type ST connector on the FIM-108 unit's rear panel connects to the transmission fiber. The transmission fiber must be matched to the fiber pigtail type specified at the time of manufacture.

The  input uses a pin diode and amplifier to convert the optical signal back to an electrical signal.

The optional single-fiber system uses a wavelength-division multiplexer to combine and then separate the two colors used.

## 3 Coaxial Connectors

Each version of the FIM-108 unit has two BNC connectors for connecting two 75-Ohm coaxial cables.

## 4 Power Connector

A UL- and CE-listed external in-line power supply, with a 3-pin connector, provides the required 12 VDC  to operate an FIM-108 unit.

## POWERING AN FIM-108 UNIT ON OR OFF

With the power off at both units, check all electrical and optical connections as described in the Installation Chapter of this manual. Firmly seat and latch all connectors.

**To power an FIM-108 unit on or off:**

1. Pull the on/off lever towards you to unlock it.
   The power lever locks to prevent inadvertent power turn off. When you pull the lever towards you, the lock disengages. Never move the front-panel lever without first unlocking it.
2. Move the lever up to turn power on, or down to turn power off.
3. Switch the power on at both FIM-108 units.
   The power at both units must be on for the system to function.
4. Verify that the green power light is illuminated on each unit, and that the red link status light is not illuminated on each unit.
   If the lights do not illuminate as described, refer to the troubleshooting section in the Maintenance Chapter for further instructions.

# 2 INSTALLATION

## UNPACKING

When you receive your Clear-Com FIM-108 System, check to make sure you have received all components of the system. The following items make up a Clear-Com FIM-108 System:

- Two FIM-108 multiplexer/demultiplexer units
- Two external power supplies

Inspect the units for mechanical damage. Inspect all electrical connectors for bent or damaged pins and latches. Report any damage to the carrier and to Clear-Com Intercom Systems.

Leave the protective plastic caps on the optical connectors until it is time to attach the fiber(s) to the units.

## INSTALLING AN FIM-108 UNIT IN A RACK

Clear-Com ships each FIM-108 unit ready for installion in an equipment rack. If you are not installing the units in a rack, you can remove the rack adapters by unscrewing the two #10 flat-head screws that hold each adapter in place, as shown in Figure 1.

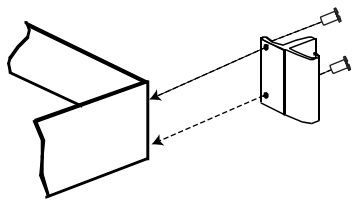


*Figure 1: Installing or Removing the Rack Adapters*

Place the FIM-108 units in their intended locations before attaching any wires or cables. Doing so will prevent accidental damage to the cables or their connectors during installation.

## INSTALLING FIBER-OPTIC CABLE

The person installing the FIM-108 units is responsible for providing the fiber optic cable runs. Be sure that the fiber core diameters are compatible with the

intended installation distances as shown in Table 1. The factory configures the FIM-108 units for the required fiber type before shipping.

| FIBER CORE DIAMETER | MAXIMUM FIBER LENGTH |
|---|---|
| 50 microns (multimode) | 3 miles (5 km) |
| 62.5 microns (multimode) | 2 miles (3 km) |
| 8 microns (single mode) | 12 miles (20 km) |

*Table 1: Maximum Fiber Lengths*

Mark or tag the optical fibers when they are pulled, carefully avoiding the fiber tip, so that their identity is known at both ends. If there is confusion about the identity of the two fibers, shine a flashlight at one end of the fiber and look for light at the other end.

**WARNING: Do not use the FIM-108 optical output to identify cables. Never look directly into the end of the optical fiber while either end of the system is operating. Even if you do not see visible light, eye damage is possible.**

Inspect the fiber ends and clean them with clean, dry compressed air or with Kim-Wipes that have been saturated with isopropyl alcohol. Fingerprints or other dirt on the optical connector end surfaces will reduce the received optical signal level.

# CONNECTING FIBER-OPTIC CABLE TO THE FIM-108

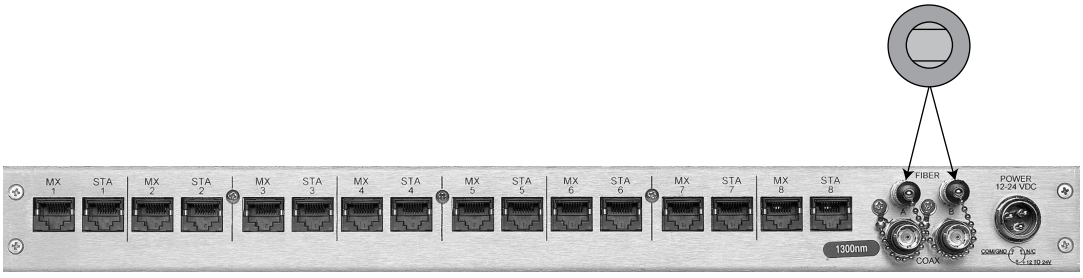



*Figure 2: ST Optical Connectors on an FIM-108 Unit's Rear Panel*

Refer to Figure 2 before connecting the optical fiber to the ST optical connectors on the FIM-108 unit's rear panel.

The FIM-108 is compatible with industry standard ST-type connectors.You may use installed backbone cables or dedicated cables with it.

**Always follow the connector manufacturer's directions when fastening a connector to the cable.**

On a two-fiber system, connect the cables so that:

- transmitter ST **A** at one end connects to receiver ST **B** at the other end, and
- transmitter ST **B** at one end connects to receiver ST **A** at the other end.

On a one-fiber system, connect the fiber optic cable to the ST **A** at each end.

Figures 3 and 4 illustrate the entire wiring scheme for the FIM-108 system. Figure 3 illustrates the wiring for a two-fiber system (FIM-108D) and Figure 4 illustrates the wiring for a single-fiber system (FIM-108M or FIM-108S).

# CONNECTING AUDIO/DATA CABLES TO THE FIM-108

RJ-45 connectors on the FIM-108 unit's rear panel connect the unit to audio and data inputs and outputs as shown in Figures 3 and 4. Figure 5 illustrates the CAT-5 and above cable pinout configuration. The maximum length for CAT-5 cables is 10,000 feet (3 km).

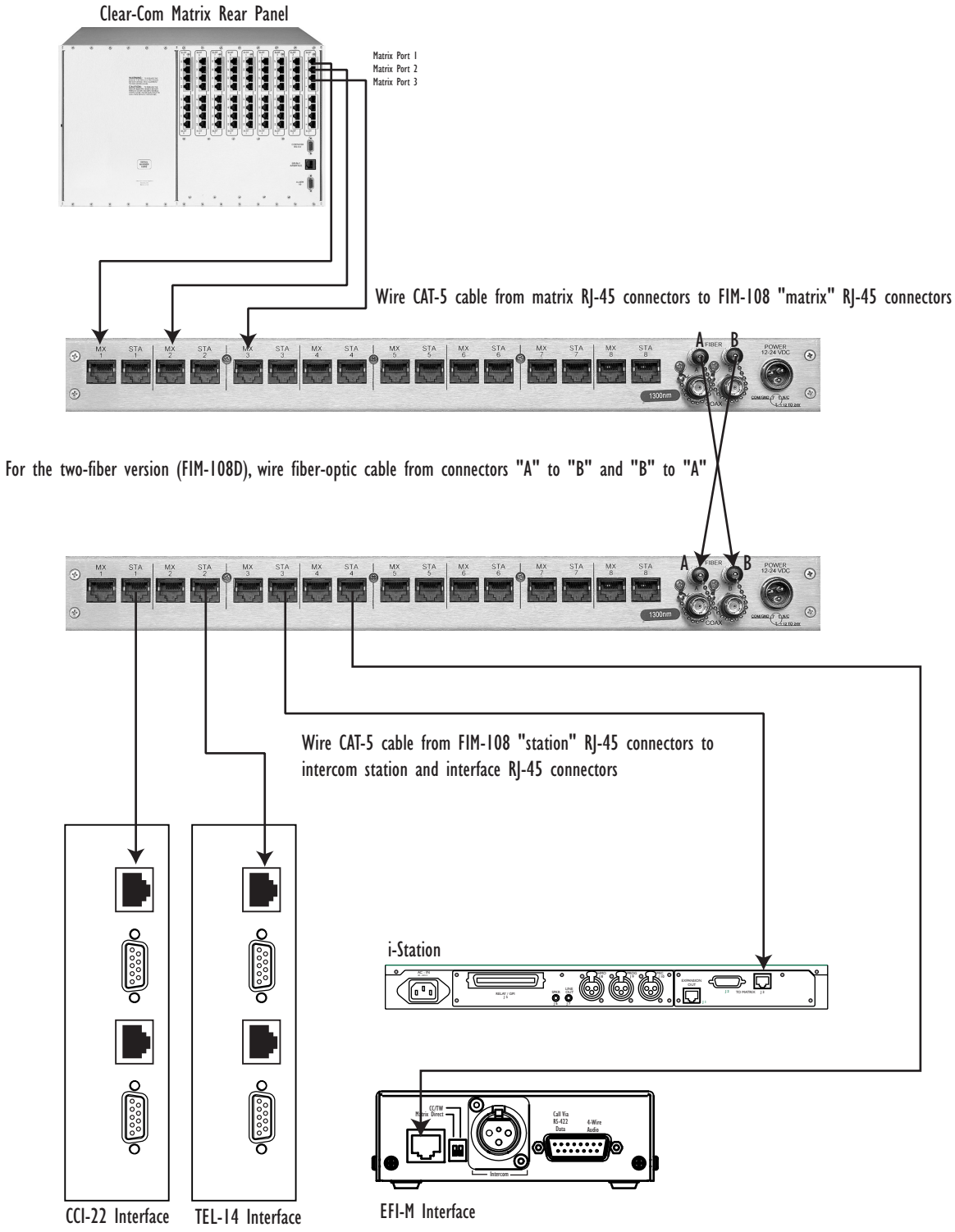



*Figure 3: Wiring a Two-Fiber System (FIM-108D) to Intercom Stations and Interfaces with Fiber-Optic Cable*

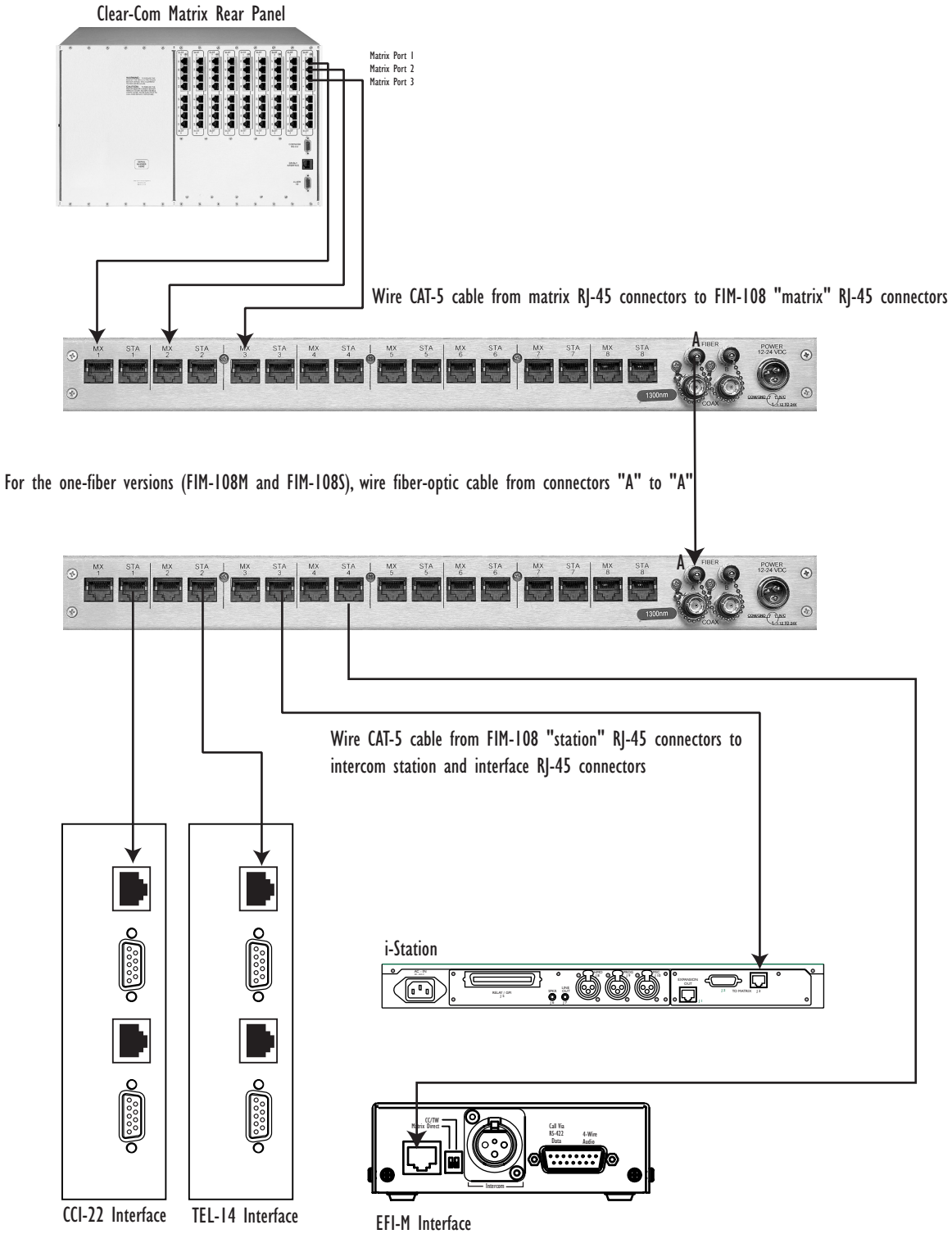
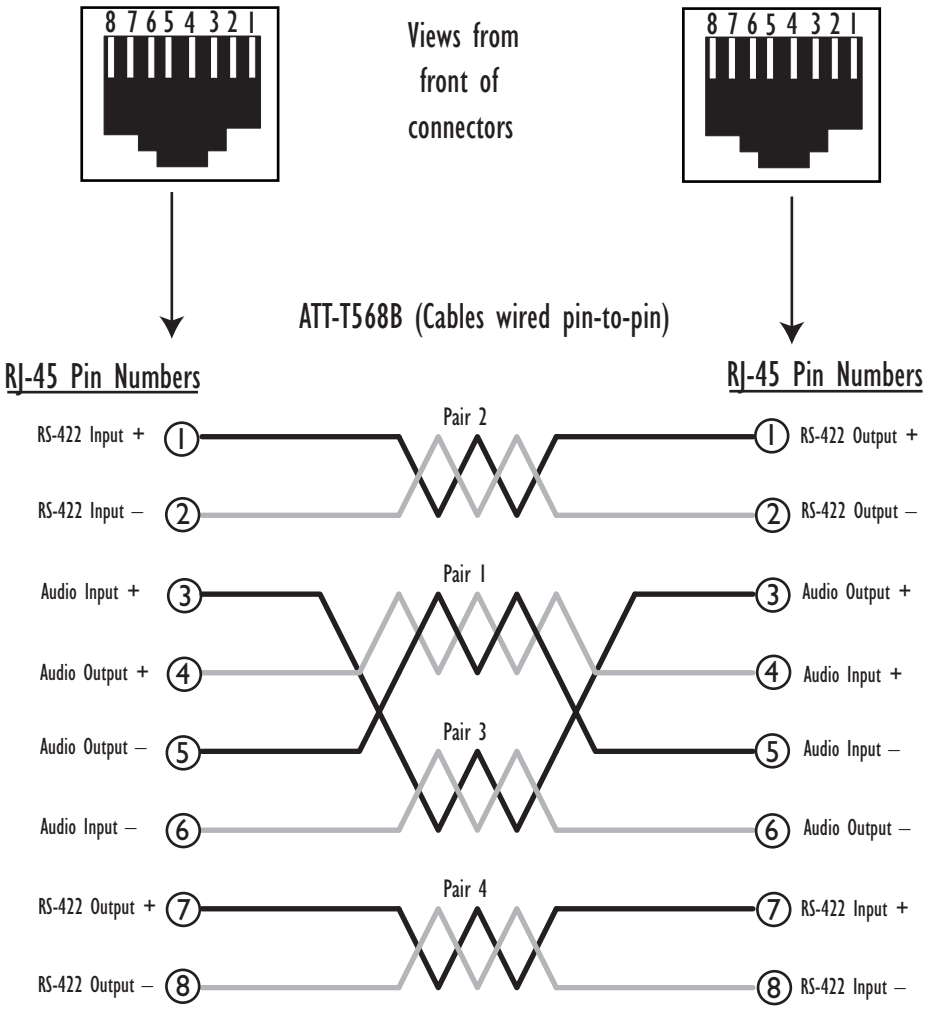



*Figure 4: Wiring a One-Fiber System (FIM-108M or FIM-108S) to Intercom Stations and Interfaces with Fiber-Optic Cable*

# CAT-5 CABLE PINOUT DIAGRAM




**Pair 1** Audio output
**Pair 2** RS-422 data input
**Pair 3** Audio input
**Pair 4** RS-422 data output

*Figure 5: Cat-5 Cable Pinout Diagram*

# CONNECTING COAXIAL CABLE TO THE FIM-108

Use 75-Ohm coaxial cable to connect to the BNC coaxial connectors. Connect the cables so that:

- transmitter A at one end connects to receiver B at the other end, and
- transmitter B at one end connects to receiver A at the other end.

Figure 5 illustrates an FIM-108 System wired with coaxial cable.

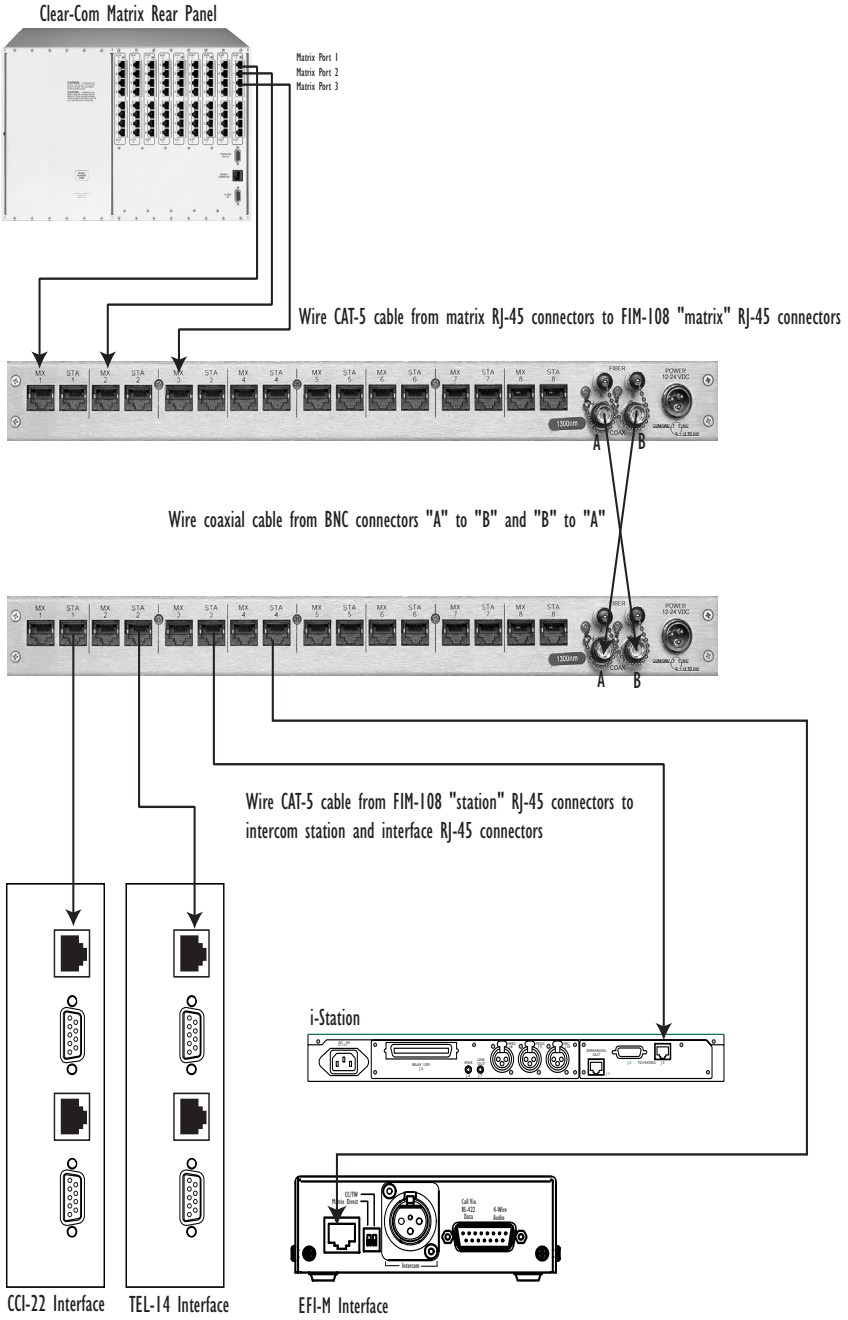



*Figure 6: Wiring the FIM-108 to Intercom Stations and Interfaces with Coaxial Cable*

# 3 MAINTENANCE

## TROUBLESHOOTING TIPS

Listed below are some of the more common problems that you may experience, their possible causes, and suggested solutions.

| SYMPTOM | POSSIBLE CAUSE | |
|---|---|---|
| No operation, indicators all off. | No power. | Make sure the power switches of both units are on, and their external supplies are delivering between 12 to 24 VDC. |
| No operation, but front-panel Link Status light is on. | Optical communications failure. | Check for broken or disconnected fibers. Check to see if the FIM-108 at the other end is operating correctly. For a one-fiber system, check the block diagram on page ???. |
| FIM-108 units are operating correctly, but connected stations or interfaces are not. | | Check RJ-45 cables or Matrix configuration. |

If you are unable to resolve a problem with your FIM-108 unit, call Clear-Com Intercom Systems at (510) 496-6666 and ask for the Service Department. See the Warranty Chapter for more information.

## PREVENTIVE MAINTENANCE

Every two years verify the adequacy of optical power at the far end of each optical fiber with an optical power meter.

## BLOCK DIAGRAM OF A ONE-FIBER SYSTEM (FIM-108M OR FIM-108S)

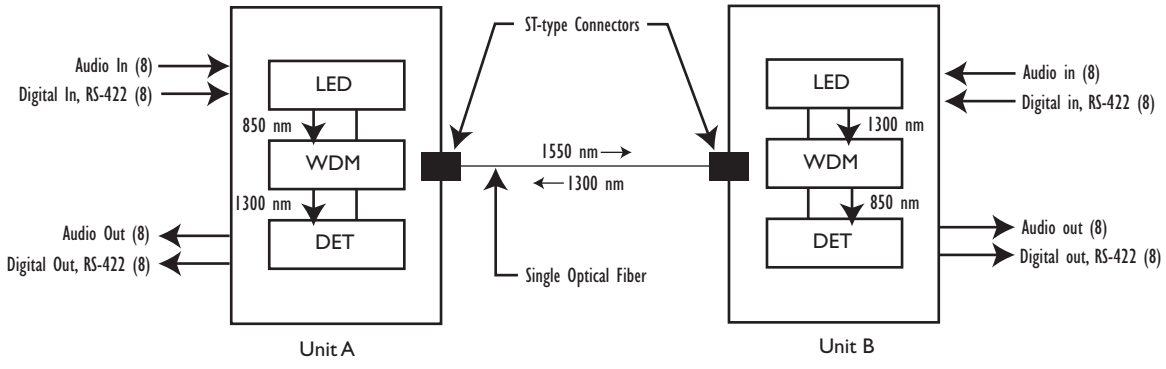



*Figure 1: Block Diagram for One-Fiber Systems (FIM-108M and FIM-108S)*

# COMPONENT LAYOUT DRAWING

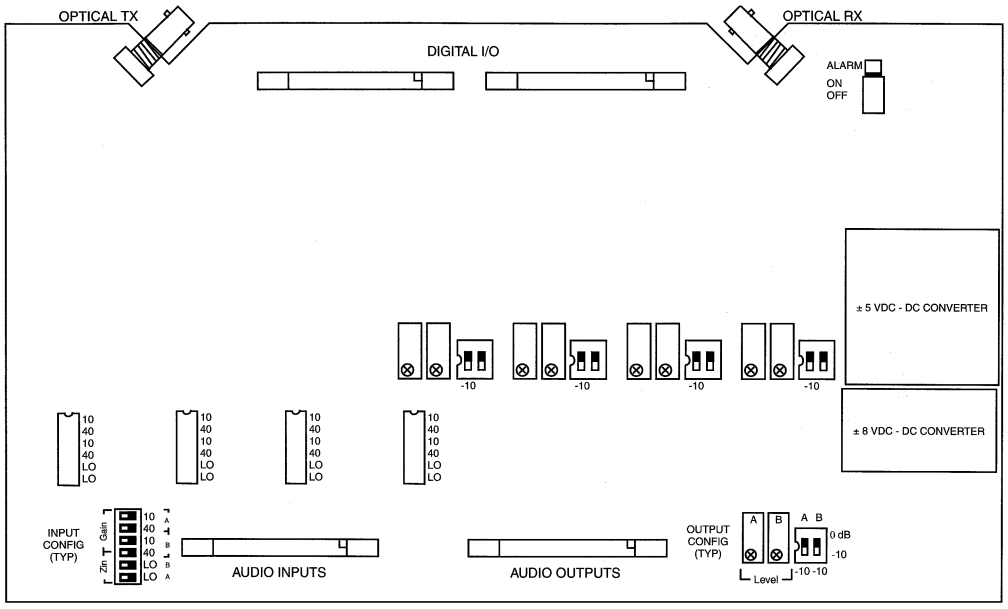



*Figure 2: Component Layout Drawing of Main Circuit Board*

# 4 GLOSSARY

**fiber-optic cable** A fiber-optic cable consists of a glass core covered with a reflective material called "cladding" and several layers of buffer coating to protect the cable from the environment. A laser sends light pulses through the glass core to the other end of the cable.

**full duplex** Refers to transmission of signals in two directions simultaneously.

**interface** A piece of electronic hardware designed to convert the 4-wire signals of a central matrix port to some other form of communications, such as 2-wire party line, telephone, etc. The interface is connected to a central matrix port. The external non-4-wire device is then connected to the interface.

**mode** A term used to describe a light path through a fiber, as in multimode or single mode.

**multimode fiber-optic cable** The glass core of a multimode fiber is larger than the core of a single mode fiber, which causes the transmitted light beam to disperse as it travels through the core. Single mode fiber, with its smaller core, concentrates the light beam so that it carries signals further. Multimode fiber was the first type of fiber offered by manufacturers. Single-mode fiber evolved as production methods improved.

**multiplexing** The process by which two or more signals are transmitted over a single communications channel. Examples include time division and wavelength division multiplexing.

**nanometer (nm)** Common unit of measure for wavelength. One billionth of a meter.

**optical signal** A laser at one end of a fiber-optic cable pulses on or off to send a light signal through the glass core of the cable to the other end of the cable. Because the light signals are binary (on or off), the signal is digital.

**port** Any of the input/output connections (RJ-45 connectors) on the back panel of the central matrix. These connectors, and the attached cables, connect the central matrix to remote intercom devices. The term "port" emphasizes that the connection is a "portal" between the central matrix and the remote intercom devices.

**remote station** Any intelligent intercom device connected to the back-panel ports of the central matrix. This term does not refer to devices connected through interfaces.

**single-mode fiber-optic cable** The glass core of a single-mode fiber is smaller in diameter than the core of a multimode fiber, so that the light signal transmitted over the core is more concentrated than with multimode fiber, which allows the signal to travel further. Single-mode fiber evolved from multimode fiber as production methods improved.

**wavelength-division multiplexing (WDM)** A method of multiplexing optical signals developed for use on fiber-optic cable. Each signal is assigned a particular wavelength on the light spectrum and therefore many signals can be transmitted simultaneously without interfering with each other.

# 5 SPECIFICATIONS

## Audio

| | |
|---|---|
| Transmission Method | Digital, TDM, 18-bit, 48 ksamples/sec |
| Input Impedance | 600 Ohms balanced |
| Output Impedance | 30 Ohms balanced |
| Maximum Input Level (600 Ohms) | +18 dBm (peak) |
| Maximum Output Level (from 30 Ohms balanced) | +18 dBm into 600 Ohms |
| Frequency Response (@8 dBm) from 20 Hz to 20 kHz | ±0.2 dB |
| Total Harmonic Distortion + Noise | |
| from 20 Hz to 20 kHz (@ +8 dBm) | <0.05% |
| at 1 kHz (@ +18 dBm) | <0.0085% |
| Intermodulation Distortion (SMPTE) | |
| 60 Hz + 3 kHz mixed 4:1 @ +8 dBm | <0.04% |
| Signal to Noise Ratio, unweighted, 20 Hz - 20 kHz, ref. to +18 dBm clip level | >90 dB |
| Aggregate Digital Data Rate | 43 Mbaud |

## Mechanical/Electrical/Environmental

| | |
|---|---|
| Connectors | RJ-45; coaxial |
| Optical Connectors | ST-type |
| Power Connector | 3-pin DIN |
| Input Voltage Range | 12 to 24 VDC (30 VDC max.) |
| Power Consumption (per end, all channels at full level) | <12 watts |
| Temperature Range | –40° to 65° C |
| Humidity Range | 0 to 95% non-condensing |
| A/C Adapters | supplied |

## Electro-Optical System Margin Data

| Operating Wavelength | 1300 nm | 1550 nm |
|---|---|---|
| TX output into cable | –10 dBm | –10 dBm |
| RX sensitivity | –30 dBm | –30 dBm |

## Matrix Data Communications (Frame-to-Station Digital Data)

| | |
|---|---|
| Transmission Rate | RS-422, Balanced TTL Levels, 0 to 150 kBits/sec |
| Jitter | 1.12 msec* |

*Higher rates possible dependent upon user system jitter tolerance.

## Power Requirements

Voltage 12 to 24 VDC

*Caution: Absolute maximum voltage is 30 VDC. Equipment damage may occur at higher voltages.*

## Notice about Specifications

While Clear-Com makes every attempt to maintain the accuracy of the information contained in its product manuals, that information is subject to change without notice. Performance specifications included in this manual are design-center specifications and are included for customer guidance and to facilitate system installation. Actual operating performance may vary.

# 6 CLEAR-COM LIMITED WARRANTY

This product is guaranteed by Clear-Com Intercom Systems to be free of manufacturing defects in material and workmanship under normal use for one year from the date of purchase.

The Clear-Com Intercom Systems warranty does not cover any defect, malfunction, or failure caused beyond the control of Clear-Com, including unreasonable or negligent operation, abuse, accident, failure to follow instructions in the manual, defective or improperly associated equipment, attempts at modification and repair not authorized by Clear-Com, and shipping damage. Products with their serial numbers removed or defaced are not covered by this warranty.

*Return authorization numbers are required for all returns.*

This warranty is the sole and exclusive express warranty given with respect to Clear-Com products. It is the responsibility of the user to determine before purchase that this product is suitable for the user's intended purpose.

*Both warranty and non-warranty repairs are available.*

Any and all implied warranties, including the implied warranty of merchantability, are limited to the duration of this express limited warranty. Neither Clear-Com nor the dealer who sells Clear-Com products is liable for incidental or consequential damages of any kind.

For your own records fill in the information below:

Model No._____Serial No._____
Date Purchased_____
Purchased from (dealer)_____
Address_____
City_____State____ ZIP_____

## FACTORY SERVICE

All equipment returned for repair must be accompanied by documentation stating the return address, telephone number, date of purchase, and a description of the problem.

Before returning equipment for repair, you must obtain a return authorization number. To obtain a return authorization number, call our customer service department at the number listed below. By talking with our representatives, many problems can be resolved over the phone. You can also send a fax to our customer service department or send an email to support@clearcom.com.

After obtaining a return authorization number, send equipment to be repaired to:

**Customer Service Department**
**Clear-Com Intercom Systems**
**4065 Hollis Street**
**Emeryville, CA 94608-3505**
**Telephone: (510) 496-6666**
**Fax: (510)496-6610**
**Web site: www.clearcom.com**

## WARRANTY REPAIR

If in warranty, no charge will be made for the repairs. Equipment returned for warranty repair must be sent prepaid and will be returned prepaid.

## NON-WARRANTY REPAIR

Equipment that is not under warranty must be sent prepaid to Clear-Com. If requested, an estimate of repair costs will be issued prior to service. Once repair is approved and repair of equipment is completed, the equipment will be shipped freight collect from the factory.