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Model 903
Fiber Optic Video/Data Multiplexer
(FMB-X-2.5 Version)
User's Guide

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REFERENCE DOCUMENTS

Document Number	Document Title/Description
903-0602-00 Rev. C	Model 903 Fiber Optic Video/Data Multiplexer User's Guide
903-0622-00 Rev. 2	FMB-X-2.5 Diagnostics Manual
700-0425-00 Rev. 2	FMB-X User's Guide
907-0601-00 Rev. C	Model 907 Fiber Optic Video/Data Multiplexer User's Guide

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Safety Precautions

The following safety precautions should be observed before using this product.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with safety precautions required to avoid possible injury. Do not make module connections unless qualified to do so.

Before connecting this product to the power source, verify that the output voltage is within the specifications of the product's power supply.

Before removing or installing a board, make sure the main module is turned off and disconnected from power source. Do not attempt to modify or repair any circuit unless recommended by the manufacturer.

Protect the power cable from being walked on or pinched by items placed or against them.

Always unplug the power cable at the plug, do not pull on the cord itself.

Do not block any ventilation openings or fans.

Do not look into the end of a fiber when it is plugged into a transceiver or active fiber, especially when using a magnifying instrument, such as a fiber microscope.

Handle optical fiber with extreme care. Glass fiber is subject to breakage if mishandled.

Grounded ESD wrist straps must be worn and proper ESD safety precautions observed when handling printed circuit boards.

ACRONYMS AND ABBREVIATIONS

AIB	Adaptable Interface Board
APD	Avalanche Photodiode
CIB	Control Interface Board (TOR)
CWDM	Coarse Wavelength Division Multiplexer
DIB	Data Interface Board
ECL	Emitter Coupled Logic
EIA	Electronic Industries Association
EIB	Ethernet Interface Board
ESD	Electrostatic Discharge
FC/APC	Ferrule Connector (Threaded optical connector) / Angled Physical Contact
FC/PC	Ferrule Connector (Threaded optical connector) / Physical Contact
FMB	Fiber (Optic) Multiplexer Board
FORJ	Fiber Optic Rotary Joint
FPGA	Field Programmable Gate Array
Gbps	Gigabits Per Second
I/O	Input/output
kbps	Kilobits Per Second
LED	Light Emitting Diode
Mbps	Megabits Per Second
MDI/MDIX	Automatic medium-dependent interface crossover
NRZ	Non Return to Zero (Data Signaling)
NTSC	National Television System Committee (Composite Video Format)
P/N	Part Number
PAL	Phase Alternation Line (Composite Video Format)
PCBA	Printed Circuit Board Assembly (Populated PCB)
PECL	Positive Emitter Coupled Logic
PLD	Programmable Logic Device
RGB	Red, Green, Blue (Component Video)
ROV	Remotely Operated Vehicle
SERDES	Serializer/Deserializer
SMB	Sub-Miniature “B” (Connector)
SMT	Surface Mount Technology
ST/PC	Straight Tip optical connector / Physical Contact
TDM	Time Division Multiplexing
TTL	Transistor-Transistor Logic
VOAT	Variable Optical Attenuator
WDM	Wavelength Division Multiplexer
Y/C	Luminance/Chrominance

1.0 Introduction

Focal's Model 903 is a video/data multiplexer and fiber optic transmission system designed for Remotely Operated Vehicle (ROV) applications. The Model 903 uses Time Division Multiplexing (TDM) and Wavelength Division Multiplexing (WDM) to provide high multiplexing density in a compact, low-power package. Typical systems support 8 broadcast quality composite video channels, up to 64 digital channels, and 2 additional bidirectional optical channels for high-speed sonar, digital video, or 1 Gbps Ethernet links.

This user's guide provides complete information on the design, configuration, installation and operation of the Model 903 multiplexer system based on FMB-X-2.5 cards. **This manual and the appropriate reference documents should be reviewed prior to installation or reconfiguration of the multiplexer**. Some sections of the manual apply to optional cards or features that are not included with the delivered system but may be added later.

Appendices include the following information:

Appendix A - A list of connectors and pin configurations
Appendix B - A list of all fuses used in the system
Appendix C - Guidelines for upgrading from FMB to FMB-X-2.5 base systems
Appendix D - Obsolete systems included in this manual for reference

2.0 System Overview

Each Model 903 multiplexer system consists of a 3U Eurocard remote module (subsea or ROV end) and a 3U Eurocard console module (surface or shipboard end), often mounted inside a standard 19" rack. Each module is provided completely packaged with an integrated power supply unit (PSU) and all necessary optical components. Eurocard PCB dimensions are 100 x 160 mm with front panel widths typically varying from 4 HP (20.3 mm) to 8 HP (40.6 mm).

The Model 903 systems based on FMB-X-2.5 motherboards support 8 simultaneous video channels and up to 64 data channels. The aggregate data uplink/downlink rate, including formatting bits, is 2.5 Gbps.

Video cards are not interchangeable between the remote and console module, since the signals are unidirectional: the remote cards have video inputs and the console video cards have video outputs. Data cards generally have bidirectional and symmetrical data channels and hence the cards are usually interchangeable between the remote and console modules.

The following figure shows a typical ROV application of the Model 903 system.

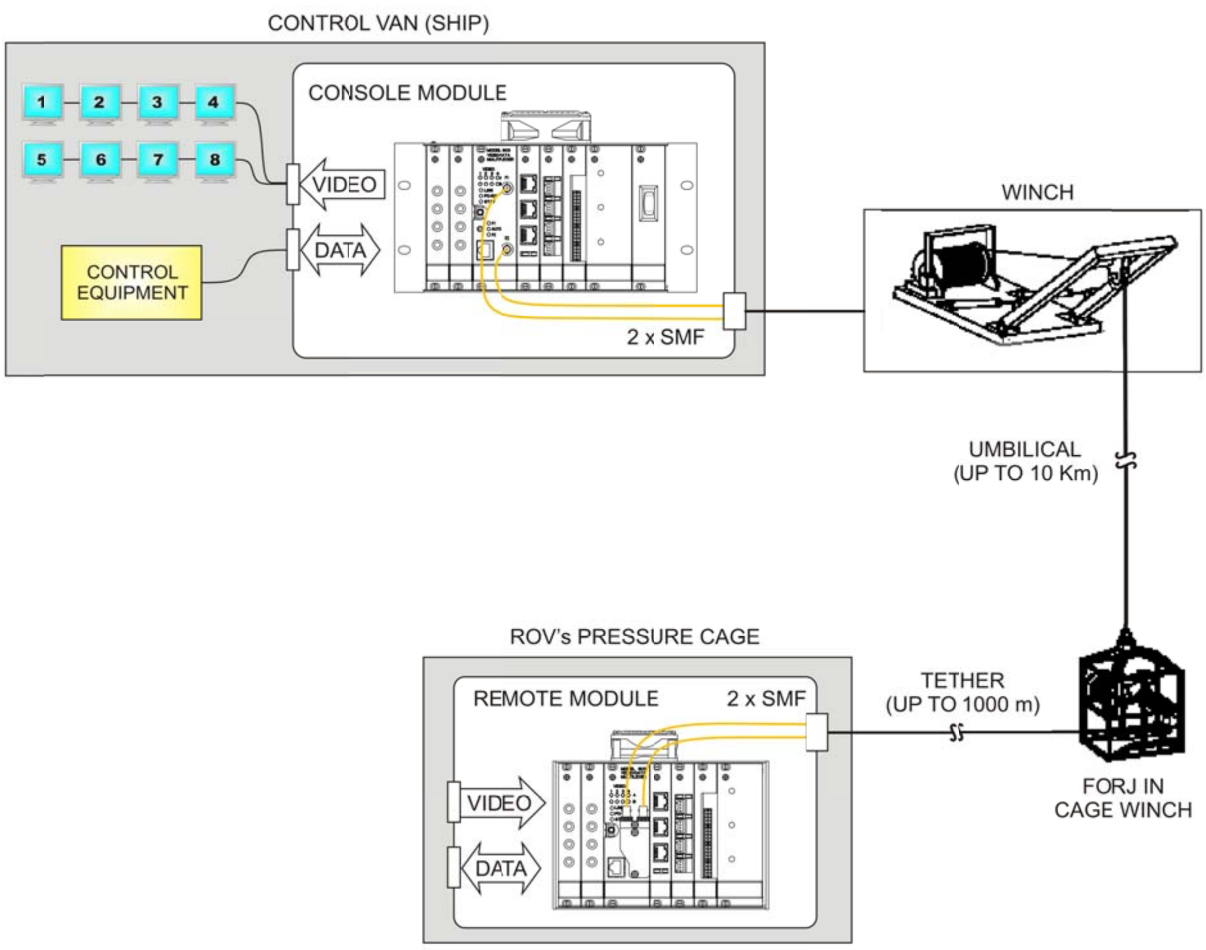


Figure 2.0-1: Model 903 Multiplexer, Typical ROV Application

2.1 Rack Configuration

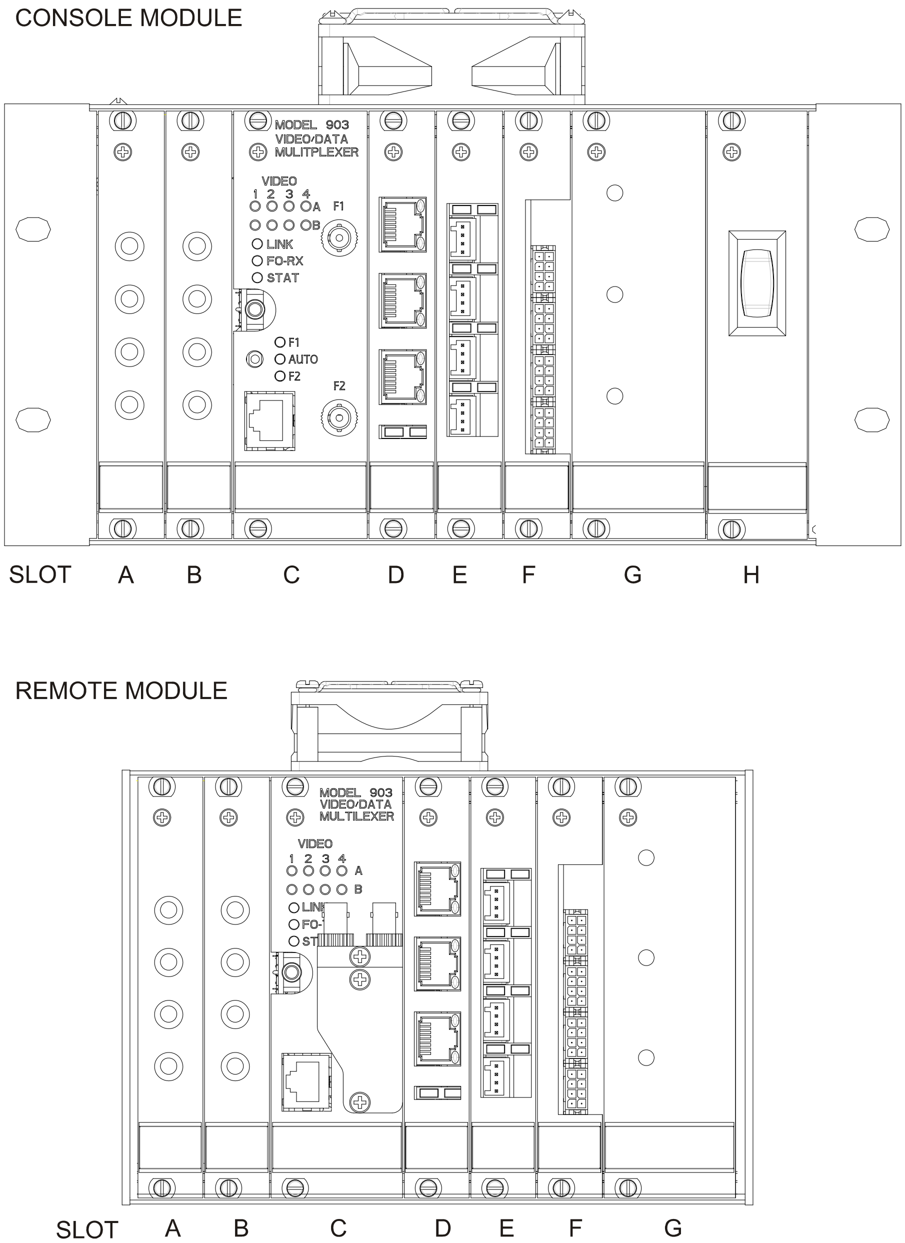
Various rack widths are available, supporting different numbers of slots for card installation. Typically a 903 rack has 2 slots for video cards, 1 slot for the FMB-X-2.5, 3-4 slots for data cards, and 1 slot for a Eurocassette PSU. Many remote racks substitute a DC-DC module on the back cover in place of the Eurocassette PSU to reduce the width of the rack by 8 HP (4 HP = 0.8" or 20.3 mm). The remote rack usually has a wire pigtail for applying AC or DC power; the console rack generally has a front panel switch and an IEC-320 jack on the rear cover to support a variety of plug cables. Console modules can be provided in full 19" racks or as reduced width sub-racks with add-on flanges for installation in 19" racks.

Slots in each rack are referenced by letter, per the installation drawings. Slots A and B are 4 HP wide and are intended for video cards, slot C is an 8 HP slot for the FMB-X-2.5, slot D and above are typically 4 HP wide data slots with the exception of the last slot, which is usually 8HP for the power supply module. The console module usually includes an additional panel for the power switch.

Some racks include one or two slots dedicated for media converter cards. These slots provide only power at the backplane connectors, since the media converters do not require any backplane data lines. Media converters may also be installed in data slots, which in this case the backplane data lines are unused. Optical expansion cards, such as CWDMs may be installed in any video, data or media converter slot.

Refer to installation drawings 903-8XXX-XX for the actual as-built rack configuration.

The following figure shows front panel views of a 903 remote and console module with typical card configuration.

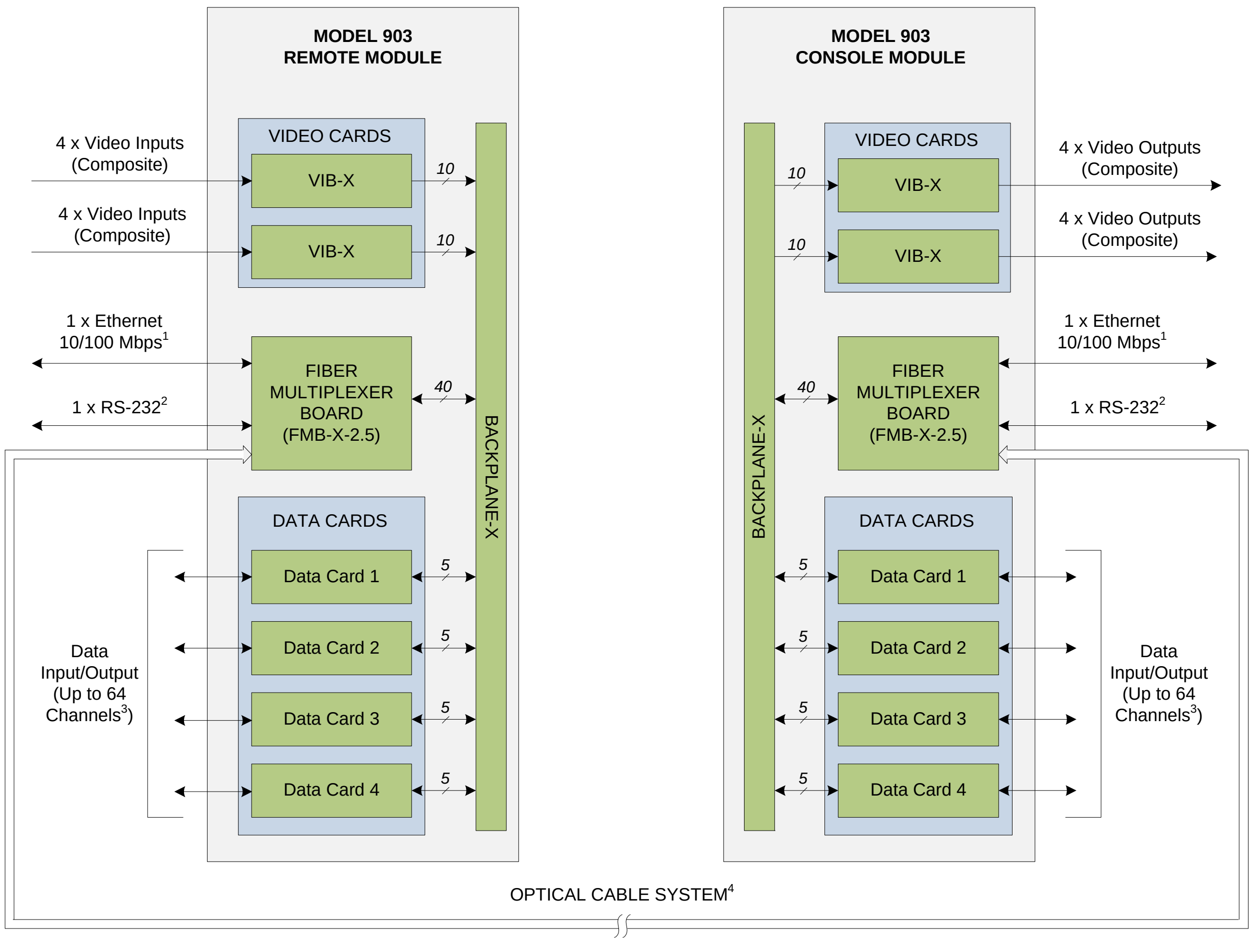


SLOT(S)	SLOT TYPE	CARD/MODULE NAME	DESCRIPTION
A,B	VIDEO	VIB-X	4 X VIDEO CARD
C	FMB	FMB-X-2.5	FIBER MULTIPLEXER BOARD "-X-2.5" VERSION
D	DATA	EIB-10/100	3 X 10/100 Mbps ETHERNET CARD
E	DATA	AIB-4	4 X DATA, ADAPTABLE INTERFACE BOARD
F	DATA	907-232E	8 X RS-232 907-232E CARD
G	PS	POWER SUPPLY	POWER SUPPLY UNIT
H	PS	SWITCH	POWER SWITCH PANEL ASSY (CONSOLE)

Figure 2.1-1: Model 903 Console & Remote Front Panel View – Typical Card Configuration

2.2 Electrical Configuration

The following figure shows the signal configuration of a Model 903 system. Each video card "pre-multiplexes" four video channels on 10 video lines to the FMB-X-2.5 resulting in 10-bit digitization for each video channel. Each data card slot has 5 lines on the backplane to and from the FMB-X-2.5. In total there are 20 data lines. Some data cards, such as the AIB-4, map a single data input to a single data line to the FMB-X-2.5. Other data cards, such as the CIB-10 and DIB-232-16, map several data channels to a single line to the FMB-X-2.5.



Notes:
1. System diagnostics is available via the 10/100 Mbps Ethernet port as Modbus TCP/IP or through an embedded web server. Diagnostic packets are handled as low priority and must be polled by the external computer. When accessed, diagnostic packets use up less than 0.1 % of the Ethernet channel capacity.
2. RS-232 port on the FMB-X-2.5 is for system diagnostics only.
3. Up to 64 data channels calculated using 4 x 16 high density RS-232 (DIB-232-16) cards.
4. Refer to “Optical Configuration” section of this manual for details about the optical configuration of the Model 903 system.

Figure 2.2-1: Model 903 Signal Configuration

2.3 Optical Configuration

Model 903 systems based on FMB-X-2.5 cards are provided in standard optical configurations with singlemode fiber and dual fiber connection for redundancy. Typical systems use 1310 nm as the uplink wavelength (remote to console) and 1550 nm as the downlink wavelength (console to remote), which are combined with a wavelength division multiplexer (WDM) on the FMB-X-2.5. Dual fiber configurations increase reliability with an integrated splitter at the remote FMB-X-2.5 and an automatic fiber switch at the console FMB-X-2.5, as shown in the figure below.

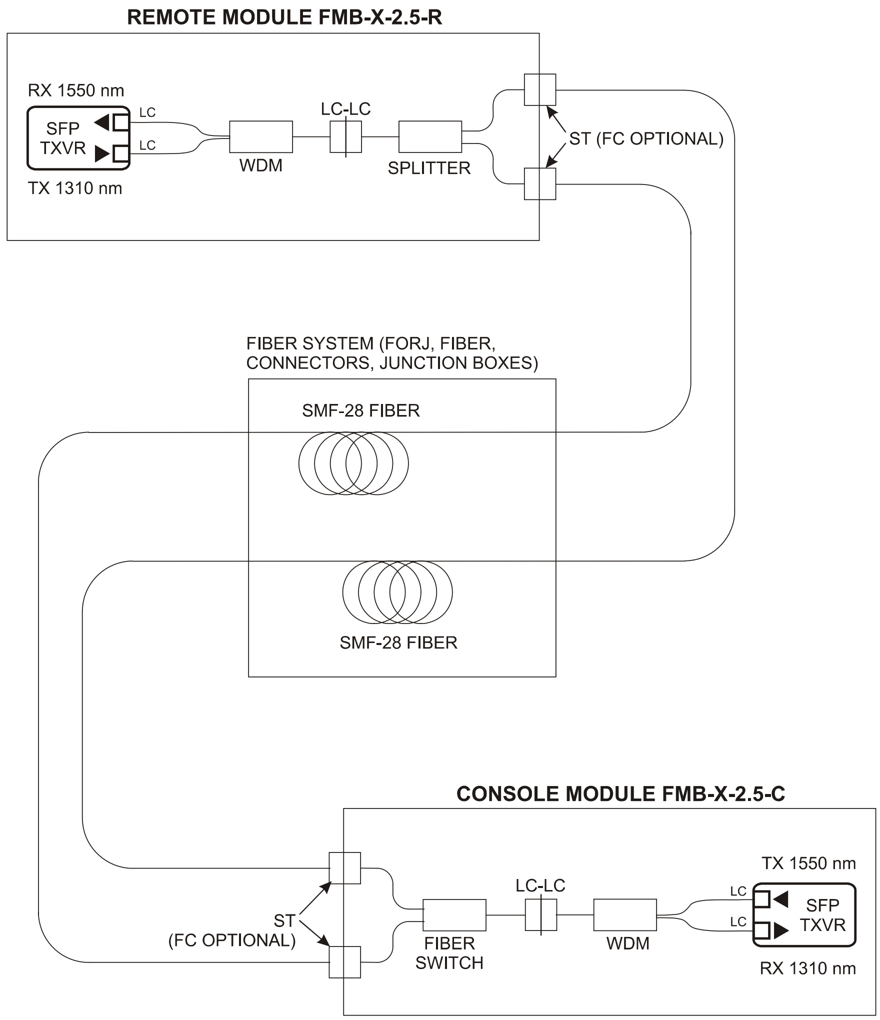


Figure 2.3-1: Model 903 Fiber Optic Transmission System

Standard FMB-X-2.5 cards use lasers with loosely controlled wavelengths that can vary significantly from unit to unit and over temperature. Since 1310 nm and 1550 nm are widely separated on the optical spectrum, there is no problem with crosstalk or interference even when the exact wavelengths are variable.

FMB-X-2.5 cards are also available with more carefully controlled wavelengths for use in multi-channel systems based on CWDM (Coarse Wavelength Division Multiplexing) or DWDM (Dense Wavelength Division Multiplexing). CWDM systems support 4 to 16 wavelengths; DWDM systems support 16 or more wavelengths. Both CWDM and DWDM enable the combination of two or more FMBs, plus other media converter cards, on a single optical fiber, allowing considerable expansion of the Model 903 video and data channel capacity.

CWDM wavelengths may be used to expand an existing Model 903 system by adding separate optical links, typically for high-speed sonar, Gigabit Ethernet or HD-SDI Video. Daisy-chaining media converter cards (cards with on-board optical transceivers using CWDM wavelengths) into the existing 1310/1550 nm optical link allow the upgraded system to continue operating on a single fiber. Media converter cards such as the ECL-02, EIB-10/100 (optical version) or HD-SDI may be installed in any data card slot.

The figure below shows an example of an expanded Model 903 fiber optic transmission system using media converter cards with CWDM wavelengths. In this example, the remote and console media converter cards are “daisy chained” into an existing 1310/1550 nm system and four wavelengths are used. The media converter card uses 1471 nm and 1491 nm wavelengths and the FMB-X-2.5 card uses 1310 nm and 1550 nm wavelengths. Note that the 903 system continues operating on a single fiber (second fiber is optional). Refer to section 6.0 for more information about the media converter cards available for Model 903 systems.

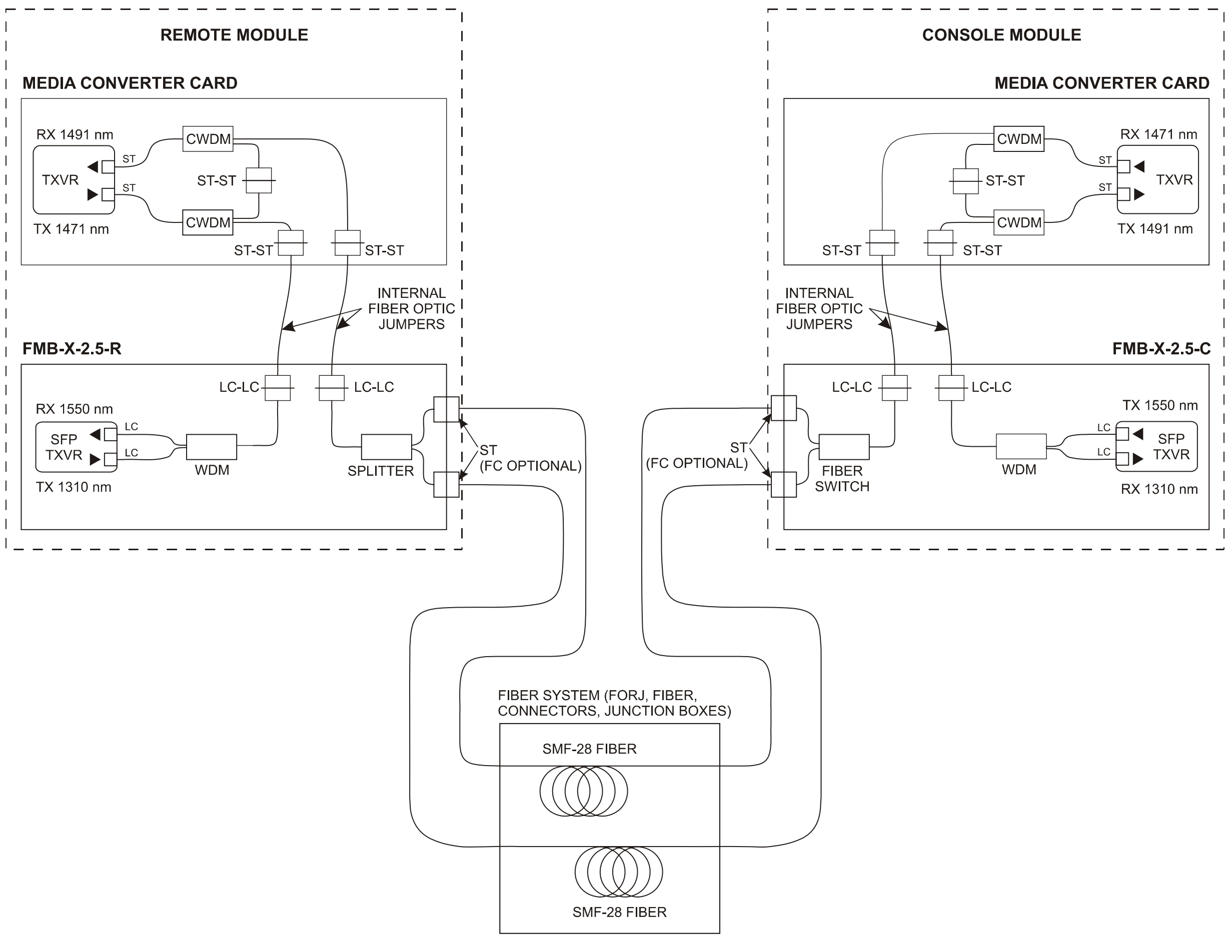


Figure 2.3-2: Model 903 Fiber Optic Transmission System Expanded

Systems that require more than four wavelengths must use a dedicated CWDM card to combine all wavelengths. (Also all transceivers must be CWDM wavelengths.) Optical configuration drawings are provided for systems with more than two wavelengths.

3.0 Fiber Multiplexers and Backplanes

Fiber Multiplexer Boards (FMBs) are used to combine all of the video, Ethernet, and data signals into a single optical link and then regenerate the original copper signals at the other end of the system. Backplane cards are used to connect all of the Model 903 cards together within remote or console modules. A complete Model 903 system includes at least one remote and one console module.

3.1 FMB-X-2.5 Fiber Multiplexer Board

The FMB-X-2.5 cards use FPGA SERDES (Serializer/Deserializer) modules that run at an optical data rate of 2.5 Gbaud on both uplink and downlink. This high optical data rate allows more capacity for video, data and Ethernet traffic than older FMBs. FMB-X-2.5 cards are designed to work only with singlemode fibers to support the high data rates. System diagnostics can be accessed via the RS-232 port or RJ-45 Ethernet port of both remote and console FMB-X-2.5 cards. More information about diagnostics is provided in Appendix D and the diagnostics manual (P/N 903-0622-00).

Note: The FMB-X-2.5 FPGA-based SERDES optical link is not backwards compatible with FMB-VTX, FMB-VRX or GLINK FMB-X cards. More details about upgrading to FMB-X-2.5 are found in Appendix C. Details on the GLINK-FMB-X cards are given in Appendix D.

3.1.1 Remote FMB-X-2.5

Card P/N 903-5082-00

The front panel view of the remote FMB-X-2.5 is shown in the figure below. Redundant ST fiber connectors are accessible on the right angled turret. An internal splitter provides roughly equal power output levels on both ST connectors. Output power should be greater than -6 dBm at 1310 nm (uplink). Receive sensitivity at the turret should be better than -26 dBm at 1550 nm (downlink). Front panel LEDs provide critical status indicators described in detail in section 3.1.2.

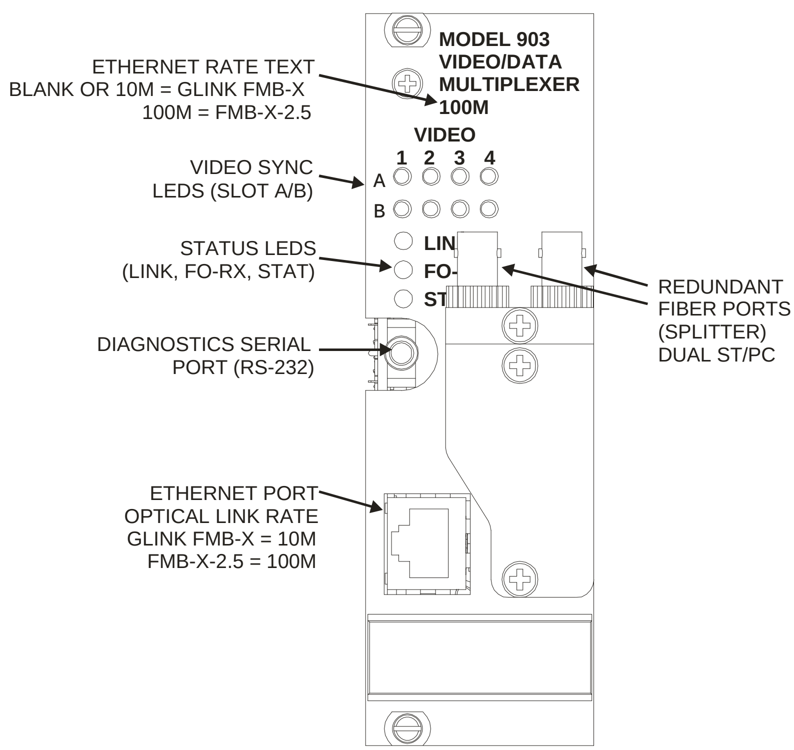


Figure 3.1-1: Remote FMB-X-2.5 Front Panel View

LEDs on the front panel match those described in the console FMB-X-2.5 section and allow direct monitoring of the optical link status (LINK), optical receive power (FO-RX), and the status (STAT) of the on-board diagnostics. See the console FMB-X-2.5 section for more details on LEDs.

The Ethernet port supports both 10 Mbps and 100 Mbps devices on the copper link. The optical Ethernet link through the multiplexer is 100 Mbps.

Diagnostics for the FMB-X-2.5 can be accessed at the RS-232 port on both remote and console cards, and also via the RJ-45 Ethernet port at both remote and console ends. See console FMB-X-2.5 for more information about diagnostics.

A plan view of the remote FMB-X-2.5 is shown in the figure below. The 1310/1550 nm singlemode WDM coupler and 1 x 2 splitter are not visible: both are mounted on the underside of the optical daughtercard below the two dual LC bushings shown.

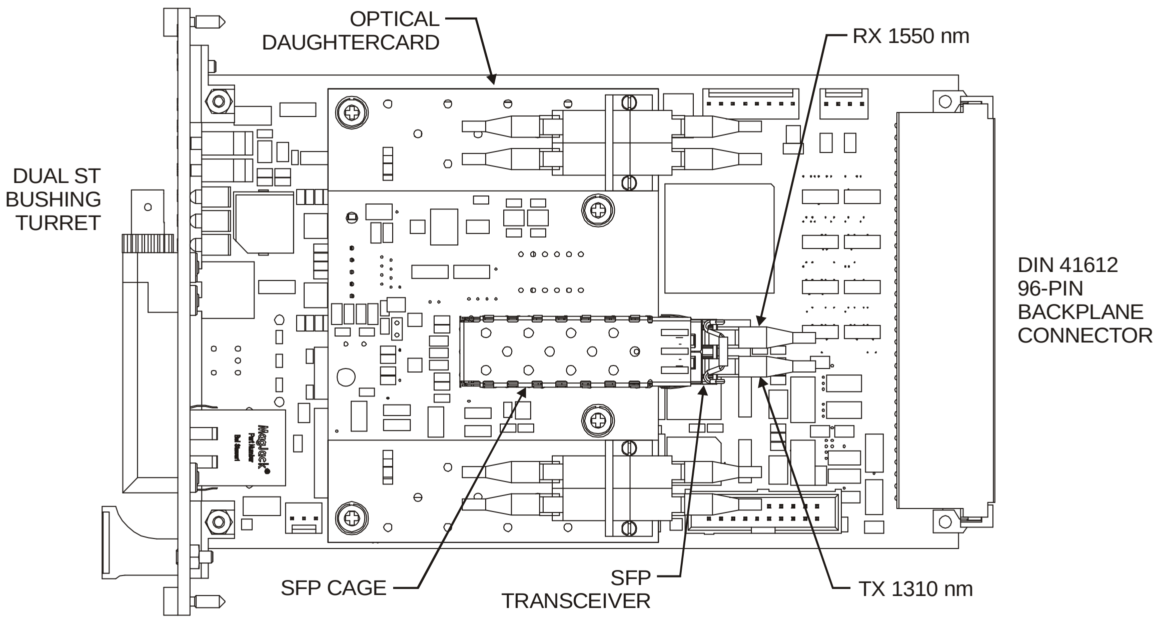


Figure 3.1-2: Remote FMB-X-2.5 Plan View

No customer switch settings are required for configuration of the FMB-X-2.5 remote card. All video channels are handled at 10-bit digitization and all data slots are sampled as “high speed” slots, similar to slot “D” on older 903 systems.

3.1.2 Console FMB-X-2.5

Card P/N 903-5083-00

The front panel view of the console FMB-X-2.5 is shown in the figure below. Redundant ST fiber connectors are accessible as straight bushings on the front panel marked "F1" and "F2". An internal fiber switch chooses one of the fibers for the optical link, either automatically or manually via the front panel toggle switch. Output power should be greater than -2 dBm at 1550 nm (downlink). Receive sensitivity at the front panel should be better than -28 dBm at 1310 nm (uplink).

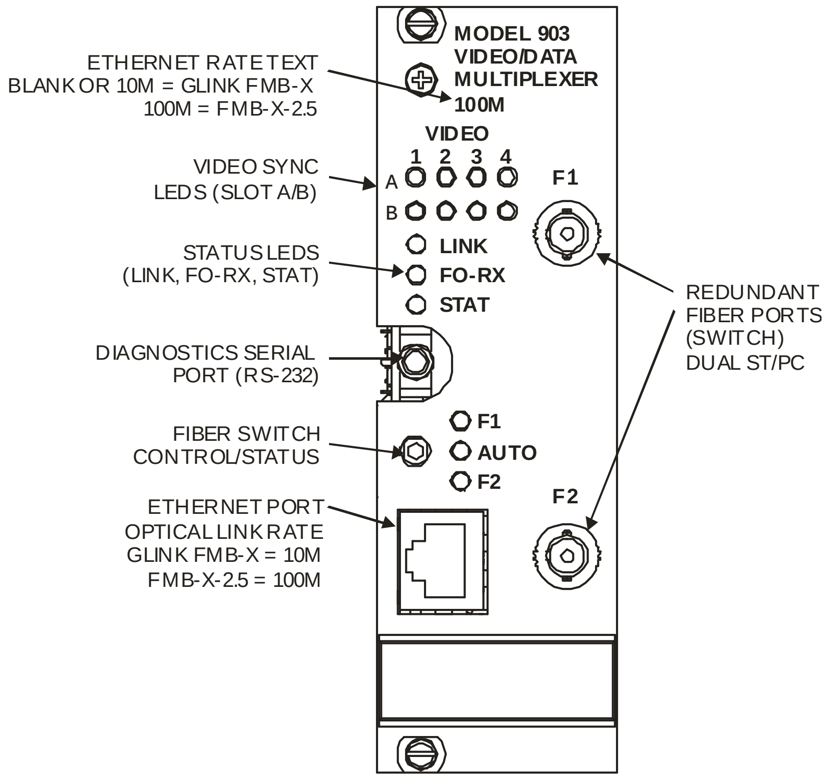


Figure 3.1-3: Console FMB-X-2.5 Front Panel

LEDs on the front panel of the remote or console FMB-X-2.5 provide status of video channels, optical link, and card health per table below.

Table 3.1-1: FMB-X-2.5 Front Panel LEDs

LED	Description
VIDEO	VIDEO LEDs are green when video sync is detected on each video channel from slot A and slot B in the rack.
LINK	LINK LED is green when a valid optical link is being received and red if no link is present.
FO-RX	FO-RX LED is green when the received optical power is well above threshold. This LED will change to orange (warning), indicating low margin, or red (alarm), indicating low optical power. Problems with optical power should be investigated using the diagnostic software and/or fiber optic power meters.

LED	Description
STAT	STAT (Status) LED is green when on-board diagnostic readings are within expected values. The STAT LED is orange (warning) if any of the on-board diagnostic readings are close to an alarm state. The STAT LED is red (alarm) if any of the on-board diagnostic readings are outside of the specified range, in which case the diagnostic software should be used to troubleshoot the problem. Monitored signals included temperature and all major voltage rails (+12V, -12V, +5V, and +3.3V). An alarm state exists if any voltage is worse than ±20% of nominal value or temperature is > +80C. A warning state exists if any voltage is worse than ±10% of nominal value or temperature is > +75C, but the reading is not in an alarm state.
F1/F2	F1/F2 LEDs indicate which fiber is active, per the marked ST bushings. The active fiber is shown by the green LED. (Toggle up forces the fiber switch to F1 and toggle down forces it to F2.) The LED(s) will turn red if no link is present.
AUTO	AUTO LED is green when the fiber switch is in automatic mode, as determined by the toggle switch position. When in automatic mode and there is no link, this LED will be red.

Diagnostics are available at the 1/8" (3.5 mm) stereo jack in RS-232 format compatible with the standard Model 903 Diagnostics GUI software, e.g. 903-0406-00. Wiring for the RS-232 connections is shown in the table below.

Table 3.1-2: RS-232 Diagnostic Port Connections

Stereo Jack Pin	DB-9F pin	Function
1 (Tip)	3	TXD
2 (Middle Ring)	2	RXD
3 (Base Ring)	5	SIG GND

The function described in the table above is relative to the PC, i.e. TXD is data transmitted from the PC to the FMB-X-2.5 and RXD is data received into the PC from the FMB-X-2.5. This RS-232 interface also has command based diagnostics, which provides advanced diagnostics information. See 903-0622-00 diagnostic manual for more information.

Diagnostics are also available via the RJ-45 port as Modbus TCP/IP or through an embedded web server. Since this port is also used for general Ethernet traffic between remote and console, diagnostics packets are handled as low priority and must be polled by the external computer. When accessed, diagnostic data packets typically use up less than 0.1% of the Ethernet channel capacity.

The fiber switch may be placed in automatic mode or forced to fiber F1 or F2 using the front panel toggle switch. In automatic mode, with the toggle switch in the center position, the FMB-X-2.5 tests both fibers on initial power up and chooses the one with the highest optical power. This will stay locked until the switch is forced to the other fiber, via the toggle switch, or link is lost on the active fiber. The LED by F1 is green when that fiber is active – the same applies to F2. The LED marked "AUTO" is green when in automatic switching mode.

When the optical link is lost, in auto mode, the switch toggles automatically roughly once per second between F1 and F2 for up to 10 times. If no link is found, the switch returns to the original fiber it was on before the link failure and waits for a link to be re-established. In this state, the “AUTO”, “F1” and “F2” LEDs are red and a continuous audible alarm is produced until a fiber link is restored. Power cycling or manually forcing the toggle switch to a fiber (F1 or F2 position) and then back to AUTO will reset the automatic fiber switch.

The FMB-X-2.5 also sounds a continuous audible alarm when an optical link fails in AUTO mode, even if the other fiber has a valid link. This informs the operator of a fiber fault that otherwise might not be noticed, as the switchover from one fiber to the other is often seamless. The alarm can be turned off by briefly forcing the toggle switch to the active fiber in manual mode and then back to the automatic setting. The FMB-X-2.5 alarm can also be disabled via software commands.

A plan view of the console FMB-X-2.5 is shown below. The 1310/1550 nm singlemode WDM coupler is not visible and is mounted on the underside of the optical daughtercard below the dual LC bushings shown.

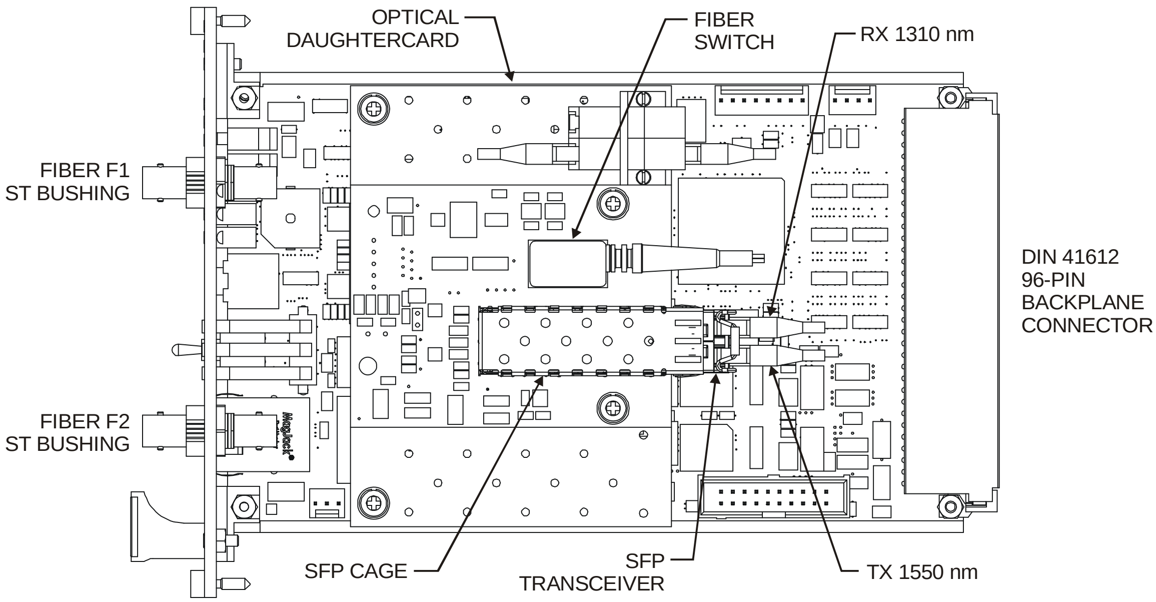


Figure 3.1-4: Console FMB-X-2.5 Plan View

3.1.3 Configuration Settings

Switch configuration settings for the remote and console FMB-X-2.5 cards are given in Table 3.1-3 and Table 3.1-4. Note that both DIP switches (SW1 and SW2) are typically configured at the factory and therefore the settings should never be changed from their original positions.

Table 3.1-3: SW1 Configuration Settings

Description	SW1:1	SW1:2	SW1:3	SW1:4
Remote FMB-X-2.5	ON	ON	ON	ON
Console FMB-X-2.5	OFF	ON	ON	ON

Table 3.1-4: SW2 Configuration Settings

Description	SW2:1	SW2:2	SW2:3	SW2:4
High Density Backplanes	OFF	ON	OFF	OFF
Standard Backplanes	OFF	OFF	OFF	OFF

3.2 Backplanes -X

Card P/N 903-72XX-00

The "-X" backplane cards are used to connect all the Model 903 cards and modules together to make up a Model 903 system. The -X backplanes provide diagnostic capabilities that are used to monitor the overall status of the system.

A variety of -X backplanes are available with various combinations of video, data and power slots. Typically each video and data slot occupies a standard 0.8" (4HP) width in the card cage. The FMB-X-2.5 and power supply slots are 1.6" (8HP) wide. Boards are referenced by location within the rack in relation to the FMB-X-2.5 slot. There are no addresses to set on a backplane -X board, and each board can be interchanged with another of the same type assuming jumper settings are identical. Slots are generally identified by letter in the installation drawings, where slot C is normally reserved for the FMB-X-2.5, slots A and B are for video cards, slots D, E or D, E, F, or D, E, F, G are data slots, and the last slot, if present, is for the power supply.

Table 3.2-1 below shows typical rack sizes and -X backplanes used to make up a Model 903 system. The three digits following the CBP- designator represent the number of video, data, and PSU slots respectively. An "R" in the suffix indicates the remote rack and a "C" in the suffix indicates the console rack, which is generally 6 HP wider to accommodate a front panel power switch. Custom rack sizes are also available. Remote racks that do not have a PSU slot have a DC-DC converter mounted on the back cover plate.

Table 3.2-1: Typical Rack Sizes and "-X" Backplanes

"-X" Rack Type	Number of Slots			Rack Width	
	Video	Data	PSU	Remote	Console
CBP-241-XR/XC	2	4	1	44 HP	50 HP
CBP-231-XR/XC	2	3	1	36 HP	42 HP
CBP-230-XR	2	3	0	28 HP	N/A
CBP-121-XR/XC	1	2	1	28 HP	28 HP
CBP-100-XR	1	0	0	12 HP	N/A
CBP-200-XR	2	0	0	16 HP	N/A
CBP-240-XR	2	4	0	32 HP	N/A

Assembly views of a 28 HP backplane -X PCB (CBP-121-XR/XC) and a 44 HP backplane -X PCB (CBP-241-XR/XC) are given in Figure 3.2-1 and Figure 3.2-2 respectively. The bottom side of the backplane faces outwards from the assembly and is accessible by removing the back cover plate. Fuse F1 is a standard replaceable glass cartridge type for the primary power input (fuse value depends on type of power supply). Header J15 is a serial number programming port; J1 is a port for an optional video switching harness; J13 is a connector to the chassis fan. Rail voltages and grounds are directly accessible via screw terminals J18, J19, J9, J17, and J10 for +12 V, -12 V, +5 V, AGND (analog ground), and DGND (digital ground) respectively.

Primary power inputs are wired into screw terminals:

- J16 is not connected for AC sources and acts as the 0V reference for DC sources
- J12 is neutral for AC sources and is not connected for DC sources
- J11 is line for AC sources and +V input for DC sources
- J14 is an earth connection that is made through the power supply module to the mechanical rack, but is otherwise isolated from all other grounds unless external connections are made

As a default configuration, AGND and DGND are connected on the backplane through a ferrite bead. Insulating covers are used over the primary terminals as a safety precaution and must not be removed while the rack is connected to mains power.

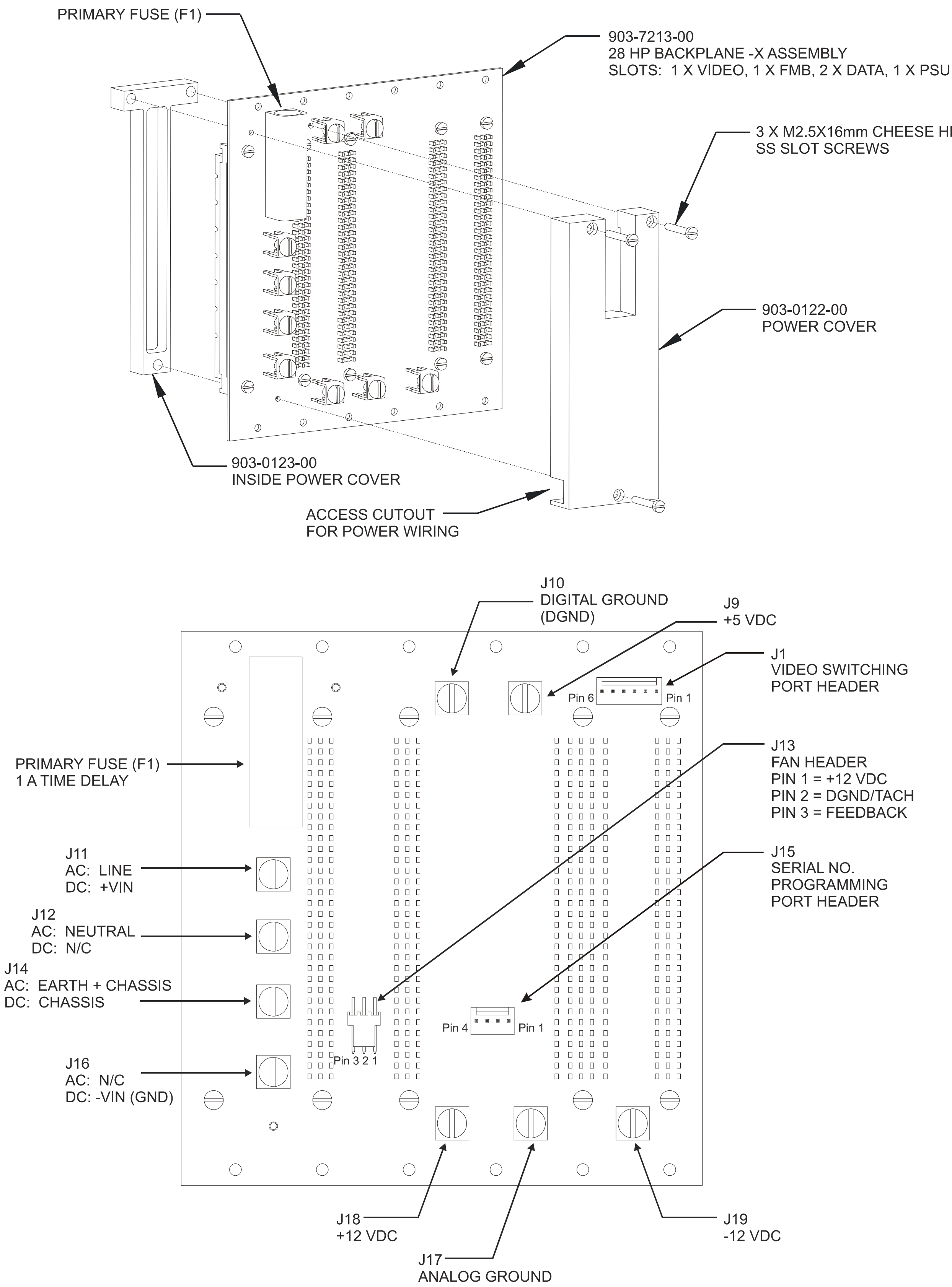


Figure 3.2-1: 28 HP Backplane -X (CBP-121-XR/XC)

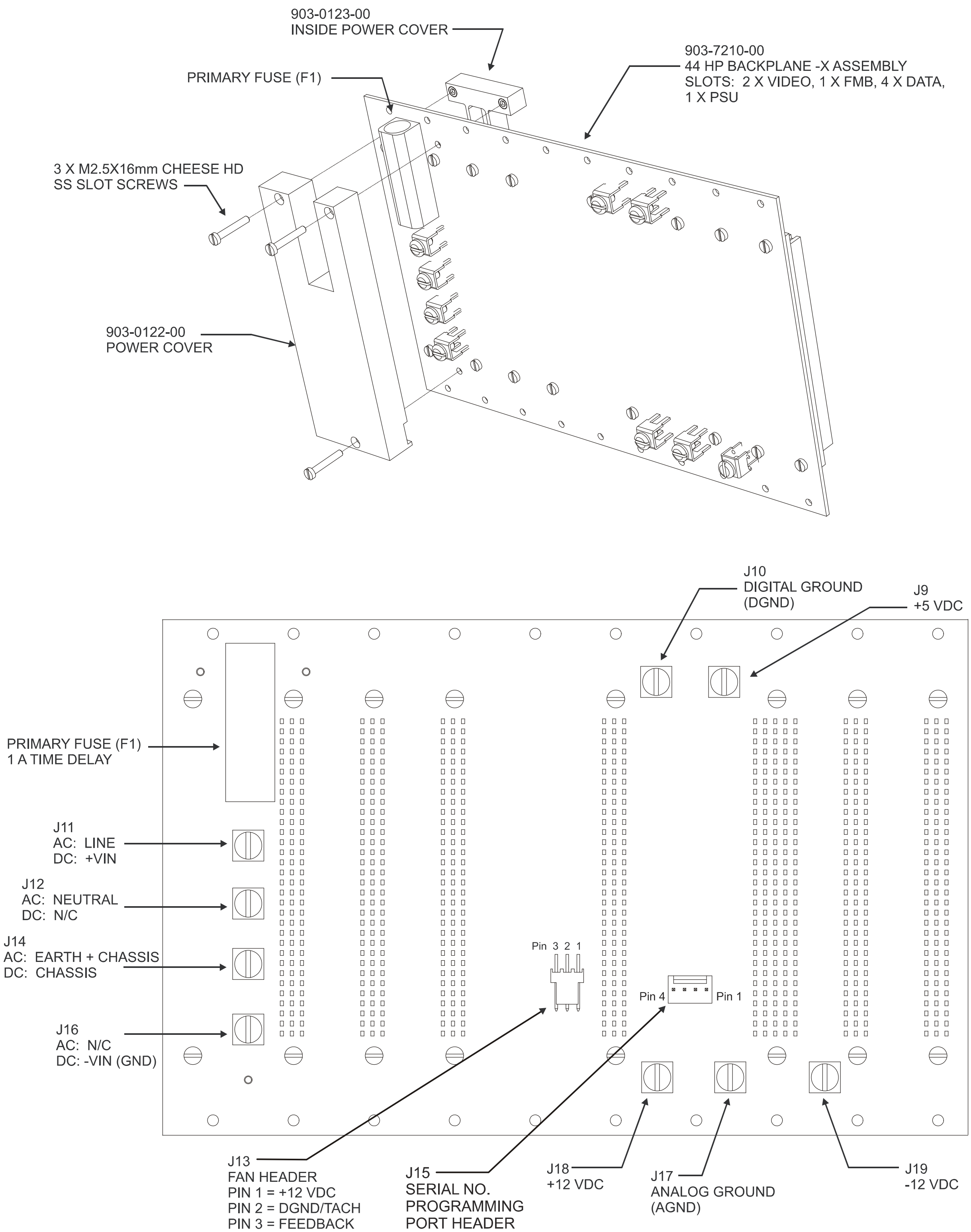


Figure 3.2-2: 44 HP Backplane -X (CBP-241-XR/XC)

3.3 Power Supply

The standard power supply is a 3U x 8HP Eurocassette with a 100 mm guiding height. The correct module is determined at the factory, per user's specification, in one of three possible configurations:

AC Module:	115-230 VAC, 50/60 Hz Auto-ranging
24 VDC Module:	Input range 18-36 VDC
48 VDC Module:	Input range 36-60 VDC

Standard DC power supply modules are available with 24 VDC or 48 VDC input. For other ranges, please contact Focal. Current draw from the primary 115 VAC for a typical console module is approximately 0.3 A. See Appendix B for fuse details.

The console module has a power switch on the far right panel and a detachable (IEC-320) power cord on the back cover plate. Status of the three internal rail voltages — +5 VDC, +12 VDC and -12 VDC — is represented by green LEDs located on the front panel of the power supply module. A flickering or dim LED indicates a problem with the corresponding rail voltage, possibly caused by an excessive load.

All standard Eurocassette power supplies provide full transformer isolation between the primary input and the backplane rail outputs. If AC input power is used, the protective earth lead on the power cable is connected through the Eurocassette frame to the rack of the multiplexer, which is normally isolated from internal digital and analog ground. If DC input power is used, the console module frame is floating. It may be connected to a ground reference with a short strap between the Earth terminal and the desired reference. Figure 3.2-1 and Figure 3.2-2 show the location of the Earth terminal (J14) for a 28 HP and 44 HP backplane -X respectively.

Some remote modules use DC-DC converters mounted on the back cover of the rack to reduce the overall width of the rack.

WARNING: RISK OF ELECTRIC SHOCK
To avoid risk of injury from electric shock, do not open the enclosure of the power supply module. Refer servicing to qualified personnel.

4.0 Video Cards

This section contains information about the video cards that can be used in a Model 903 system. Typically the video cards are inserted in slot A and slot B of the 903 rack.

4.1 VIB-X Video Board

Card P/N 903-0014-00 (Remote), 903-0015-00 (Console)

The VIB-X video interface board is a generic, 4-channel video card for use with Model 903 multiplexer systems.

The VIB-X cards are designed around an FPGA (Field Programmable Gate Array) connected to four input circuits for digitizing video channels and four output circuits for regenerating analog signals from the digital samples. Switch settings on the VIB-X select the code loaded into the FPGA on power up, which sets the front panel jacks as either video inputs or video outputs. Additional switches determine the formats of the input/output signals. Video signals are digitized in 10-bit samples at 15.625 MHz with FMB-X-2.5 cards.

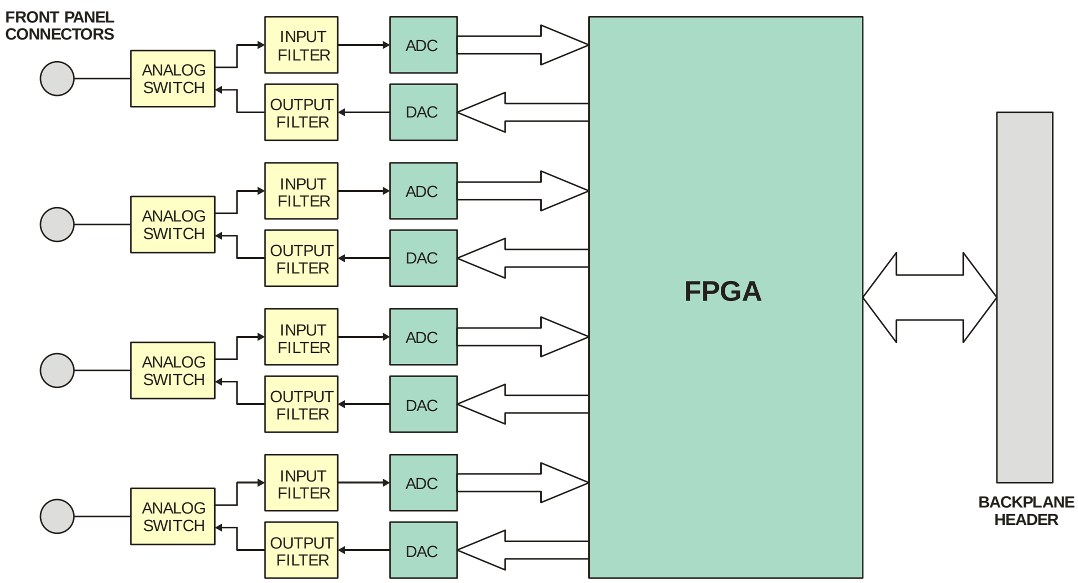


Figure 4.1-1: Block Diagram of VIB-X Card

The VIB-X video interface board is configured with four SMB video jacks on the front panel, per Figure 4.1-2. This 3U Eurocard is switch configured as either a video input card, used in the remote or subsea multiplexer module, or a video output card, used in the console or surface multiplexer module. The current setting can be verified by the front panel LEDs marked "Remote" or "Console" indicating whether the card is operating as a video input (remote) or video output (console).

Note: VIB-X cards shipped before August 2011 only support LED diagnostics but do not support enhanced diagnostics, which provides card serial number information and a video test pattern generator.

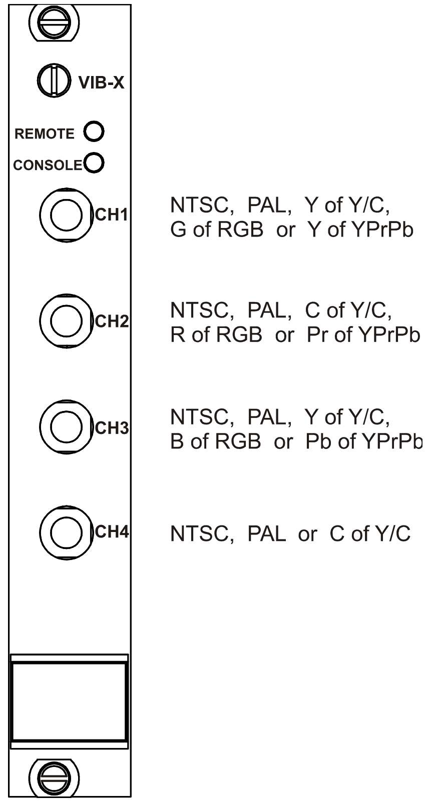


Figure 4.1-2: VIB-X Front Panel

The VIB-X replaces the older video cards VIB-TX and VIB-RX, including filter daughtercards, with a single assembly that is switch configured to behave as a VIB-TX card (video input) or VIB-RX card (video output). VIB-X cards are backwards compatible with the older VIB-TX and VIB-RX cards and may be paired with them for standard video signal formats. Although designed to take advantage of -X backplanes, VIB-X cards are also backwards compatible with older Model 903 backplanes. The only difference between the VIB-X versions of VIB-TX and VIB-RX cards is the factory switch setting.

4.1.1 Input/Output

VIB-X video inputs and outputs are compatible with standard composite signals (NTSC, PAL), Y/C or S-video formats, and component video formats RGB (sync on G) and YPrPb. Inputs and outputs have 75-ohm impedance with ESD protection and should be used with high quality, 75-ohm coaxial cables, such as RG-179. Mating connectors should be "Mini" 75-ohm SMB plugs, though 50-ohm SMBs are compatible and acceptable for video bandwidth signals. Inputs should be standard video levels, typically 1.0 to 1.2 Vpp. Signals will start to clip at 1.4 Vpp, and absolute maximum levels are 3 Vpp. Input bandwidth is limited to 6 MHz by anti-aliasing filters.

4.1.2 Configuration Settings

The VIB-X is configured as a remote (video input) or console (video output) using switch SW3, as shown in Figure 4.1-3 and Table 4.1-1. Circuit 1 is used to set the card as video input or output and circuit 2 is used for setting normal operation (mux mode, default) or for factory test options (test mode).

Table 4.1-1: VIB-X Card Configuration Settings (Switch SW3)

CCT1	CCT2	Description
ON	OFF	Remote Configuration (Video input, e.g. video signal from camera is connected to this card)
OFF	OFF	Console Configuration (Video output, e.g. video signal from this card is connected to a monitor)
ON	ON	Loop-Test Mode: Ch 1 In to Ch 3 Out; Ch 2 In to Ch 4 Out
OFF	ON	Loop-Test Mode: Ch 3 In to Ch 1 Out; Ch 4 In to Ch 2 Out

Input and output video formats are configured with switch SW1 per Table 4.1-2. Switch SW2 is not required for the VIB-TX and VIB-RX configurations of the VIB-X card, and all SW2 circuits should be in the OFF state. Note that in Y/C modes, “Y” (luma) must be connected to channel 1 to provide sync to “C” (chroma) on channel 2, and for dual S-video mode, “Y” must be connected to channel 3 to provide sync to “C” on channel 4. In RGB or YPrPb mode, the sync on “G” or “Y” must be connected to channel 1 to provide sync to channels 2 and 3. Switch configurations for video format on the remote and console video cards must match.

Table 4.1-2: VIB-X Input/Output Video Format Configuration (Switch SW1)

CCT1	CCT2	CCT3	CCT4	Description
OFF	OFF	OFF	OFF	All Composite (Channels 1, 2, 3, 4 = Composite)
ON	OFF	OFF	OFF	Single S-Video (Channels 1/2 = Y/C, Channels 3, 4 = Composite)
OFF	ON	OFF	OFF	Dual S-Video (Channels 1/2 = Y/C, Channels 3/4 = Y/C)
ON	ON	OFF	OFF	RGB Mode (Channels 1/2/3 = G/R/B, Channel 4 = Composite)
OFF	OFF	ON	OFF	YPrPb Mode (Channels 1/2/3 = Y/Pr/Pb, Channel 4 = Composite)

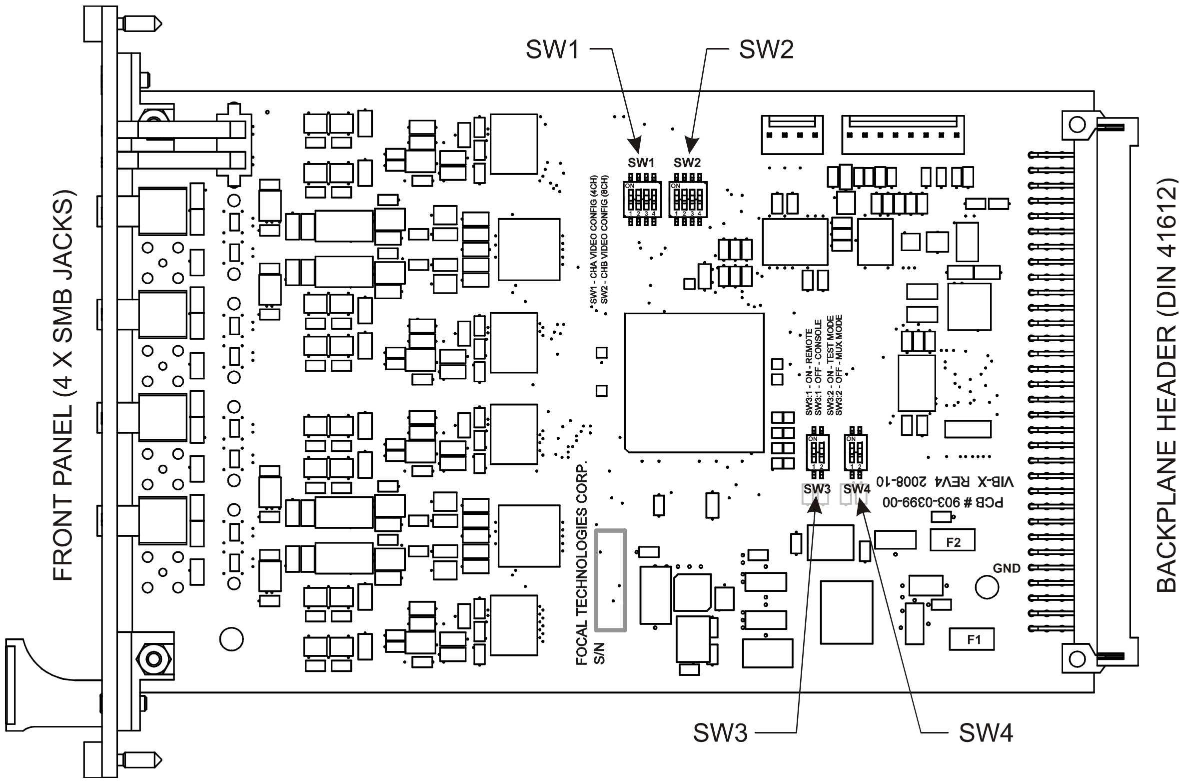


Figure 4.1-3: VIB-X Plan View

Fuses on the rails from the backplane provide over-current protection near the 96-pin DIN 41612 connector at the back of the card, per Figure 4.1-3. Fuse F1 is a 3A fuse on the +5 V supply rail and fuse F2 is a 1A fuse on the -12 V rail, which is used to generate -5 V on the board. These fuses are soldered in place and are not intended to be field replaceable, as any over-current fault sufficient to blow a fuse can potentially damage the VIB-X card. Cards with blown backplane fuses should be returned to Focal for assessment.

The sync status of each video channel is represented by the sync LEDs on the corresponding FMB-X-2.5 modules. Furthermore, for 903 systems that have both the FMB-X-2.5 and backplane -X cards, the diagnostics software at the surface can monitor the status of the remote VIB-X card, including input voltage overload flags, current video format configuration, and card assembly information, such as serial number. A black and white bar test pattern is also available on the VIB-X at either the remote or the console through the diagnostic software (command mode). This test pattern is generated in the FPGA and at the remote end this test pattern can be output at the front panel as well as to the backplane, and at the console end the test pattern can be only output to the front panel. Refer to FMB-X-2.5 diagnostics manual (P/N 903-0622-00) for more details.

Note that VIB-X cards do not support "non-video" signals on channel 4, as with older VIB-TX and VIB-RX cards. Typically the "non-video" signals were audio or special high speed sonar signals, which are now handled by other card types. Please consult Focal for any non-standard video signals or switched video configurations.

5.0 Data Cards

Data cards are typically bidirectional, with some exceptions. Most data cards are interchangeable between the remote and console module.

5.1 DIB-232 - RS-232 Interface Board

Card P/N 903-0016-00

The DIB-232 card is obsolete, and this section is for information only. RS-232 channels for new systems can be provided by other cards, such as DIB-232-16, AIB-4 and 907-232E.

The RS-232 Data Interface Boards (DIB-232) support bidirectional RS-232 signals. DIB-232 cards may be used at either end of the system in any available data slot. RS-232 signals are limited to 120 kbaud.

5.1.1 Input/Output

The five front panel connectors, as shown in Figure 5.1-1, are all three pin, right angle, 733 series WAGO connectors (mate: WAGO 733-103). All five channels are separately isolated and can operate to a maximum bit rate of 120 kbaud. All channels are protected by 250 mA fuses and transient voltage suppression diodes. One spare fuse is provided on the board. The black dot at the top of the front panel marks channel 1.

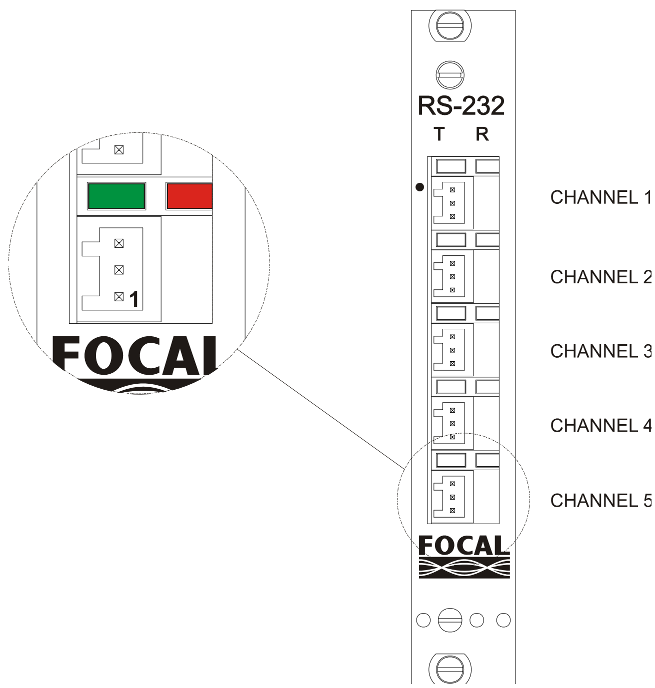


Figure 5.1-1: DIB-232 Front Panel

LED indicators are provided for each DIB-232 channel. **T** denotes data transmitted out of the DIB board's front panel connection as indicated by the green LED. **R** denotes data received by the DIB-232 board as indicated by the red LED.

5.1.2 Configuration Settings

Generally, the DIB-232 channels do not require any configuration settings. The boards may be factory configured for TTL signals on selected channels.

The pin-out convention for the WAGO connectors (733-103) used for each RS-232 channel is shown in Figure 5.1-2. The WAGO connectors should be used with wire gauges 20 - 28 AWG at a maximum current of 0.25A. Pin designations are given in Table 5.1-1.

Figure 5.1-2: RS-232 3-Pin WAGO Connector (733-103)

Table 5.1-1: Pin Designations for DIB-232 Connectors

Pin	Designation
1	Isolated Ground
2	RXD (Data to 903)
3	TXD (Data from 903)

A view of the DIB-232 PCB is given in Figure 5.1-3.

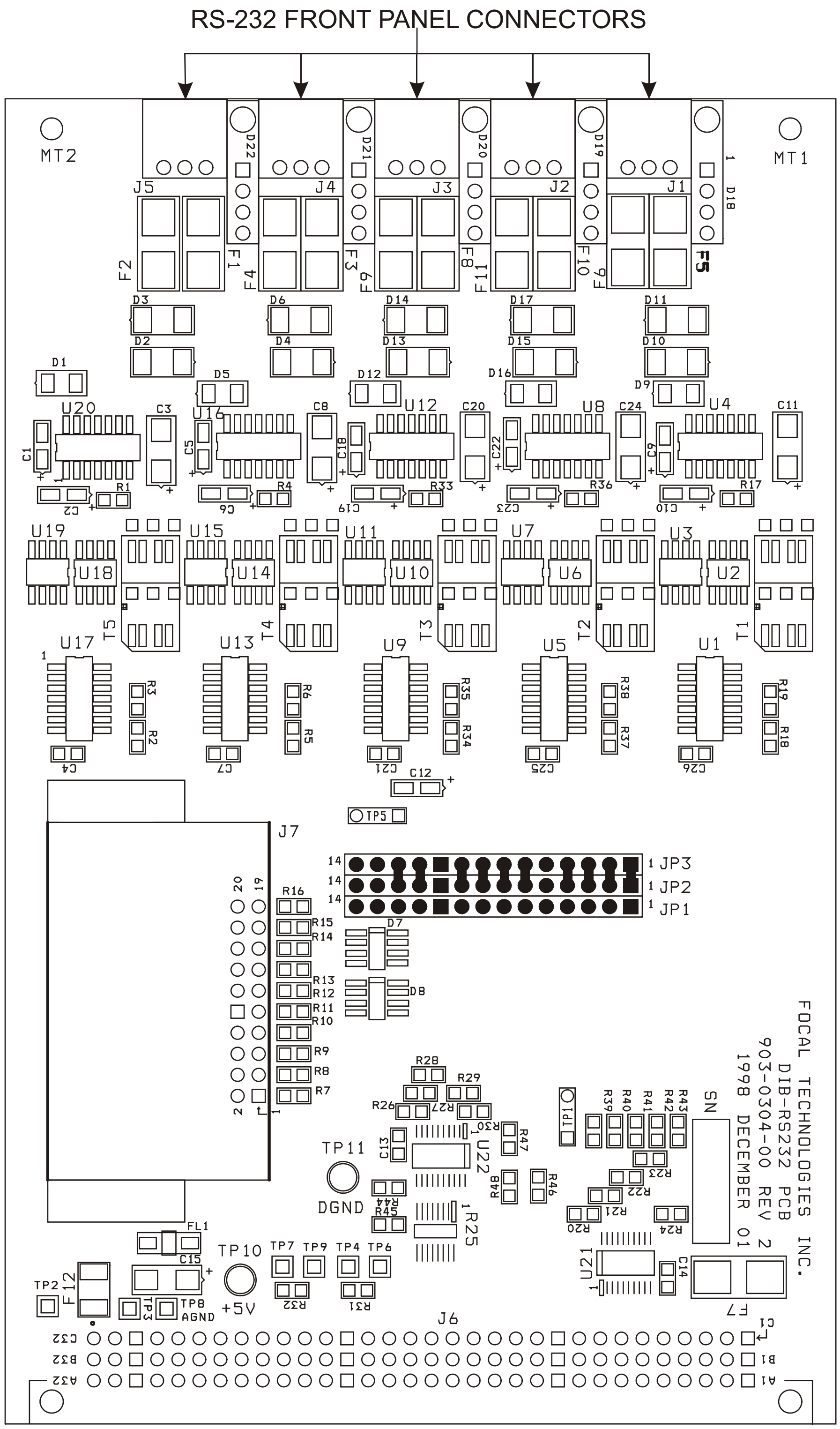


Figure 5.1-3: DIB-232 PCB

5.2 DIB-232-16 - High Density RS-232 Card

Card P/N 903-5020-00

The High Density RS-232 card (DIB-232-16) supports sixteen bidirectional channels of RS-232 data. Channels 1-8 are located on the motherboard; channels 9-16 are located on a daughtercard. The front panel connector is a high density, 62-pin D-subminiature type, as shown below in Figure 5.2-1. Pin connections are given in Appendix A.

Each channel includes pins for receive, transmit, and isolated ground, where receive data is defined as coming into the front panel of the Model 903 from an external device. Each channel is fully opto-isolated from the other channels and the internal digital ground of the Model 903.

Maximum RS-232 NRZ data rate is 115 kbps. Switch S1:1 should be set “off” (open) for correct operation with FMB-X-2.5 systems, which support high speed sampling on all data ports. Figure 5.2-2 shows the DIB-232-16 motherboard PCBA, including the location of switch S1. If the daughtercard is replaced for some reason, ensure that the alignment dot on the daughtercard matches the location of the alignment dot on the motherboard.

Options for breakout boxes and harnesses are available from the factory. For testing, mating pigtail harness is P/N 903-9002-02.

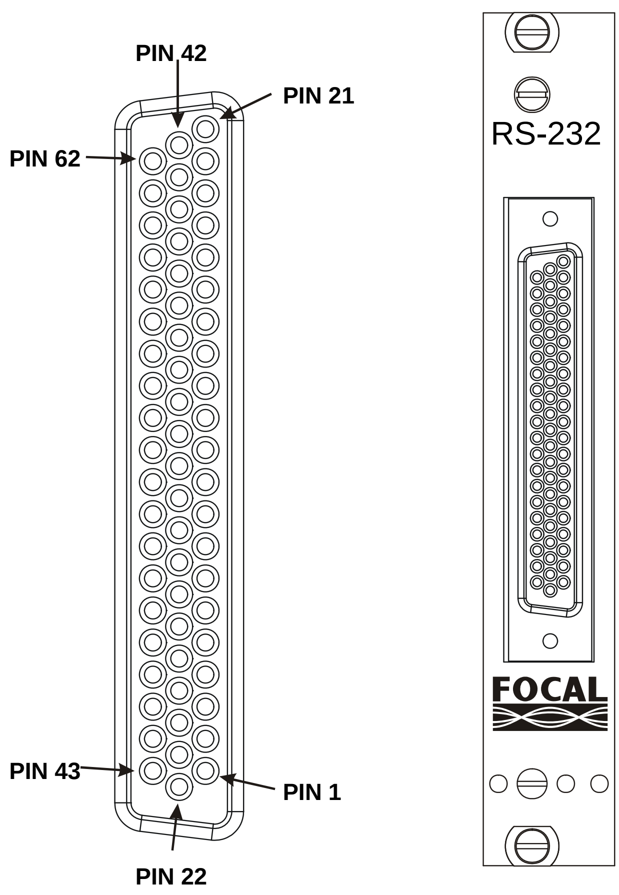


Figure 5.2-1: DIB-232-16 High Density RS-232 Board

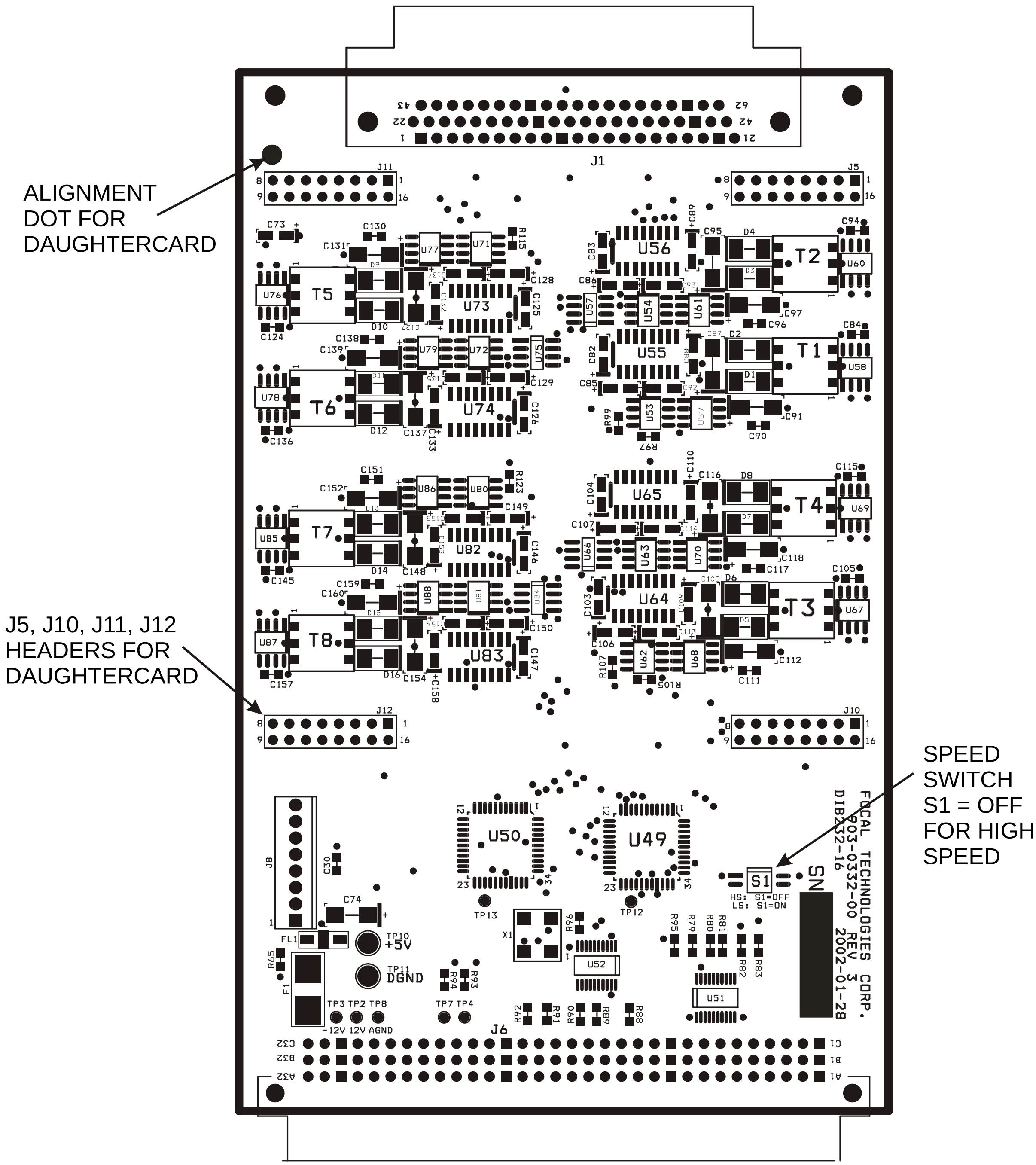


Figure 5.2-2: DIB-232-16 Motherboard (Daughtercard Not Shown)

Figure 5.2-3 shows a block diagram of the DIB-232-16 motherboard; Figure 5.2-4 shows the input/output schematic for channels 1 and 2. (The other 14 channels are identical.)

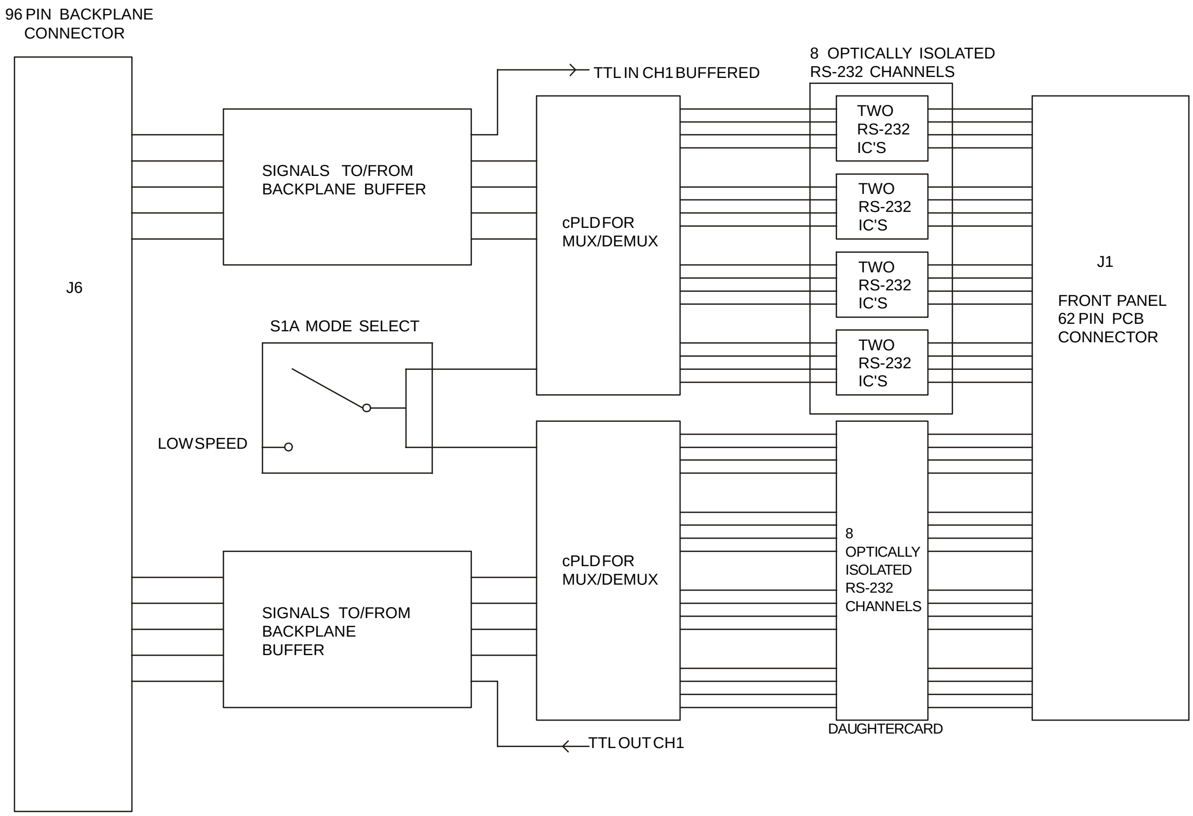


Figure 5.2-3: DIB-232-16 Block Diagram

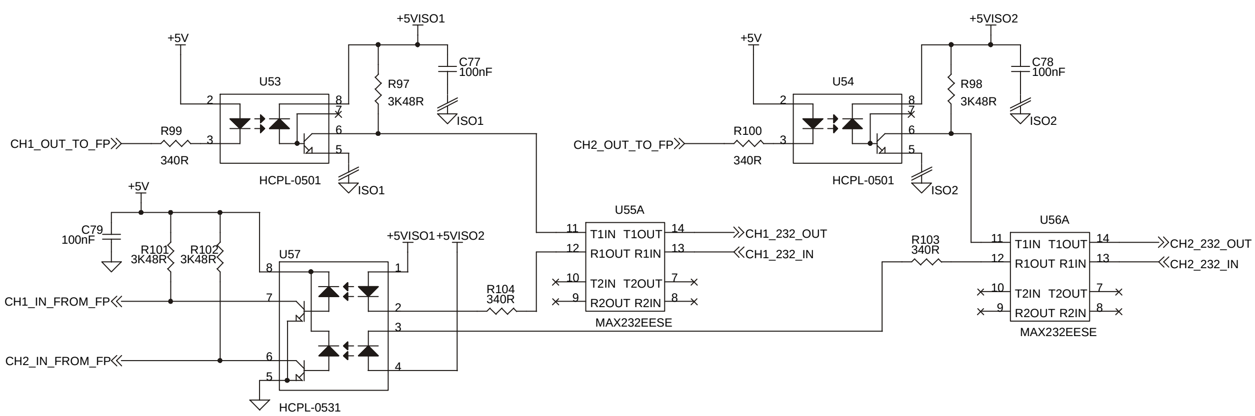


Figure 5.2-4: DIB-232-16 Input/Output Schematic (Channels 1 and 2)

5.3 DIB-485 - RS-422/485 Data Interface Board

Card P/N 903-0017-00

The DIB-485 card is obsolete, and this section is for information only. RS-422/485 channels for new systems can be provided by other cards, such as AIB-4 and 907-485E.

RS-422/485 Data Interface Boards (DIB-485) are compatible with several types of bidirectional RS-422, RS-485, and TTL signals. The DIB-485 cards are default configured with channels 1, 2 and 3 as RS-485 half duplex (autosense = 9600 baud) and channels 4 and 5 as RS-422. The DIB-485 cards may be installed at either end of the system in any slots available for data boards.

5.3.1 Input/Output

All lines of the five front panel connectors shown in Figure 5.3-1 are protected by 250 mA fuses and transient voltage suppression diodes. Channel 1, denoted with a black dot, is slew rate limited, which minimizes sensitivity to noisy lines while allowing operation at data rates up to 250 kbaud. Channel 1 may also be configured for compatibility with AC-coupled, or transformer-coupled, RS-485 used by such devices as Kraft manipulators.

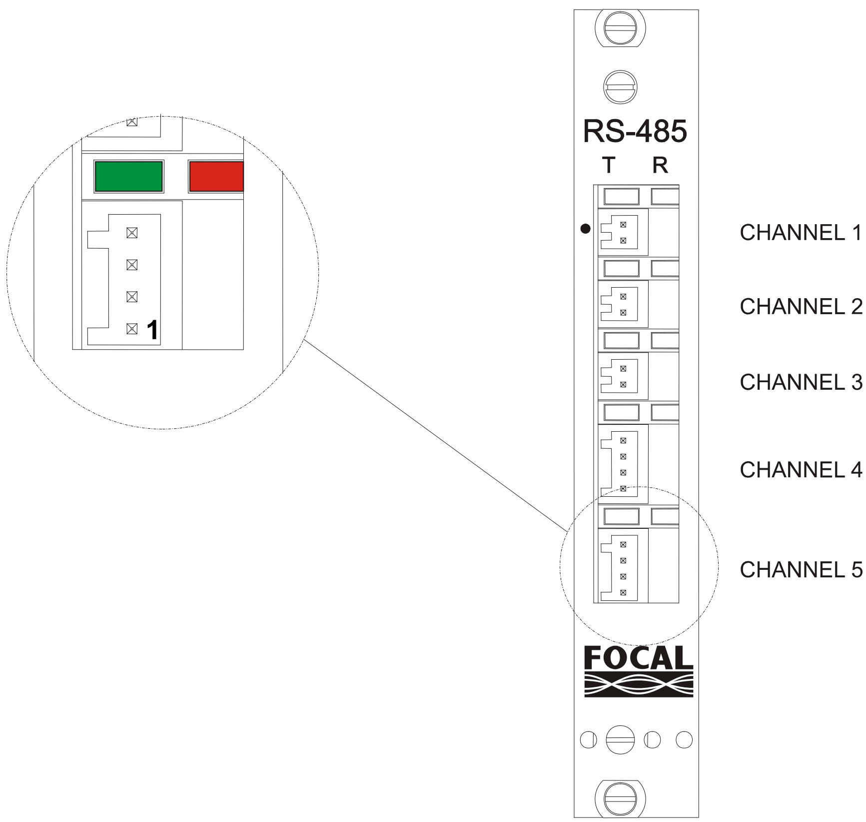


Figure 5.3-1: DIB-485 Front Panel

Channels 2 through 5 are not slew rate limited and can operate at asynchronous data rates up to 2.5 Mbaud. Channels 1, 2, and 3 are 2-wire RS-485 half duplex channels; channels 4 and 5 are 4-wire full duplex RS-422 channels, which can be configured as 2-wire RS-485 channels. Channel 5 can also be configured for TTL.

All channels have LEDs indicating data transfer: the red LED indicates data being received by the DIB channel and the green LED indicates data exiting the DIB channel at the front panel. Connectors are all right angle 733 series WAGO connectors. The full duplex channels use 4 pin connectors (mate: WAGO 733-104), and the half duplex channels use the two pin type (mate: WAGO 733-102). Channel configurations are given in Table 5.3-1. A view of the mating 2-pin and 4-pin WAGO connectors is given in Figure 5.3-2. The WAGO connectors should be used with wire gauges 20 - 28 AWG at maximum current of 0.25A.

Table 5.3-1: DIB-485 Channel Configuration

Channel	PCB Connector Designator	Description
1	J1	Half-duplex, DC or AC coupled
2	J2	Half-duplex
3	J3	Half-duplex
4	J4	Full-duplex or Half-duplex
5	J5	Full-duplex, TTL or Half-duplex

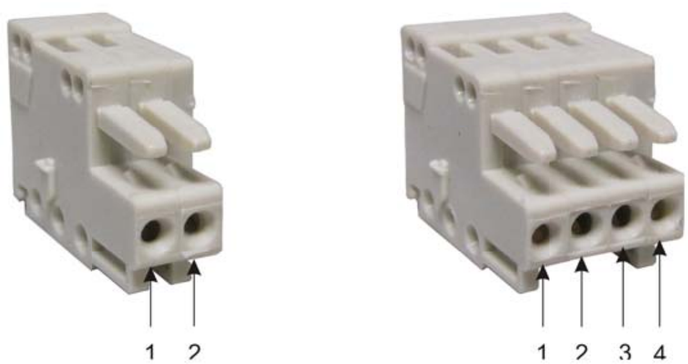


Figure 5.3-2: WAGO RS-422/485 data connectors

Table 5.3-2: WAGO Pin Designations

2-Wire (733-102)	4-Wire (733-104) RS-422	4-Wire (733-104) RS-485	4-Wire (733-104) TTL (CH5 Only)
Pin 1 = A +Tx/+Rx	Pin 1 = A +Rx	Pin 1 = A +Tx/+Rx	Pin 1 = INPUT
Pin 2 = B -Tx/-Rx	Pin 2 = B -Rx	Pin 2 = B -Tx/-Rx	Pin 2 = N/C
	Pin 3 = Y +Tx	Pin 3 = N/A	Pin 3 = OUTPUT
	Pin 4 = Z -Tx	Pin 4 = N/A	Pin 4 = ISOGND5

5.3.2 Configuration Settings

Channels 1-3 have the following possible settings: RS-485 autosense (half duplex), RS-485 unidirectional transmitter (simplex Tx), and RS-485 unidirectional receiver (simplex Rx). Channels 4 and 5 additionally have the option for RS-422 (full duplex, four-wire connection) and Channel 5 has the option for full duplex TTL. Configuration settings for the switches and jumpers are shown in Table 5.5-3. For DIP switches, a "1" indicates a switch is "on" or "closed" and a "0" indicates a switch is "off" or "open". For 2-pin jumpers, a "shunt" indicates the pins are connected with a shorting terminal and "open" indicates the shorting terminal is removed. For 3-pin jumpers, the table entry indicates which pins are shorted together.

The RS-485 autosense mode uses a timer circuit to automatically switch from transmit to receive mode. By default, a channel in autosense mode is a receiver waiting for data to come in through the front panel and switches to a transmitter when it gets data from the backplane. Once the RS-485 channel is in transmitter mode, it will wait ten bit times (one start bit, eight data bits and one stop bit) from the last positive data edge before reverting back to its default receiver state.

This half-duplex mode operates in a ping-pong fashion that must be supported by the end equipment. Although the circuit can sense data at a certain data rate and be either a receiver or a transmitter, the data being passed must be sent or received under timing conditions that inherently avoid collisions. (If a data collision does occur, transmission out of the front panel connector will override incoming data.) Autosense settings only affect half-duplex operation. Default settings for the autosense timer (9600 baud) are appropriate for most sonars, even when the sonar is operating at higher baud rates, since delays between sonar send and receive are typically many milliseconds.

A channel configured in simplex Tx or simplex Rx is a two-wire interface that is only designated to transmit or receive data. Tx is defined as Model 903 transmitting data out the front panel whereas Rx is defined as the Model 903 channel receiving data from an external device.

Table 5.3-3: DIB-485 Configuration Settings (Defaults Shaded)

CHANNELS 1, 2 and 3 MODE CONFIGURATION							
FUNCTION	**CHANNEL 1**			**CHANNEL 2**		**CHANNEL 3**	
	JP1	**JP2**	**JP3, JP4, JP5**	**JP6**	**JP7**	**JP8**	**JP9**
RS-485 Half Duplex (Autosense)	2-3	2-3	SHUNT	2-3	2-3	2-3	2-3
RS-485 Simplex Tx	1-2	1-2	SHUNT	1-2	1-2	1-2	1-2
RS-485 Simplex Rx	OPEN	OPEN	SHUNT	OPEN	OPEN	OPEN	OPEN
Kraft (AC RS-485)	2-3	2-3	OPEN	Not Applicable			
CHANNEL 4 MODE CONFIGURATION							
FUNCTION	**JP10**	**JP11**	**JP12**	**JP13**	**JP14**		
RS-485 Half Duplex (Autosense)	2-3	2-3	OPEN	SHUNT	SHUNT		
RS-485 Simplex Tx	1-2	1-2	OPEN	SHUNT	SHUNT		
RS-485 Simplex Rx	OPEN	OPEN	OPEN	SHUNT	SHUNT		
RS-422 Full Duplex	OPEN	1-2	SHUNT	OPEN	OPEN		
CHANNEL 5 MODE CONFIGURATION							
FUNCTION	**JP15**	**JP16**	**JP17**	**JP18**	**JP19**	**JP20**	**JP21**
RS-485 Half Duplex (Autosense)	2-3	2-3	OPEN	SHUNT	SHUNT	1-2	2-3
RS-485 Simplex Tx	1-2	1-2	OPEN	SHUNT	SHUNT	1-2	2-3
RS-485 Simplex Rx	OPEN	OPEN	OPEN	SHUNT	SHUNT	1-2	2-3
RS-422 Full Duplex	OPEN	1-2	SHUNT	OPEN	OPEN	1-2	2-3
TTL Full Duplex	OPEN	1-2	OPEN	OPEN	OPEN	2-3	1-2

AUTOSENSE BAUD RATE FOR SW1, SW2, SW3, SW4, SW5 DIP SWITCHES (SW1 = CH1, SW2 = CH2, SW3 = CH3, SW4 = CH4, SW5 = CH5)								
BAUD RATE CCT#	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
9600	1	0	0	0	0	0	1	0
19200	0	1	0	0	0	0	1	0
28800	0	0	1	0	0	0	1	0
57600	0	0	0	1	0	0	1	0
115.2K	0	0	0	0	1	0	0	1
≥230.4K	0	0	0	0	0	1	0	1
KRAFT (CH 1 only)	0	0	0	1	0	0	0	1

1 = ON = CLOSED, 0 = OFF = OPEN

JP22 and JP23 should remain shunted at all times. JP24 should have pins 1-2 shunted at all times. JP25 is a spare shunt.

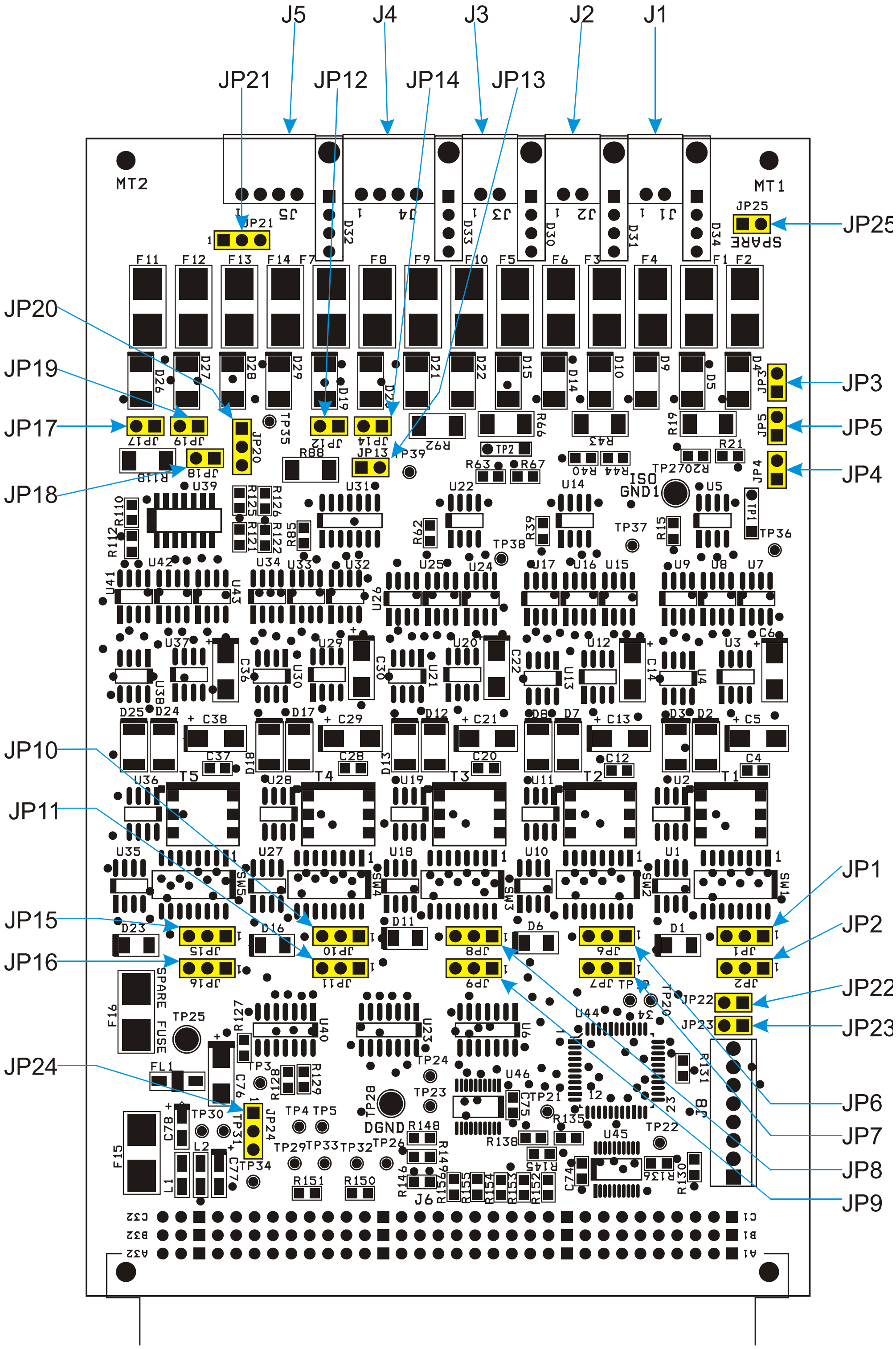


Figure 5.3-3: DIB-485 PCBA

5.4 CIB-10 Control Interface Board

Card P/N 903-5040-XX

The CIB-10 control interface board, as shown in Figure 5.4-1 below, provides 10 bidirectional independent control lines, also known as TOR (tout ou rien) channels. Each TOR input controls the corresponding output at the other end of the system. When the input is "on", the output solid state relay acts like a closed switch for a maximum of 24 VDC and 100 mA. When the input is "off", the output is in an open state.

TOR inputs are of two types: type 1 accepts voltage inputs (24 V = logic 1 = on; 0 V = logic 0 = off), type 2 inputs are self-powered, requiring a closed switch to turn "on" the corresponding output. Inputs are passed through opto-couplers; outputs are passed through photo-MOS "relays". Each input may be switch configured for Type 1 (voltage input) or Type 2 (switch input). Type 2 inputs share the same +5V isolated supply to drive the opto-couplers. All TOR outputs have completely isolated pins.

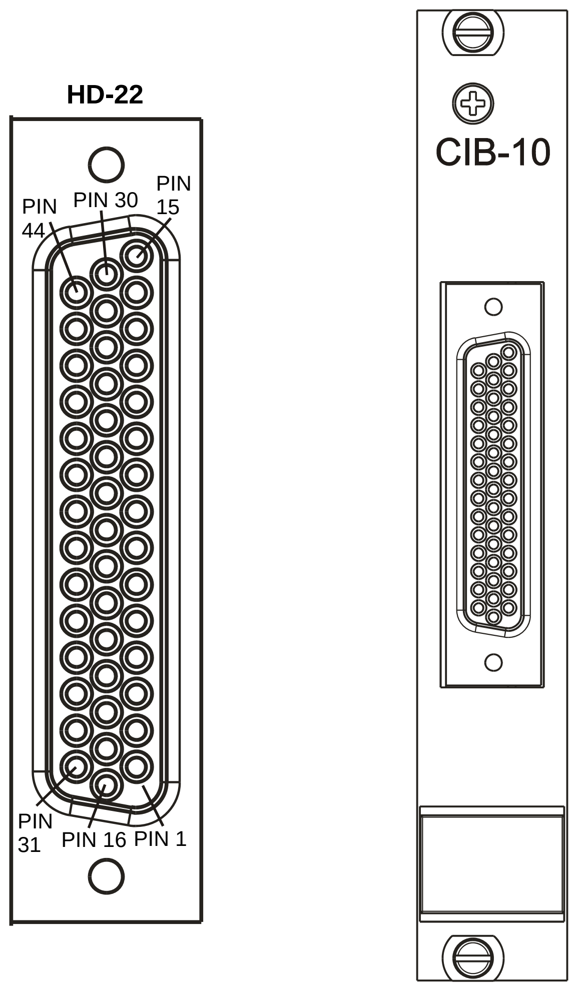


Figure 5.4-1: CIB-10 Front Panel

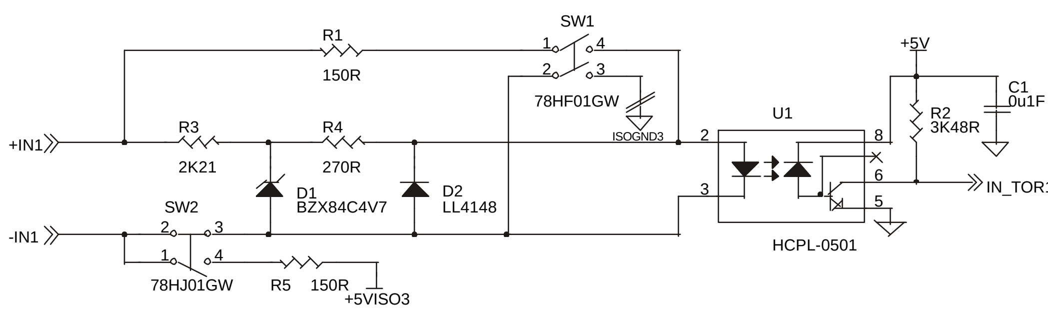
Schematics for channel 1 TOR input and output are shown in Figure 5.4-2, with the Type 1 (both dual switches open) shown. The other TOR channels are identical, where channel 2 input is configured by switches SW3 and SW4, channel 3 input is configured by switches SW5 and SW6, etc. Both switches must be “open” (off) for Type 1 and “closed” (on) for Type 2 configuration. Note that SW2, SW4, SW6... SW20 are single pole double throw (SPDT) switches with no common, where circuit 1 is “open” and circuit 2 is “closed”, or vice versa. Setting SW2, for example, to “open” refers to circuit 1 being open. Figure 5.4-2 shows SW1 and SW2 both “open” (off).

TOR inputs are polled at regular intervals by a microcontroller and encoded in a frame on a single 9600 baud data stream, which is sampled by the Model 903 multiplexer. The microcontroller at the other end of the system reads the demultiplexed 9600 baud data stream and sets the TOR outputs according to the encoded bits. Latency is less than 5 milliseconds.

Any time the Model 903 optical data link is lost, including initial start up, the TOR outputs are all set to the open state until the link is restored. If the receiving microcontroller detects errors in the frame, the outputs are set to open until an error-free frame is received.

Opto-couplers on the TOR inputs invert the incoming signal. This is compensated for by the microcontroller program, which translates low TTL inputs to high TTL outputs for the remainder of the Model 903 system.

TOR INPUT (TYPE 1 OR 2)



TOR OUTPUT

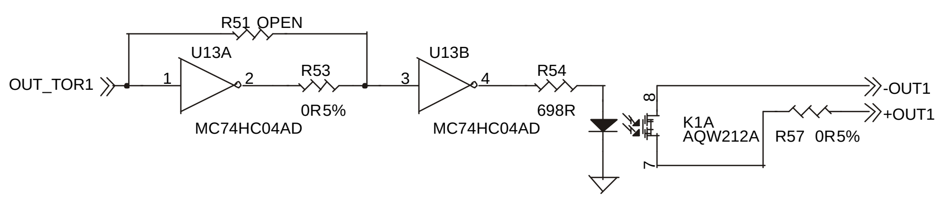


Figure 5.4-2: CIB-10 TOR Input and Output

Figure 5.4-3 shows a view of the CIB-10 PCBA with location of configuration switches.

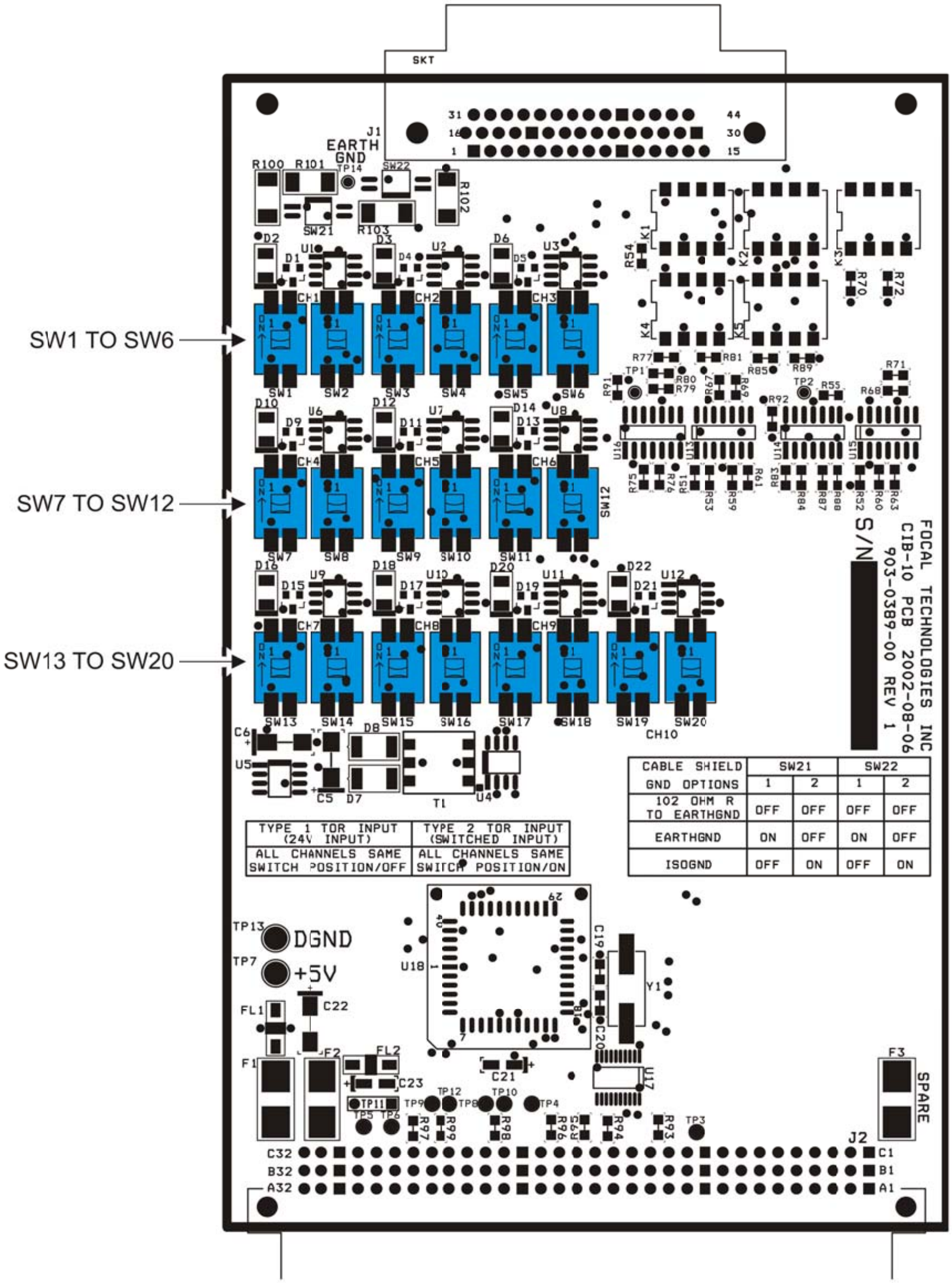


Figure 5.4-3: CIB-10 PCBA

Figure 5.4-4 below shows a block diagram of the CIB-10 board.

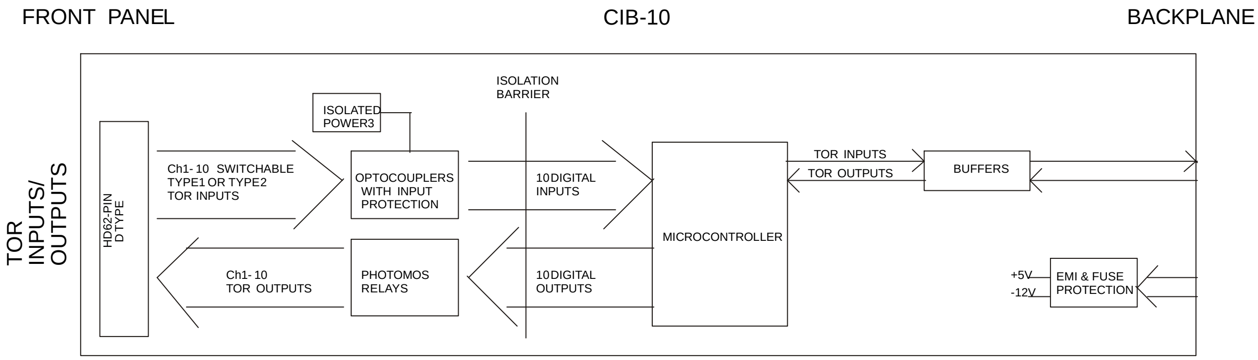


Figure 5.4-4: CIB-10 Block Diagram

Two pins are provided for shield connections: TOR In Shield = pin 41; TOR Out Shield = pin 42. Both of these pins may each be shorted directly to chassis ground or ISOGND3, which is the common ground for Type 2 inputs. The default configuration is with all shield switches open, as shown in Figure 5.4-5.

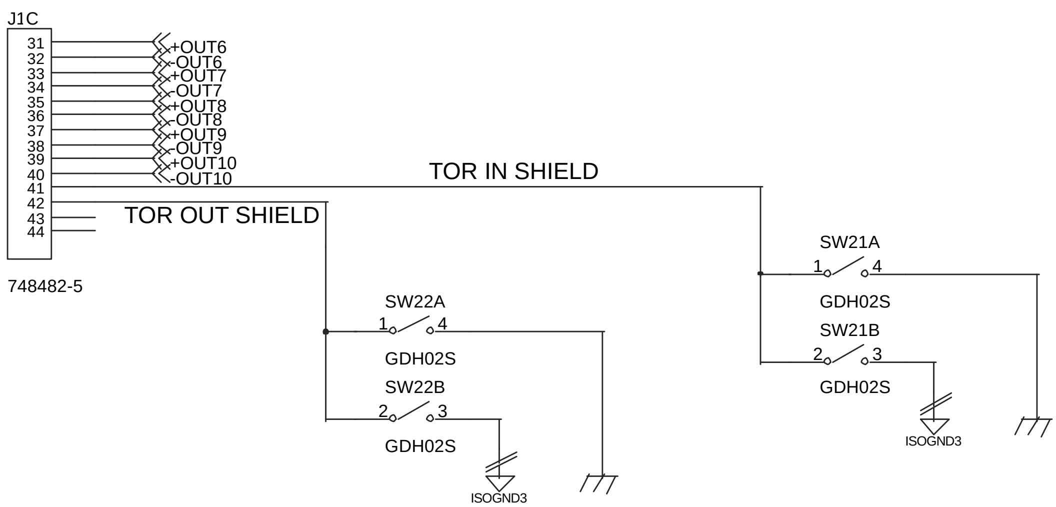


Figure 5.4-5: CIB-10 Shield Options

Pin designations for the front panel 44-pin connector are given in Appendix A.

5.5 EIB-10/100 Ethernet Board (Electrical Version)

Card P/N 903-5044-00

The EIB-10/100 Ethernet Interface Board provides three RJ-45 ports of 10Base-T (10 Mbps) or 100Base-TX (100 Mbps) Ethernet inputs to an internal switching hub (switch). Each port auto-negotiates the data rate and duplex mode of the input.

The EIB-10/100 Ethernet Board is available in two versions, one is electrical and the other is optical. This section provides information about the electrical version of the EIB-10/100. For information about the optical version of the card, refer to section 6.2. A front panel view of the card in Figure 5.5-1 shows pin and LED locations on the RJ-45 jacks.

Unlike simple repeating hubs, which copy all incoming packets on one port to all other ports, switching hubs have the ability to store and forward packets while controlling the flow of packets through each port independently. Unicast packets are forwarded to only one port, greatly improving network efficiency.

The EIB-10/100 card (electrical version) must be installed in a high speed data slot. All data slots on -X backplanes are high speed. On older systems only data slot 1 is high speed (typically data slot 1 is identified with the letter D in the installation drawings 903-8XXX-XX). Although the front panel RJ-45 ports are compatible with both 10 and 100 Mbps traffic, the backplane link operates solely in a full-duplex, 10Base-T compatible mode, which is linked to the opposite end of the multiplexer system via the FMB optical link. The electrical version of the EIB-10/100 cards may be operated over 10 km or more of optical fiber, albeit with the throughput of a full-duplex, 10 Mbps Ethernet link.

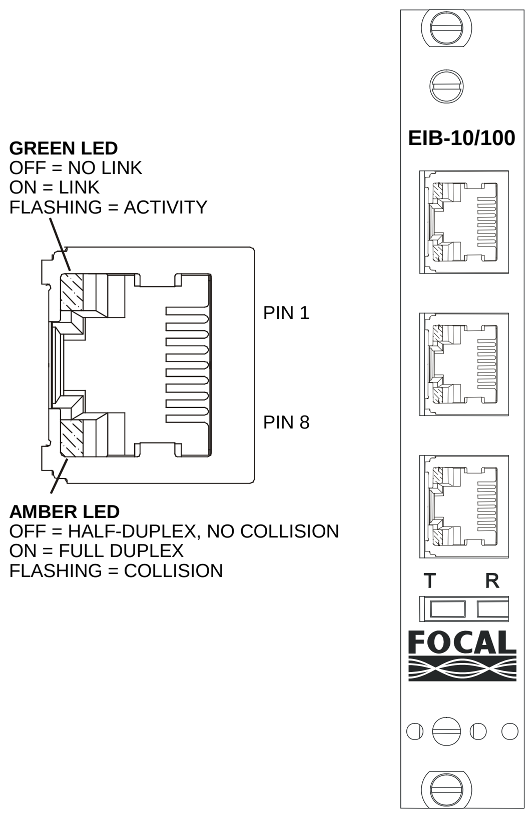


Figure 5.5-1: EIB-10/100 Front Panel

5.5.1 Input/Output

The three ports on the front panel accept industry standard RJ-45 UTP (Unshielded Twisted Pair) or STP (Shielded Twisted Pair) Cat 5e cables wired per EIA/TIA-568. All of the twisted pair ports are transformer-coupled to the internal switching hub, which has additional on-board filtering. Packets sent into one of the front panel ports will be routed by the switch only to the port associated with the matching MAC address, be it on one of the local ports or one of the ports at the other end of the system. (Broadcast and multi-cast packets are sent to all ports.) An internal 64 KB buffer is shared among all of the ports for storing and forwarding packets.

All front panel RJ-45 ports have auto-MDI/MDI-X configuration so that the jacks may be used with either "straight through" cables (wired to EIA/TIA-568B on both ends) or "cross-over cables (wired to EIA/TIA-568A on one end and EIA/TIA-568B on the other end). Auto-negotiation and auto-MDI/MDIX configuration are activated each time a new link is being established between the EIB-10/100 port and the external device, for example after power up or after changing a cable.

The pin assignments of the RJ-45 jacks are summarized in Table 5.1-1. Typically, the switch port should be in MDI configuration for connection to NICs (network interface cards) and in MDI-X configuration for connection to other repeating hubs and switches.

Table 5.5-1: RJ-45 Pin Assignments

RJ-45 Contact	MDI-X	MDI
1	TXD+	RXD+
2	TXD-	RXD-
3	RXD+	TXD+
4	Unused	Unused
5	Unused	Unused
6	RXD-	TXD-
7	Unused	Unused
8	Unused	Unused

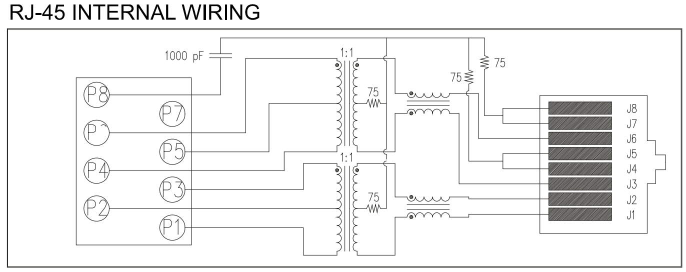
Table 5.5-2: EIB-10/100 Front Panel LEDs

LED	Description
Green (RJ-45)	The green LED on each RJ-45 jack is on when there is a link pulse present, indicating an external device is connected with a valid Ethernet link. The green LED flashes during packet transfers.
Amber (RJ-45)	The amber LED on each RJ-45 jack is on if the link is full duplex and off if the link is half duplex. When operating in half-duplex mode, the LED flashes when there is a collision. Normally the amber LEDs should be on at all times when the external equipment supports full-duplex operation. Some equipment, such as web cameras and older Ethernet gear, do not support full-duplex operation.
T and R (Bottom Panel)	The T and R LEDs at the bottom of the panel indicate traffic through a fourth port on the switching hub connected to the backplane. The green TX LED indicates data traffic arriving from the backplane and leaving the front panel, and the red RX LED indicates data traffic coming in the front panel and being sent to the backplane. The T and R LEDs are off when the optical version of the EIB-10/100 card is used.

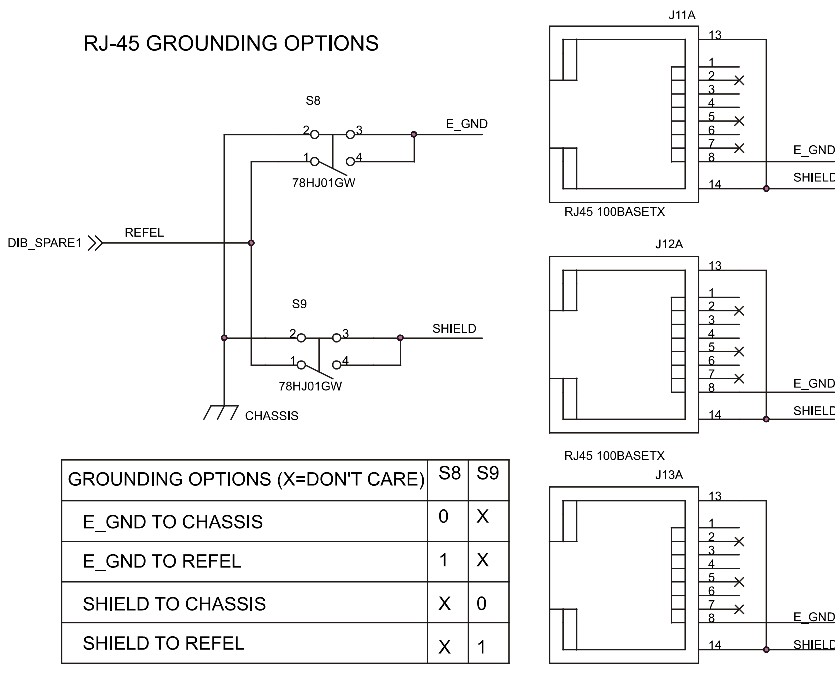
5.5.2 Configuration Settings

Internal connections of the RJ-45 PCB jack are shown below in Figure 5.5-2. Inside each jack, RJ-45 pins 4, 5, 7, 8 are connected through 75 ohm resistors and a capacitor to a voltage reference (E_GND) on pin 8 of the PCBA header. (All three jacks share the same E_GND reference.) Switch S8 on the board allows E_GND to be shorted to either chassis ground (default), through the front panel, or REFEL. Similarly, case pins 13 and 14 on all jacks are connected to a common shield reference that may be shorted to either chassis or REFEL with switch S9. If the external RJ-45 connector is shielded, the cable shield will contact the case of the RJ-45 socket. REFEL is a special voltage reference only available on custom backplanes and typically not used in most systems.

RJ-45 INTERNAL WIRING



RJ-45 GROUNDING OPTIONS



GROUNDING OPTIONS (X=DON'T CARE)	S8	S9
E_GND TO CHASSIS	0	X
E_GND TO REFEL	1	X
SHIELD TO CHASSIS	X	0
SHIELD TO REFEL	X	1

Figure 5.5-2: EIB-10/100 RJ-45 Grounding Options

Note: EIB-10/100 PCBA (Rev. 2) shows the ground/shield switches as S8 and S9 respectively and EIB-10/100 PCBA (Rev. 1) shows the ground/shield switches as S5 and S6 respectively.

A view of the EIB-10/100 PCBA is given in Figure 5.5-3. Although many configurations are available for the switching hub chip, the default settings from the factory should normally be used.

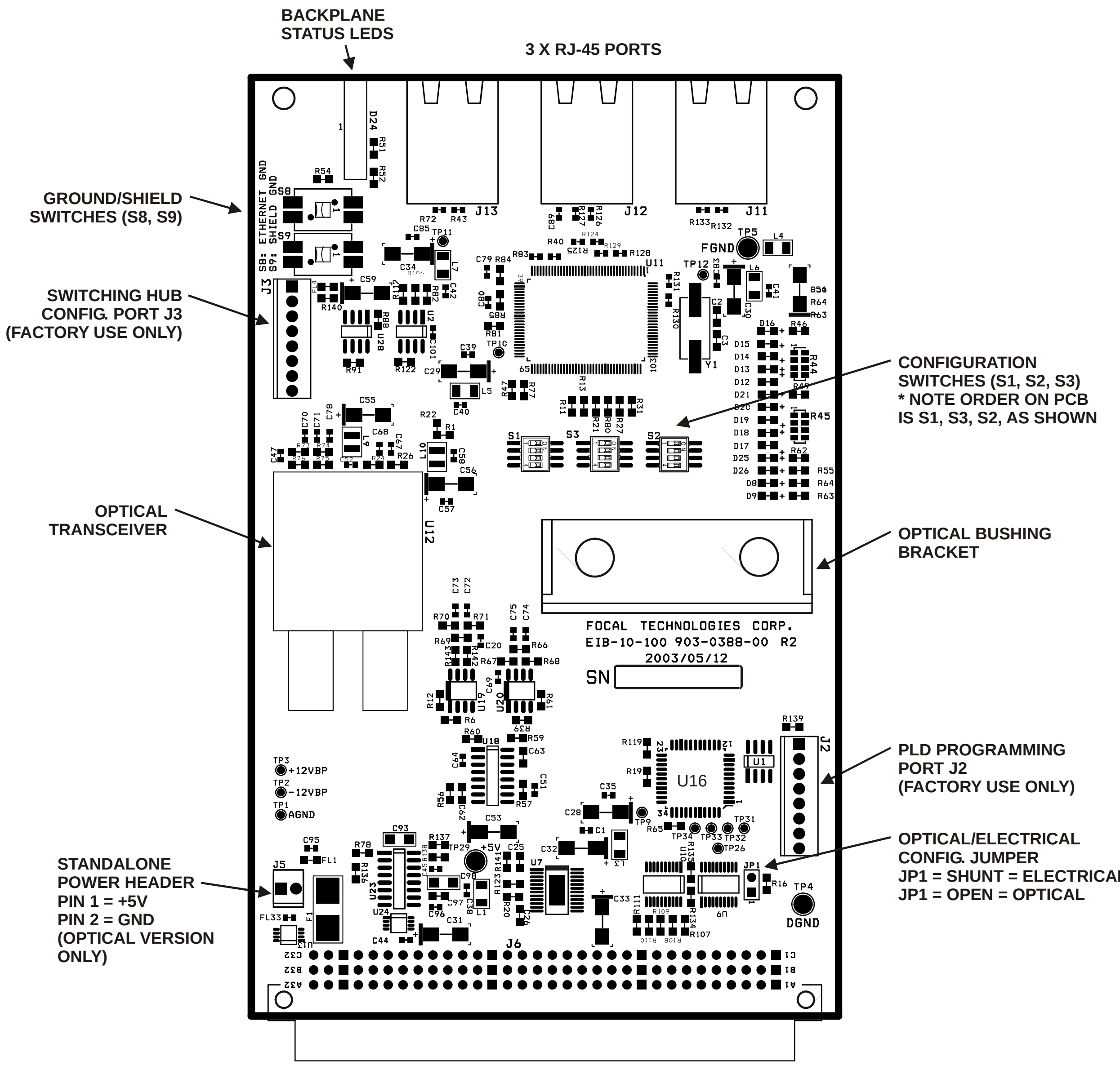


Figure 5.5-3: EIB-10/100 PCBA

Table 5.5-3 shows the settings for auto-negotiate or forced protocol. Auto-negotiate automatically configures the data rate and duplex mode of the port to match the external device connected and typically occurs within a few seconds after making a connection. Each port may be independently forced to one of the configurations listed.

In most applications, the EIB-10/100 port and external device port should be either both set to auto-negotiation or both forced to the same speed and duplex configuration. In cases where the device at one end of the link is forced and the other auto-negotiates, the link may configure itself with a duplex mismatch that causes moderate to severe degradation of the packet throughput. Moreover, older 10Base-T and 100Base-TX equipment may be incompatible with auto-negotiation altogether. In these cases, the EIB-10/100 port should be forced to match the external device. Switch-to-switch connections often work better when both ends of the link use forced configurations.

Table 5.5-3: RJ-45 Individual Port Settings

Port Configuration	Port 1			Port 2			Port 3		
	S1:1	S2:1	S3:1	S1:2	S2:2	S3:2	S1:3	S2:3	S3:3
Auto-Negotiate (default)	1	X	X	1	X	X	1	X	X
10Base-T Half Duplex	0	1	1	0	1	1	0	1	1
10Base-T Full Duplex	0	1	0	0	1	0	0	1	0
100Base-TX Half Duplex	0	0	1	0	0	1	0	0	1
100Base-TX Full Duplex	0	0	0	0	0	0	0	0	0

1 = ON = CLOSED, 0 = OFF = OPEN, X = DON'T CARE

Table 5.5-4 shows additional global settings that may be switch configured. These settings apply to all ports simultaneously.

Table 5.5-4: Global Port Settings

Parameter	Switch	Settings
Flow Control	S1:4	1 = DISABLED, 0 = ENABLED (DEFAULT)
Broadcast Protection	S2:4	1 = DISABLED, 0 = ENABLED (DEFAULT)
Backwards Compatibility	S3:4	1 = ENABLED, 0 = DISABLED (DEFAULT)
RJ-45 Port Grounding	S8	1 = REFEL (REF. GND), 0 = CHASSIS (DEFAULT)
RJ-45 Shield Grounding	S9	1 = REFEL (REF. GND), 0 = CHASSIS (DEFAULT)

1 = ON = CLOSED, 0 = OFF = OPEN

Flow control is normally enabled. This feature applies "back pressure" to the port if buffers are nearing 100% use to avoid a buffer overflow and subsequent loss of packets. Such a situation usually only arises during peak traffic periods or when a 100 Mbps device is connected to the EIB-10/100 (electrical version) card, which is limited to 10 Mbps through the multiplexer.

Broadcast protection is normally enabled. Broadcast and multicast packets are normally forwarded to all switch ports other than the originating port. With broadcast protection enabled, the switch will discard broadcast or multicast packets if the number of those packets exceeds a threshold of 25% of the network line rate, thereby minimizing "broadcast storms". Broadcast protect should be disabled if the given application requires more than 25% broadcast packets.

Backwards compatibility is normally disabled. This feature allows the electrical version of the EIB-10/100 to be used with the older EIB-10BT cards. When enabled, backwards compatibility forces the EIB-10/100 backplane Ethernet link into a 10 Mbps half-duplex mode. This limits performance to a similar level as the EIB-10BT card, which has a limit of 2 km on the optical fiber link.

5.5.3 Flow Control

The internal switching hub is a "learning switch" that monitors incoming packets to identify the MAC addresses of the sources and establish a dynamic look-up table of up to 1024 addresses. Initially this table is empty. Each time the switch receives a valid packet with a source MAC address not currently in the look-up table, the source address is added to the table along with a time stamp. If the destination MAC address is not in the look-up table, the packet is regenerated and forwarded to all other ports. Once the destination MAC address is established in the look-up table, namely by receiving a packet from that device, packets sent to that address will be regenerated only on the port identified in the look-up table.

Depending on traffic patterns, the switch typically learns all of the MAC addresses within a few seconds, though it may take longer to identify stations that do not generate much traffic. During the learning period, many packets will be copied to all ports.

If no packets are received from a given MAC address for 375 seconds, the aging feature of the switch removes the look-up table entry. If an external device is moved from one port to another on the same EIB-10/100 card, the migration feature of the switch immediately updates the table as soon as a new packet is received. If, however, an external device is moved from the switch at one end of the system to the switch at the other end, it may take up to the aging time (375 seconds) before the link through the multiplexer is properly re-established. Consider this behaviour when switching cables around during bench tests.

The switch will not forward the following types of packets:

- Error packets due to framing errors, FCS errors, alignment errors, and illegal size frames
- 802.3x pause frames
- "Local" packets. Packets are deemed "local" if the destination address from the look-up table matches the port of the incoming packet, e.g. from old repeating hubs
- Broadcast or multicast packets that exceed the threshold when broadcast protection is enabled

5.6 AIB-4 - Adaptable Interface Board

Card P/N 903-5003-00

The Adaptable (or Analog) Interface Board (AIB-4) provides four generic channels of data with four sockets that may be populated with any mixture of available plug-in modules. These include analog interfaces for hydrophones, sonars (MS900), and sensors, in addition to digital interfaces, such as RS-232, RS-485/422/TTL, and Tritech sonar ARCNET. Figure 5.6-1 below shows the location of pin 1 on the WAGO connectors when viewed from the front panel. Channel 1 is at the top of the column of connectors, as marked by the black dot along the left-hand side of the panel.

LED indicators display presence of data on the transmit and receive line for each channel. In general, the green LEDs under the "T" column are on when data is transmitted from the front panel of the AIB card. The red LEDs under the "R" column are on when data is being received into the AIB front panel from an external source. For serial data interfaces, LEDs are on when the corresponding line is in a "space" state (TTL = low) and off when the line is in a "mark" state (TTL = high). Idle lines are typically in the "mark" state. If an AIB socket is not populated, both LEDs will be on.

During unidirectional data transfer, an active red LED at one end of the system should be matched by an active green LED at the other end of the system. For example, what is received at the remote module should be transmitted by the console module.

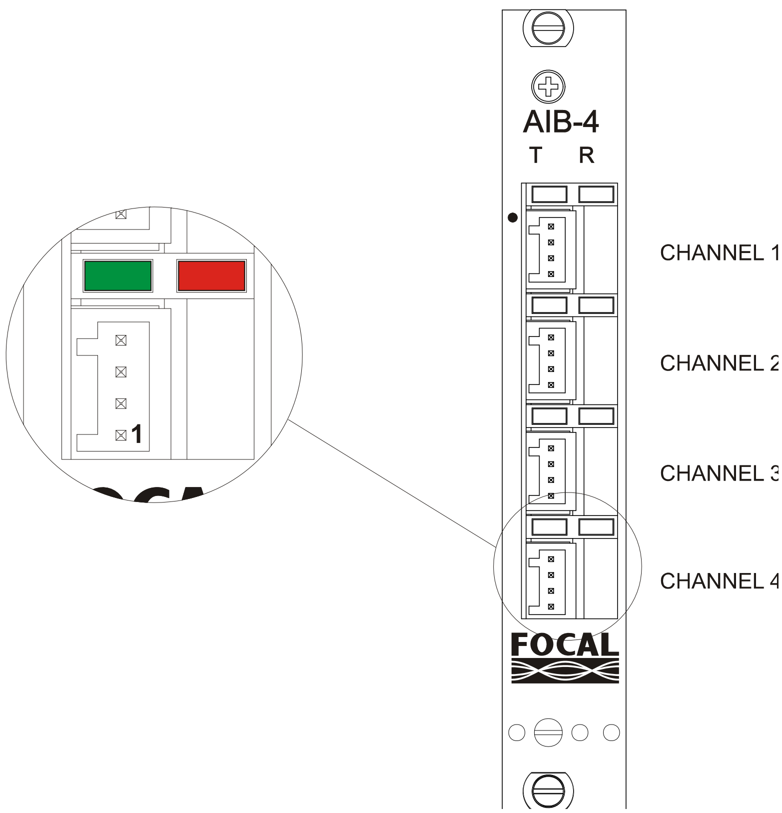


Figure 5.6-1: Adaptable Interface Board (AIB-4) Front Panel

Figure 5.6-2 shows the AIB motherboard, and Figure 5.6-3 shows the block diagram for the AIB motherboard.

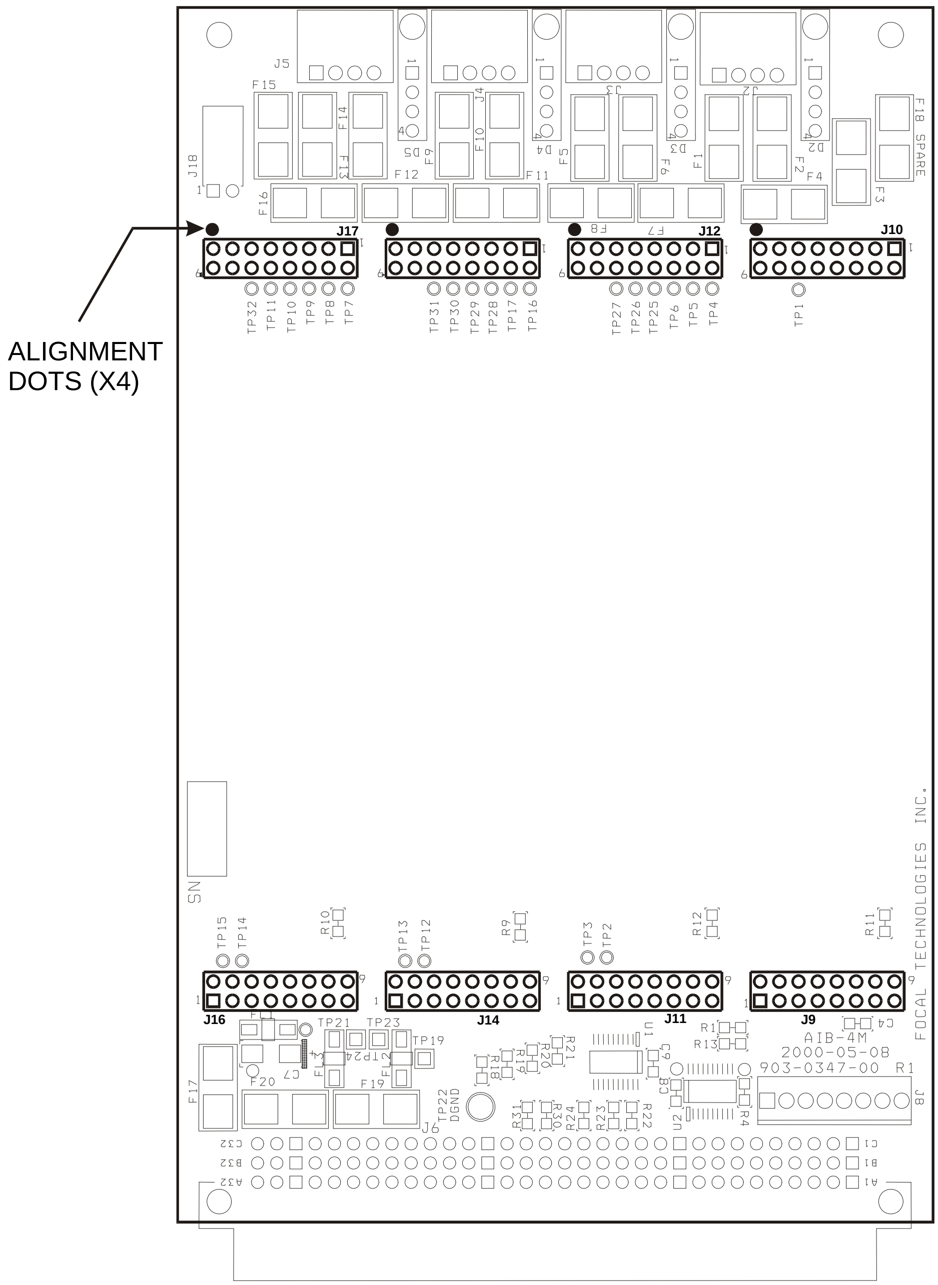


Figure 5.6-2: Adaptable Interface Board (AIB-4) PCB

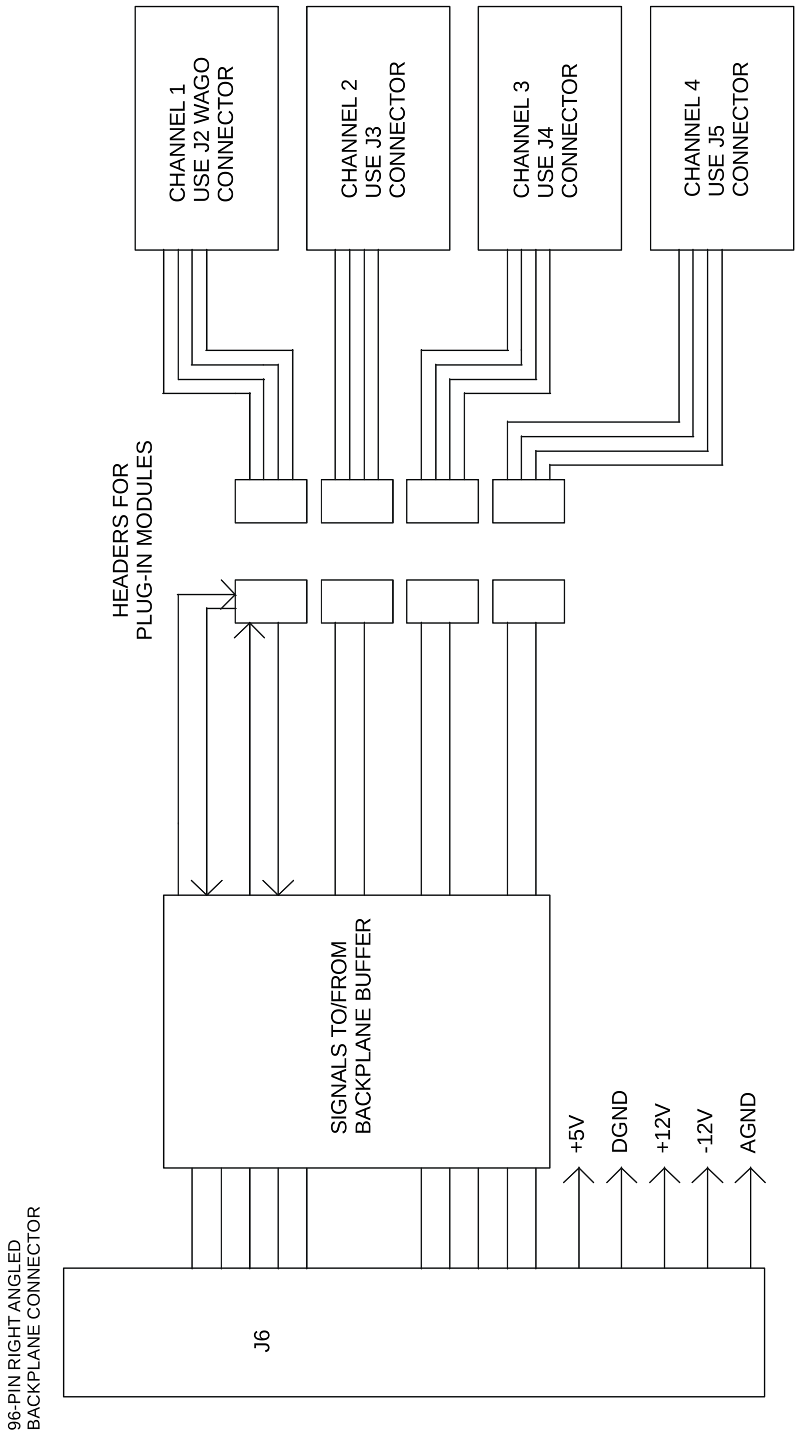


Figure 5.6-3: Block Diagram of Adaptable Interface Board (AIB-4)

5.6.1 Plug-In Modules

A variety of plug in modules is available for use with the AIB-4 cards. When installing the modules, ensure the connector marked by the white dot on the module PCB is mated with the corresponding header marked with a white dot on the AIB motherboard. When removing the modules, carefully extract the plug-in board by pulling both connectors straight out to minimize flexing of the PCB. Uninstalled AIB modules should be handled like integrated circuits: observe ESD handling precautions and store in static dissipating bags or conductive foam.

The following table shows a summary of the AIB plug-in modules available.

Table 5.6-1: AIB Plug-in Modules

Card ID	Card Description	Card P/N
AIB-232	RS-232 Plug-In	903-0251-00
AIB-TRIGGER	Responder Trigger Plug-In	903-0251-01
AIB-485	RS-485/422/TTL Plug-In	903-0252-00
AIB-ARCNET	Tritech Sonar ARCNET Plug-In	903-0261-00
AIB-HYDRO	Hydrophone/Analog Plug-In	903-0244-00
AIB-MS900	MS-900 Analog Sonar Plug-In	903-0250-00
AIB-CANBUS	CANBUS Plug-In	903-0297-00

5.6.2 RS-232 Plug-In (AIB-232/TRIGGER)

Card P/N 903-0251-00 (AIB-232)
Card P/N 903-0251-01 (AIB-TRIGGER)

The AIB-232 plug-in module, which supports RS-232, is shown below in Figure 5.6-4. No jumper or switch settings are required since the board is used solely for RS-232 data to a maximum of 120 kbaud. In addition to the ultra-fast fuses on the AIB-4 motherboard, protection for RS-232 inputs and outputs includes transient voltage suppressors and opto-isolation.

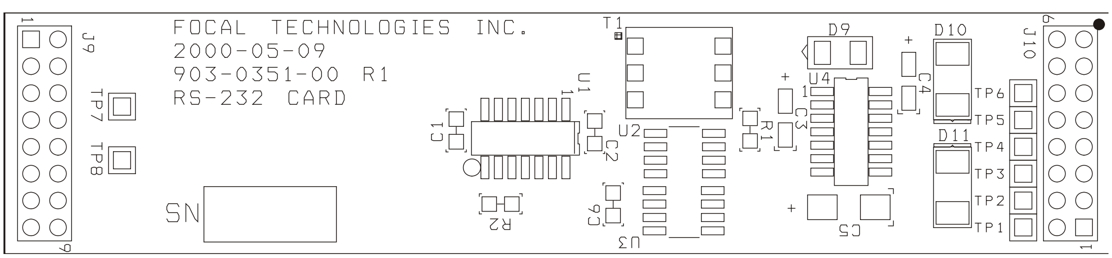


Figure 5.6-4: AIB RS-232/TRIGGER Plug-In Module

Connector pin designations for the front panel WAGO connector are given in the table below. ISOGND is the common isolated signal ground for both receive and transmit data. Front panel LEDs can be used to identify the presence and direction of serial data.

Table 5.6-2: AIB-232/TRIGGER Pin Designations

Pin	Designation
1	ISOGND
2	Receive (RXD)
3	Transmit (TXD)
4	Chassis* (optional)

*The chassis pin is normally left open on the mating connector.

Note: The AIB-TRIGGER plug-in module is identical to the AIB-232 plug-in module except that the transmit pin 3 is not RS-232 compatible; instead this pin is a 0V to +5V TTL output.

5.6.3 RS-485/422/TTL Plug-In (AIB-485)

Card P/N 903-0252-00

The AIB-485 plug-in module, which supports RS-485, RS-422, and TTL, is shown below in Figure 5.6-5. In addition to the ultra-fast fuses on the AIB-4 motherboard, protection for RS-485/422/TTL inputs and outputs includes transient voltage suppressors and opto-isolation.

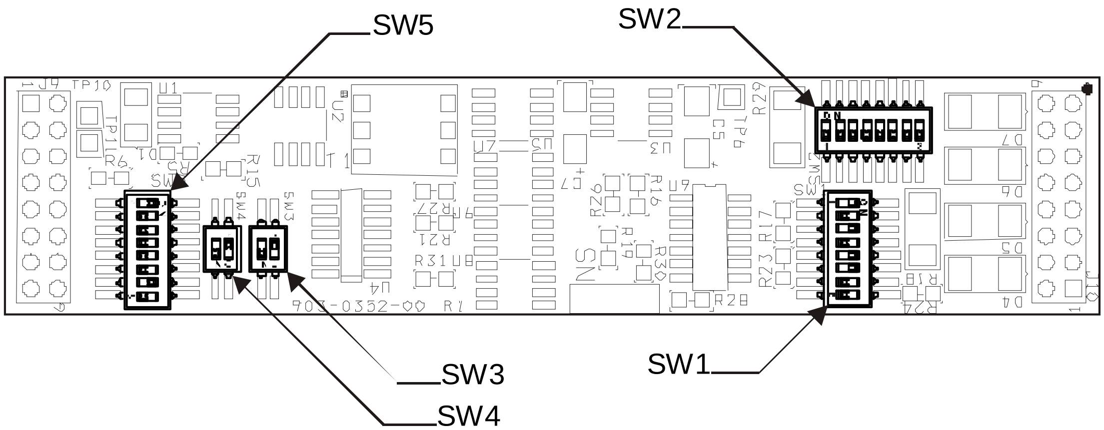


Figure 5.6-5: AIB RS-485 Plug-In Module

Each channel has the following possible settings: RS-485 autosense (half duplex), RS-485 unidirectional transmitter (simplex Tx), RS-485 unidirectional receiver (simplex Rx), RS-422 four-wire connection (full duplex), or TTL (full duplex).

The equivalent input/output schematic for an RS-422 configuration is shown in Figure 5.6-6, based on default switch settings. The switches are not shown for clarity. AIB-485 plug-in modules are default configured for RS-485, in which case the transmit and receive circuits of the RS-422 driver IC are connected together.

The RS-485 autosense mode uses a timer circuit to automatically switch from transmit to receive mode. By default, a channel in autosense mode is a receiver waiting for data to come in through the front panel and switches to a transmitter only when it receives data from the backplane. Once the RS-485 channel is in transmitter mode, it will wait ten bit times (one start bit, eight data bits and one stop bit) from the last positive data edge before reverting back to its default receiver state.

This half-duplex mode operates in a ping-pong fashion that must be supported by the end equipment. Although the circuit can act as either a receiver or a transmitter, the data being passed must be sent or received under timing conditions that allow for collision-free data transmission. (If a data collision does occur, transmission out of the front panel connector will override incoming data.) Autosense settings only affect half-duplex operation.

Default settings for the autosense timer (9600 baud) are appropriate for most sonars, even when the sonar is operating at higher baud rates, since delays between sonar send and receive are generally many milliseconds. In some cases, though, the autosense timer needs to be adjusted based on the absolute turnaround time of the external device.

A channel configured in simplex Tx or simplex Rx is a two-wire interface that is only designated to transmit or receive data. Tx is defined as Model 903 transmitting data out the front panel whereas Rx is defined as the Model 903 channel receiving data from an external device.

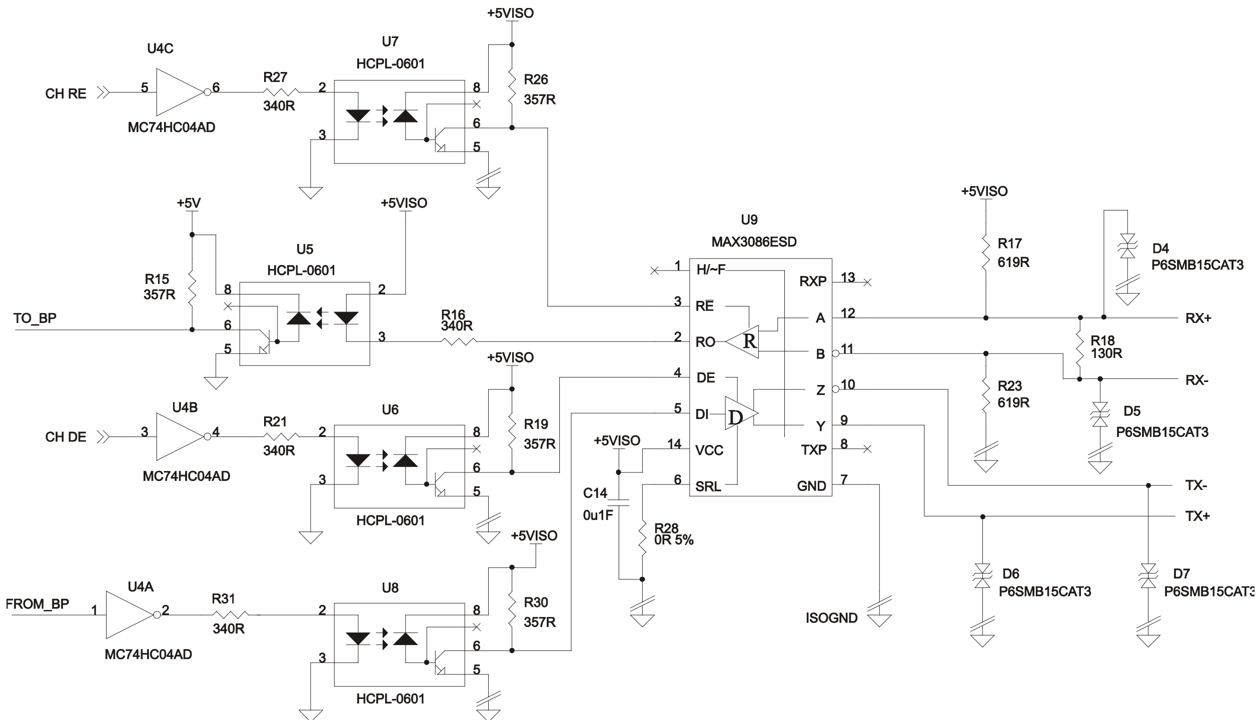


Figure 5.6-6: AIB RS-422 Interface Schematic

Full duplex communication runs transmit and receive on separate conductors, thus autosense is not required. The AIB modules support full duplex transmission as either RS-422 or TTL data.

Connector pin designations for the front panel WAGO connectors are given in the table below with default configuration shaded.

Table 5.6-3: AIB-485 Pin Designations

Pin	RS-485 Designation	RS-422 Designation	TTL Designation
1	TX+/RX+	RX+	TTL IN
2	TX-/RX-	RX-	N/C
3	N/C	TX+	TTL OUT
4	N/C	TX-	ISOGND

Switch settings for the various configurations are given in Table 5.6-4. When using the module in RS-422 or TTL input configuration, the autosense mode (SW3, SW4) should be set for full-duplex operation. Autosense baud rate settings (SW5) are ignored when the module is in full-duplex or simplex modes.

Table 5.6-4: Configuration Settings for AIB RS-485 Module (Defaults Shaded)

AUTOSENSE MODE CONFIGURATION				
FUNCTION	**SW3:1**	**SW3:2**	**SW4:1**	**SW4:2**
Full Duplex	0	0	1	0
Simplex Tx	1	0	1	0
Half Duplex (Autosense)	0	1	0	1
Simplex Rx	0	0	0	0

AUTOSENSE BAUD RATE FOR SW5 DIP SWITCH								
BAUD RATE CCT#	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
9600	1	0	0	0	0	0	1	0
19200	0	1	0	0	0	0	1	0
28800	0	0	1	0	0	0	1	0
57600	0	0	0	1	0	0	1	0
115.2K	0	0	0	0	1	0	0	1
≥230.4K	0	0	0	0	0	1	0	1
KRAFT*	0	0	0	1	0	0	0	1
INPUT CONFIGURATION FOR SW1 DIP SWITCH								
FORMAT CCT#	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
RS-485	1	0	1	0	1	1	0	0
RS-422	1	1	0	0	1	0	0	0
TTL	1	0	0	0	0	0	1	0
KRAFT*	0	0	1	1	0	1	0	1
INPUT CONFIGURATION FOR SW2 DIP SWITCH								
FORMAT CCT#	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
RS-485	0	0	0	0	0	0	0	0
RS-422	0	0	0	0	1	0	0	1
TTL	0	0	0	0	0	1	0	1
KRAFT*	0	0	0	0	0	0	0	0

1 = ON = CLOSED, 0 = OFF = OPEN

*KRAFT manipulators use an AC-coupled RS-485 format with short turnaround time

5.6.4 Tritech Sonar ARCNET Plug-In (AIB-ARCNET)

Card P/N 903-0261-00

The AIB-ARCNET plug-in module, which supports the version of ARCNET used by Tritech sonars, is shown below in Figure 5.6-7. In addition to the ultra-fast fuses on the AIB-4 motherboard, protection for Tritech inputs and outputs includes transient voltage suppressors and AC-coupled isolation through capacitors and transformers.

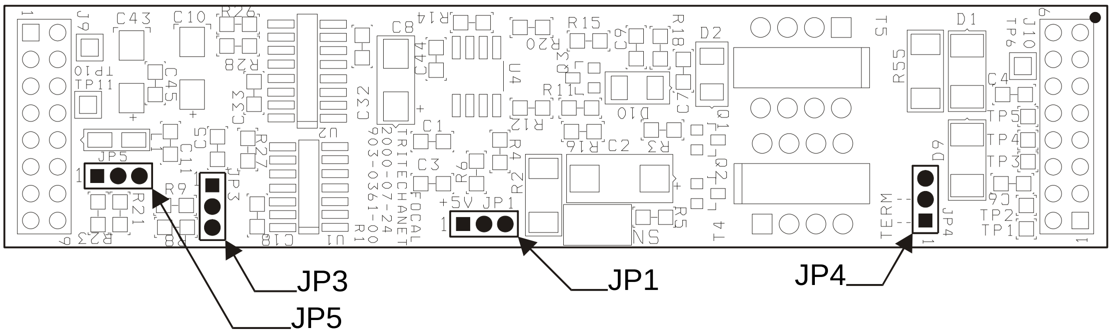


Figure 5.6-7: AIB Tritech ARCNET Plug-In Module

The Tritech sonar interface may be configured for +5 V (default) or +12 V drive levels and a data rate of 156.2 kbps (default) or 78.1 kbps, as shown in Table 5.6-5. The +12 V setting may be needed for long cable runs to the sonar equipment, but is typically not required. The lower data rate setting is available for compatibility with existing sonars configured for 78.1 kbps operation.

Table 5.6-5: Configuration Settings for AIB Tritech Module (Defaults Shaded)

Output Drive Level				
VALUE	JP1	JP3	JP5	JP4
+5 V Output	1-2	*	*	*
+12 V Output	2-3	*	*	*
Baud Rate				
78.1 kbaud	*	1-2	1-2	*
156.2 kbaud	*	2-3	2-3	*
Termination				
68 Ohms	*	*	*	1-2
Unterminated	*	*	*	2-3

*Setting does not affect given parameter

The Tritech interface lines may be terminated with jumper JP4: for an internal 68 ohm terminator, pins 1 and 2 of jumper JP4 should be shorted (default); for no internal terminator, pins 1 and 2 of jumper JP4 should be open (short pin 2 to pin 3, which is open). If the internal terminator is used, no external terminators should be added to the cable connection to the sonar equipment.

The default settings are illustrated in the shaded rows of Table 5.6-5, (and restated here for clarity) are typically used for systems with *short* cables between the sonar components and the multiplexer modules:

Short Cables (default)

Sonar Head	No terminator
Remote Mux	68 ohm terminator, +5V drive
Console Mux	68 ohm terminator, +5V drive
Sonar Processor	No terminator

For systems with a *long* run of cable between the sonar head and remote module, the recommended configuration is the following:

Long Cables

Sonar Head	39 ohm terminator
Remote Mux	68 ohm terminator, +12V drive
Console Mux	68 ohm terminator, +12V drive
Sonar Processor	No terminator

The definition of a *short* versus *long* cable is dependent on the data rate and the cable type, but typically < 5 m is short, and > 100m would be considered long. If the cable length is in between these, the user may need to try both configurations. There is not a definitive configuration of termination resistors and drive voltages that is guaranteed to work for all cable types and lengths and it may be necessary to optimize the signals. Tritech recommends the signal voltages to operate in the 7-15 Vpp range. Be aware that many Tritech Sonars are by default configured for +12V drive voltages and may need to be adjusted for short cable operation.

Front panel pin designations for the AIB-ARCNET plug-in modules are given in the table below.

Table 5.6-6: AIB-ARCNET Pin Designations

Pin	Designation
1	Chassis* (optional)
2	LAN+
3	LAN-
4	N/C

*The chassis pin is connected to the front panel of the 903 card (or to the four board mounting holes of the 907 card). The chassis pin is normally left open on the mating connector.

5.6.5 Hydrophone/Analog Plug-In (AIB-HYDRO)

Card P/N 903-0244-00

The AIB-HYDRO hydrophone plug-in module, shown below in Figure 5.6-8, is suitable for use with many hydrophones and other types of low-level analog signals. The board is used at both ends of the system and must be jumper configured, typically, as an input for the remote (subsea) module or as an output for the console (surface) module per the settings in Table 5.6-7.

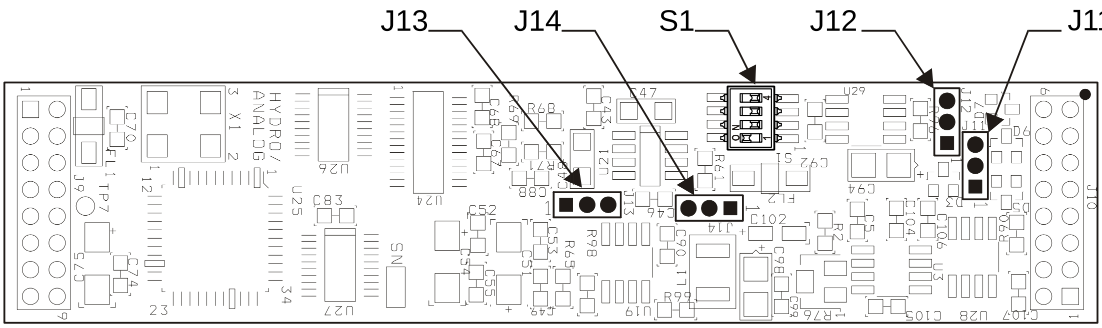


Figure 5.6-8: AIB Hydrophone Plug-In Module

Table 5.6-7: Configuration Settings for AIB Hydrophone Module

Board Set Up	Jumper Configuration*			
	J11	J12	J13	J14
Input Board (Remote)	2-3	2-3	2-3	2-3
Output Board (Console)	1-2	1-2	1-2	1-2

* Place shunts across the indicated pins of each jumper

The hydrophone board input circuits include a front-end preamplifier with a fixed 36 dB gain and additional gain supplied by switch bank S1. Inputs are protected with diode clamps and current limiting resistors as well as ultrafast fuses on the AIB motherboard. Table 5.6-8 shows the switch S1 gain settings and corresponding maximum input voltage.

Table 5.6-8: Hydrophone Gain Settings (Defaults Shaded)

S1 Gain Av (dB)	S1 Settings				Total Gain With Preamp	Maximum Input Voltage (mVpp)
	1	2	3	4		
30	1	0	0	0	66	1
20	0	1	0	0	56	3.2
10	0	0	1	0	46	10
0	0	0	0	1	36	32
-3	1	1	1	1	33	45

1 = ON = CLOSED, 0 = OFF = OPEN

Although the card is configured to operate with two-wire, un-amplified hydrophone inputs, the hydrophone plug-in may be factory modified to provide +12V to an external hydrophone pre-amplifier on a third conductor and bypass the gain of the internal pre-amplifier.

Front panel pin designations for the AIB-HYDRO plug-in modules are given in the table below.

Table 5.6-9: AIB-HYDRO Pin Designations

Pin	Designation
1	Chassis* (optional)
2	N/C
3	- Signal (GND on output)
4	+ Signal

*The chassis pin is normally left open on the mating connector.

Frequencies from 16 Hz to 28 kHz (-3 dB points) are passed through the system, though frequencies slightly outside this range may be transmitted if the added loss can be compensated by additional S1 gain. If low frequency noise pick up (typically 50 or 60 Hz) is introduced by improper shielding, the lower pole frequency may be raised by adding a shunt resistor across pins 3 and 4 to attenuate the lower frequencies. The chassis pin on the WAGO connector should be connected to the shield of the hydrophone cable.

The analog signal on the input board (remote end) is digitized at 73 kilosamples per second with a 12-bit resolution after amplification and reconstructed at the output board (console end) with no additional gain. (Switch bank S1 is not active when the hydrophone board is configured for output.) Output impedance is approximately 34 ohms, which is suitable for high impedance loads and is even capable of directly driving 8-ohm speakers, although with a corresponding loss in output power. Maximum output level is limited to 2 Vpp, yielding a dynamic range of roughly 66 dB.

5.6.6 MS-900 Analog Sonar Plug-In (AIB-MS900)

Card P/N 903-0250-00

The MS900 Analog Sonar Interface AIB plug-in (AIB-MS900) uses only one configuration jumper, J11, shown below in Figure 5.6-9. Pin 1 of J11 is the square pin, which is also marked with a silkscreen "C". If the jumper is placed across pins 1 - 2, the board is configured for the console module, which interfaces with the MS900 controller. With the jumper across pins 2 - 3 of J11, the board is configured for the remote module, which interfaces with the Model 971 sonar head. No other jumper settings are required.

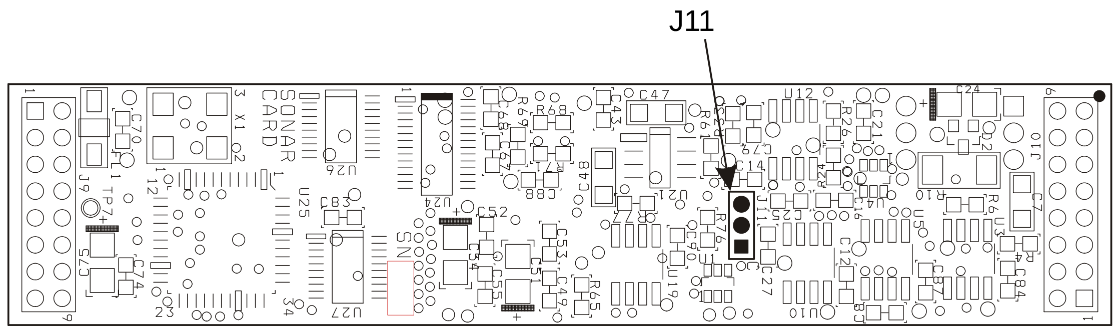


Figure 5.6-9: MS-900 Plug-In Module (Top View)

The MS900 interface must be installed on a motherboard supporting AIB plug-ins, such as the AIB-4 or the High Density Board (HDB-TX). Ensure the alignment dot, shown at the upper left of the figure below, matches the dot on the motherboard. For more information about the HDB-TX board please refer to Model 903-HD Video/Data Multiplexer User Guide P/N: 903-0612-00.

Front panel pin designations for the AIB-MS900 plug-in modules are given in the table below. The polarity of the signal lines does not matter.

Table 5.6-10: AIB-MS900 Pin Designations

Pin	Designation
1	Chassis * (optional)
2	N/C
3	Sonar Signal/Data
4	Sonar Signal/Data

*The chassis pin is normally left open on the mating connector.

5.6.7 CANBUS Plug-In (AIB-CANBUS)

Card P/N 903-0297-00

The CAN bus interface AIB plug-in (AIB-CANBUS), as shown in Figure 5.6-10, provides extension of a CAN 2.0A and CAN 2.0B bus over the fiber optic multiplexer system. Each AIB-CANBUS card acts as a node on the local CAN bus, handling media access and packet/message acknowledgements. The AIB cards at either end of the multiplexer system are connected through the fiber optic link as a bridge between two separate CAN bus networks. Packets relayed through the optical link bridge are regenerated as CAN format packets/messages at the other end and placed on the local bus.

This CAN bus “Bridge Mode” configuration is particularly well suited to sensor networks where all of the sensors are at one end of the system, e.g. an ROV, and the bus master controller, typically a PC, is at the opposite end. Due to the latency inherent in the optical bridge – typically 200 µs at 1 Mbps and 1 ms at 125 kbps – this link may not be suitable for more complex CAN bus configurations or systems requiring fast responses, such as TTCAN. The optical fiber itself adds 5 µs/km of latency in each direction.

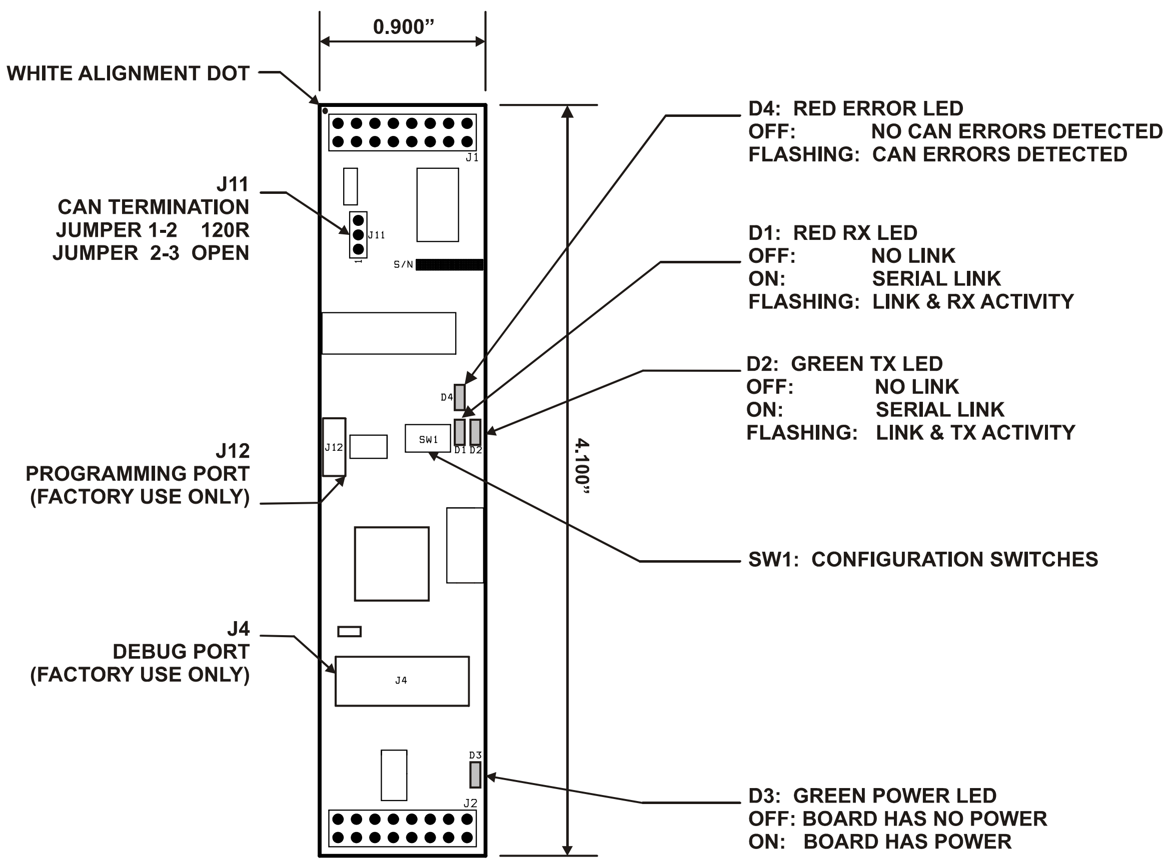


Figure 5.6-10: AIB-CANBUS Plug-In Module (Top View)

The maximum sustained packet throughput is typically limited by the bus master, not the AIB-CANBUS cards. Packets are transmitted through the optical link in a proprietary frame supported by 32-bit CRC to ensure data reliability. Time-outs in applications or higher layer protocols may need to be adjusted to account for the latency through the fiber optic system.

LEDs on the AIB-CANBUS card may be used for diagnostics during bench testing.

Table 5.6-11: AIB-CANBUS On-board LEDs

LED	Description
D1: RX	Red Receive (RX) LED flashes when packets/messages are being received into the AIB-CANBUS card from an external CANBUS device. (Received packets/messages are transmitted to the far end via the optical link.)
D2: TX	Green Transmit (TX) LED flashes when packets/messages are being transmitted from the local AIB-CANBUS to an external CANBUS device.
D3: POWER	Power LED is green when power is applied to the card. D3 is OFF if there is no power applied to the card.
D4: ERROR	Red Error LED is ON whenever CAN errors are detected. A flashing Error LED indicates that continuous CAN errors are detected. For example, the error LED will be flashing if there is no terminating resistor on the bus connected to the card and the card tries to send packets/messages.

D1 and D2 are both ON when a valid optical link exist. In the other hand, D1 and D2 are both OFF when there is no valid optical link.

When the cards are configured in “Bridge Mode”, BUS errors are handled by the local cards only and therefore a CAN error detected at the "Remote" end is not notified to the "Console" end and vice versa.

The CAN bus “Repeater Mode” is only functional at 62.5kbps with short jumper fibers. LEDs D1, D2, and D4 are disabled in this mode.

The CAN terminator (J11) shown in Figure 5.6-10 is an 120 ohm resistor rated 0.75W for bench testing purposes and it is normally left open. External high power termination resistors (>5W) must be used in place of the on-board resistors in order to handle a possible 12V or 24V fault input across the termination resistors.

Ensure each bus end (remote and console) is terminated with 120 ohm resistors and that the resulting nominal bus load is 60 ohm.

The table below shows the switch SW1 CAN speed settings for the AIB-CANBUS cards. Remote and console cards must have the same settings.

Table 5.6-12: CAN Speed Settings

Speed	SW1 Settings			
	1	2	3	4
62.5kbps BRIDGE MODE	OFF	OFF	OFF	ON
125kbps BRIDGE MODE	OFF	OFF	ON	ON
250kbps BRIDGE MODE	OFF	ON	OFF	ON
500kbps BRIDGE MODE	OFF	ON	ON	ON
1000kbps BRIDGE MODE	ON	X	X	ON
REPEATER MODE (62.5kbps)	X	X	X	OFF

X = DON'T CARE
ON = 1 = CLOSED, OFF = 0 = OPEN

Pin connections for the WAGO connector used with the AIB-CANBUS are shown in Table 5.6-13. It is recommended to use shielded, impedance controlled (120 ohm) twisted pair cabling to maintain signal quality. Figure 5.6-11 shows a WAGO 4-pin header.

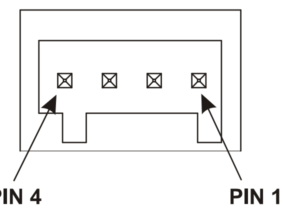


Figure 5.6-11: WAGO 4-Pin Header

Table 5.6-13: AIB-CANBUS Pin Designations

Pin	Designation
1	CAN H
2	CAN L
3	BUS - (Ground)
4	Shield

When installing the AIB card ensure that the white alignment dot matches the alignment dot found on the AIB-4 card to avoid damaging card.

Note:
Cards with firmware version “A” force a can bridge reset, i.e. when can errors are detected at one end (remote or console), the can ports at both ends are reset (bus off state) for approx. five seconds. Firmware version “B” and above do not include a bridge reset. Cards shipped before July 2011 have firmware version “A” code unless otherwise noted.

5.7 907-232E Data Board (8-Channel RS-232)

Card P/N 903-5056-00

The 907-232E data board supports eight RS-232 channels. This card combines the eight I/O channels onto the 5 data lines of the model 903 backplane. Each I/O channel supports a maximum baud rate of 115 Kbaud.

The 907-232E card is a Model 907 PC/104 form-factor card mounted on a Model 907 Eurocard adaptor board. The adaptor board provides the necessary power supply and data interface to connect the 907 card to a 903 system.

5.7.1 Input/Output

The 907-232E cards may be installed in any data slot. Also, this card is interchangeable between remote and console modules assuming configuration settings are identical.

The front panel view of the 907-232E card is shown in the figure below. Transmit (TXD) and receive (RXD) lines are relative to the board.

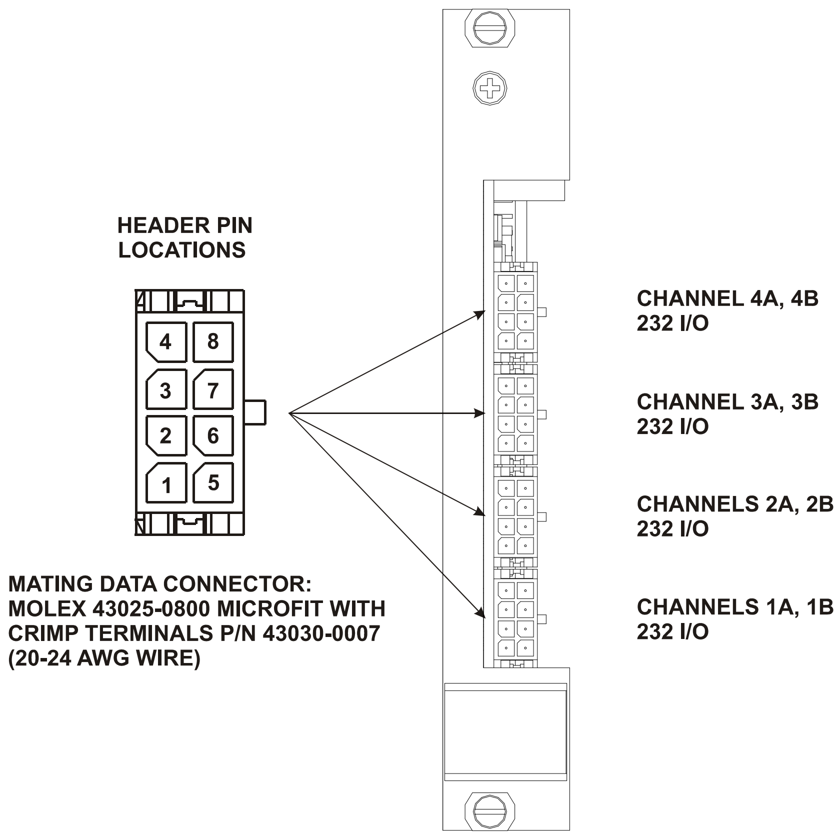


Figure 5.7-1: 907-232E Front Panel

Channels 1A, 1B, 2A, 2B are electrically isolated as a bank of 4 channels (shared isolated power, isolated signals). Channels 3A, 3B, 4A, 4B are also electrically isolated as a bank of 4 channels (shared isolated power, isolated signals).

Although inputs and outputs are protected from ESD (electro-static discharge), some internal circuits are not. Hence, observe ESD precautions during handling of the boards.

The LEDs on the 907-232 board are not visible at the front panel once the card is mounted on the 907-EURO card.

Table 5.7-1 shows the data connector pin outs of the 907-232E card.

Table 5.7-1: RS232 Data Connector Pin Outs

PIN	CONN J1	CONN J2	CONN J3	CONN J4
1	CH1A GND	CH2A GND	CH3A GND	CH4A GND
2	CH1A RXD	CH2A RXD	CH3A RXD	CH4A RXD
3	CH1A TXD	CH2A TXD	CH3A TXD	CH4A TXD
4	OPEN	OPEN	OPEN	OPEN
5	CH1B GND	CH2B GND	CH3B GND	CH4B GND
6	CH1B RXD	CH2B RXD	CH3B RXD	CH4B RXD
7	CH1B TXD	CH2B TXD	CH3B TXD	CH4B TXD
8	OPEN	OPEN	OPEN	OPEN

Table 5.7-2 shows the input / output ratings of the 907-232E card.

Table 5.7-2: Input / Output Ratings

SIGNAL	MAX. DATA RATE OR BANDWIDTH	ABSOLUTE* MAX. INPUT	ABSOLUTE* MAX. OUTPUT	PROTECTION
RS232	115 kbps, NRZ	+/-30V	+1.5 mA	15KV ESD

*Any values in excess of absolute maximum ratings may damage the electronics. Product specifications may not be met if the device is outside the operation range.

5.7.2 Configuration Settings

The RS-232 channels are limited to 115k baud regardless of the switch configuration. Switch SW9 is programmed at the factory and must always be configured to have switch 1 OFF and switch 2 through 4 ON.

The input fuse of the 907-232 card is Littelfuse 2A Slo-Blo, replaceable surface mount type, P/N 0452002. The 907-232 card is shown in the following figure.

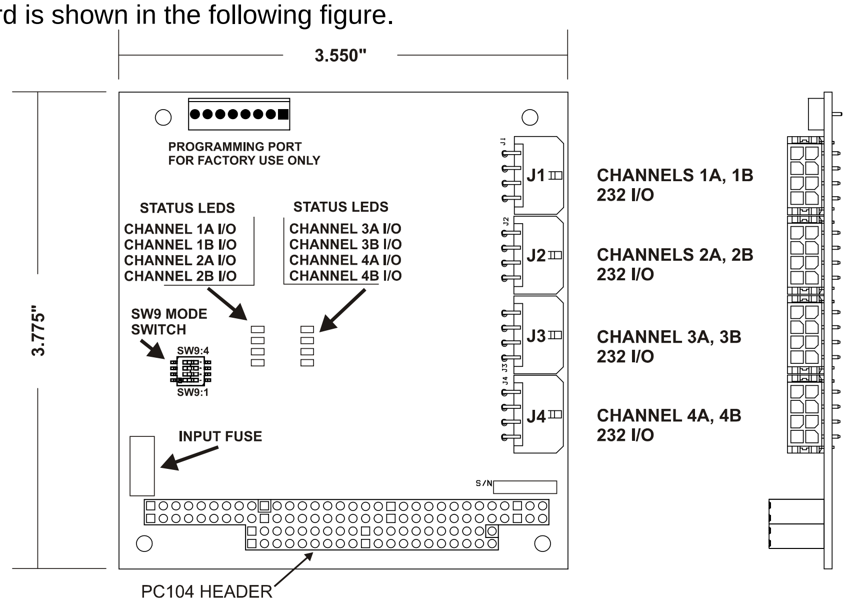


Figure 5.7-2: 907-232 (8-Channel RS-232) card

A side view of 907-232E card is shown below.

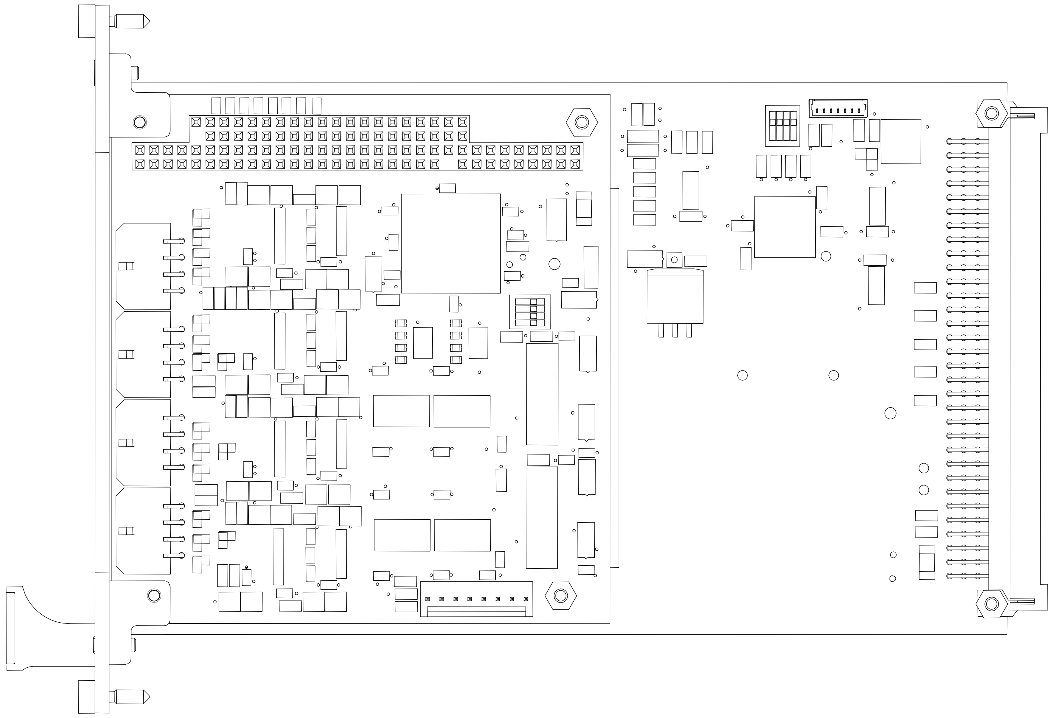


Figure 5.7-3: 907-232E Card Side View

5.8 907-485E Data Board (8-Channel RS-485/422)

Card P/N 903-5053-00

The 907-485E data board supports eight RS-485/422 channels. In the default configuration this card combines the eight channels onto the 5 data lines of the model 903 backplane. The card has a maximum baud rate of 250 Kbaud per each of the eight channels.

The 907-485E card is a Model 907 PC/104 form-factor card mounted on a Model 907 Eurocard adaptor board. The adaptor board provides the necessary power supply and data interface to connect the 907 card to a 903 system.

5.8.1 Input/Output

The 907-485E cards may be installed in any data slot. Also, this card is interchangeable between remote and console modules assuming configuration settings are identical. The front panel view of the 907-485E card is shown in the figure below.

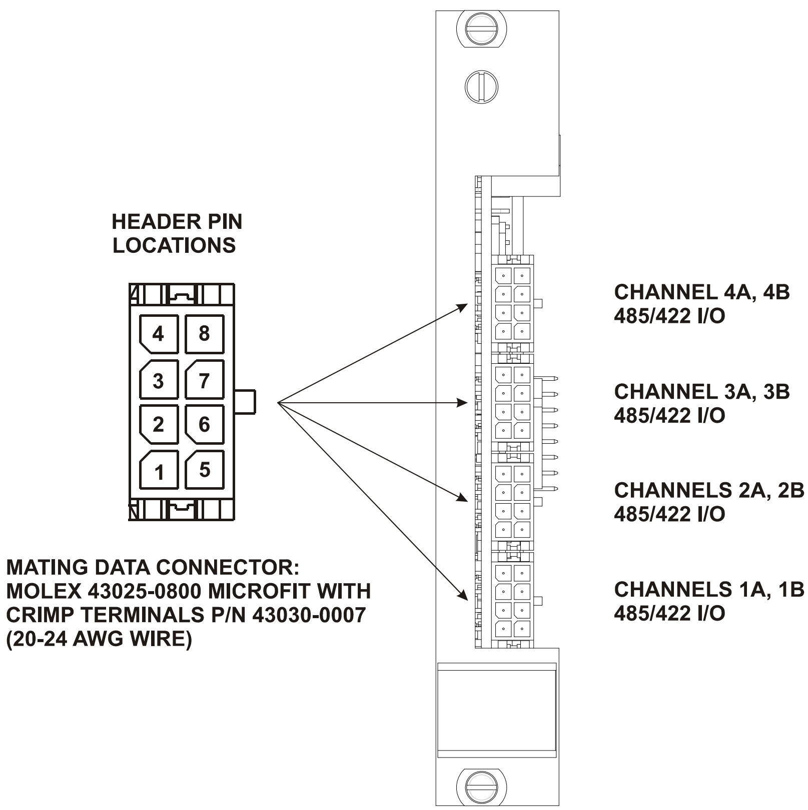


Figure 5.8-1: 907-485E Front Panel

Channels 1A, 1B, 2A and 2B are electrically isolated as a bank of 4 channels (shared isolated power, isolated signals). Channels 3A, 3B, 4A and 4B are also electrically isolated as a bank of 4 channels (shared isolated power, isolated signals).

RS422 and RS485 I/O have fail safe biasing, which ensure a defined state when the inputs are open or shorted.

Although inputs and outputs are protected from ESD (electro-static discharge), some internal circuits are not. Hence, observe ESD precautions during handling of the boards.
The following figure shows the recommended wiring connections when using the 907-485E cards in 485 mode. In this case, the connection between CH1 (CH1A) and one external RS-485 device is shown. The same connection diagram should be used for the other seven channels.

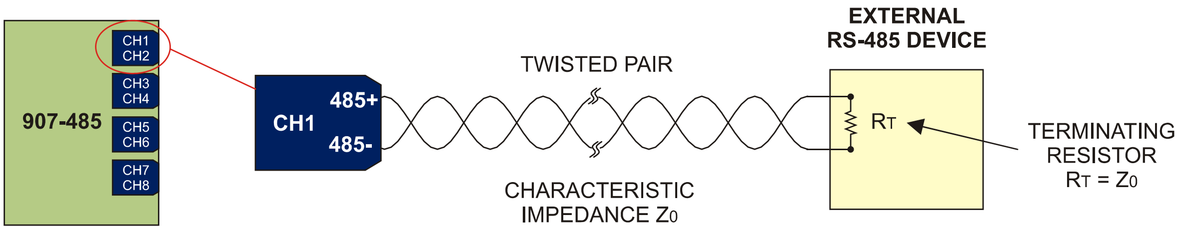


Figure 5.8-2: Wiring recommendation when using the 907-485E in 485 mode (CH1 shown)

Notes:

1. Twisted pair cable with 120 ohm nominal characteristic impedance (Z_0) and low capacitance (60 pF/m or less) should be used.
2. A terminating resistor must be placed at the end of the cable (external RS-485 device side as shown in Figure 5.8-2). The terminating resistor (R_T) should be the same value of the characteristic impedance of the twisted pair. For example: R_T = 120 ohm should be used when the twisted pair used has nominal Z_0 = 120 ohm. Large impedance mismatches create reflections that cause errors in the data.
3. The maximum length of the cable used to connect the 907-485E card and an external RS-485 device should not exceed 10 m (assuming conditions in the notes above are met). For any length larger than 10 m, terminating resistor should be used at both ends of the cable.
4. When the 907-485E card is configured for 422 mode, a 120 ohm termination exist across pins 422RX+ and 422RX-.

The LEDs on the 907-485 board are not visible at the front panel once the card is mounted on the 907-EURO.

Table 5.8-1 shows the data connector pin outs of the 907-485E card. Transmit (TX+/-) and receive (RX+/-) lines are relative to the board.

Table 5.8-1: 485/422/TTL Data Connector Pin Outs

CH	PIN	CONN J1	CONN J2	CONN J3	CONN J4
A	1	422RX+/TTL IN	422RX+	422RX+	422RX+
	2	422RX-	422RX-	422RX-	422RX-
	3	485+/422TX+/TTL OUT	485+/422TX+	485+/422TX+	485+/422TX+
	4	485-/422TX-/TTL GND	485-/422TX-	485-/422TX-	485-/422TX-
B	5	422RX+	422RX+	422RX+	422RX+
	6	422RX-	422RX-	422RX-	422RX-
	7	485+/422TX+	485+/422TX+	485+/422TX+	485+/422TX+
	8	485-/422TX-	485-/422TX-	485-/422TX-	485-/422TX-

Table 5.8-2 shows the input / output ratings of the 907-485E card.

Table 5.8-2: Input / Output Ratings

SIGNAL	ABSOLUTE* MAX. INPUT	ABSOLUTE* MAX. OUTPUT	PROTECTION
RS485/422	+/- 13V	+/- 13V	15KV ESD ISOLATED

*Any values in excess of absolute maximum ratings may damage the electronics. Product specifications may not be met if the device is outside the operation range.

5.8.2 Configuration Settings

Dip switches SW1 to SW8 and SW10 of the 907-485E card are used to configure each channel as either RS-485 or RS-422. For example, to configure CH1 (CH1A) of the RS-485 card as RS-485 channel, SW10 circuit 1 must be ON and SW1 circuits 1, 3 and 4 must be ON and circuit 2 must be OFF. On the other hand if CH1 (CH1A) needs to be configured as an RS-422 channel, then SW10 circuit 1 must be OFF and SW1 circuits 1, 3 and 4 must be OFF and circuit 2 must be ON.

Table 5.8-3: SW1 - SW8, SW10 RS485/422 Configuration

Mode	SW1 - SW8	SW10
RS485	SW(CH) : 1, 3, 4 = ON SW(CH) : 2 = OFF	SW10 : (CH) = ON (EG. SW10:1 = ON, CH1 CONFIG FOR RS485)
RS422	SW:(CH) 1, 3, 4 = OFF SW:(CH) 2 = ON	SW10 : (CH) = OFF (EG. SW10:1 = OFF, CH1 CONFIG FOR RS422)

The RS485 drivers are configured with no slewrate limiting. Slewrate limiting of 500kbps and 115kbps can be factory configured.

Switch SW9 is programmed at the factory and must always be configured to have switch 1 OFF and switch 2 through 4 ON.
The input fuse of the 907-485 card is Littelfuse 2A Slo-Blo, replaceable surface mount type, P/N 0452002.
The 907-485 card is shown the figure below.

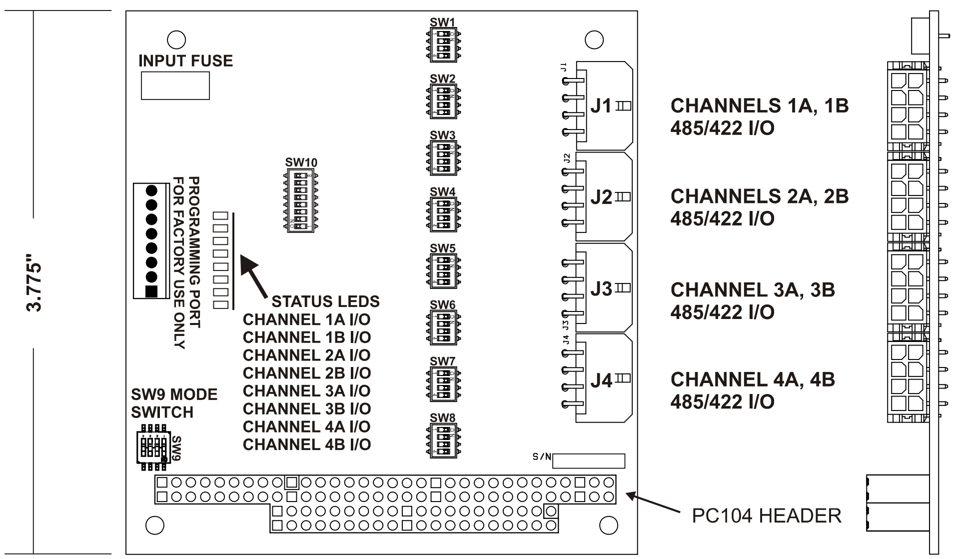


Figure 5.8-3: 907-485 (8-Channel RS-485/422) card

A side view of the 907-485E card is shown in the figure below.

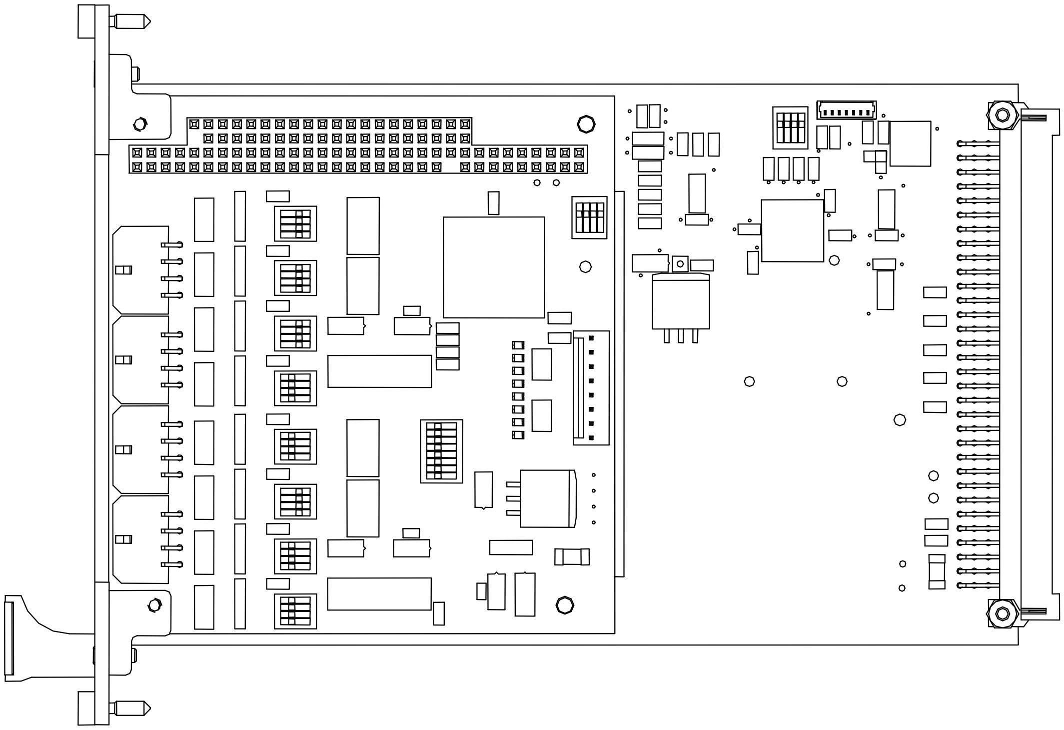


Figure 5.8-4: RS-485 Card Side View

The RS-485 card is also available with one TTL channel (CH1) but this version of the card is not switch selectable. Please contact Focal for more information about this version of the RS-485 card.

6.0 Media Converter Cards

Media Converter Cards use their own optical link, either on a separate fiber or combined as separate wavelengths on an existing fiber, to transmit typically high data rate signals, such as high resolution sonars, HD-SDI video, 100 Mbps Ethernet, and high-speed ECL/PECL data links. The media converter cards can be also be used in a standalone format with their own small enclosure and power supply.

Various hybrid cards are also available which combine several signal types (optical, data, video) on a single card, for example the high-density boards used on high-density remote racks.

6.1 ECL-02 - Dual ECL Interface Board

Card P/N 903-5050-XX

The ECL-02 Dual ECL interface board is an optical interface card providing fiber optic transmission of two high-speed ECL signals between the remote and console modules. Each channel may be independently configured as an input or output: typically both channels are inputs at the remote end for sonar heads, and both channels are outputs at the console end for connection to sonar processing units. The ECL-02 may be installed in any data card slot or in a standalone mode with its own small enclosure

A front panel view of the card in Figure 6.1-1 shows connector and LED locations. The data mode LEDs by each channel indicate the current optical and signal mode: red LEDs mark an ECL input, usually on the remote card, and green LEDs mark an ECL output, usually on the console card. Both channels A and B have dual SMB connectors. In single ended configurations, such as the Reson 81xx, only the ECL+ input/output SMB connectors are used.

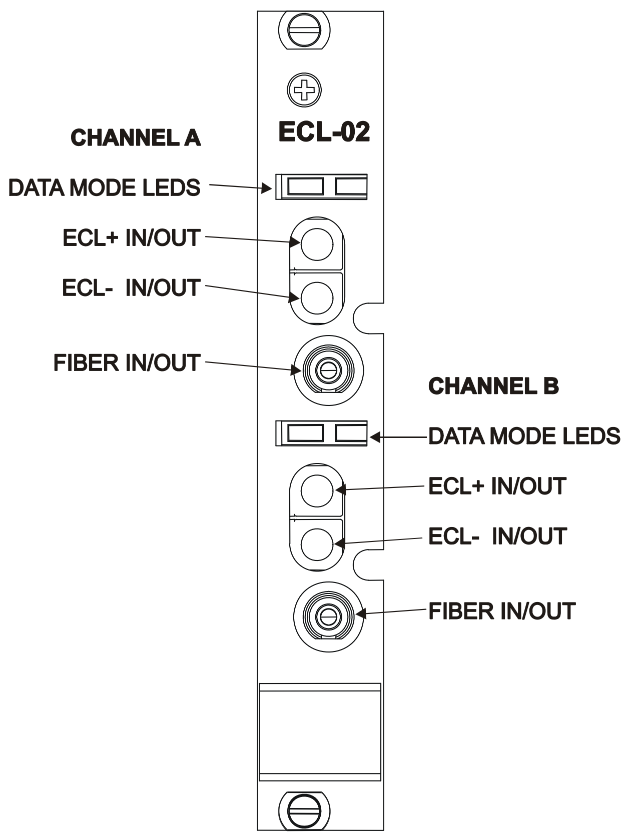


Figure 6.1-1: ECL-02 Front Panel

Supported sonars include the Reson 81xx series, Klein, and Kongsberg EM2000 and EM3000. Inputs and outputs may be switch configured for 50 ohm or 75 ohm input and for single ended or differential ECL inputs. Input lines are AC-coupled, allowing the ECL input to be standard ECL, PECL, or Pseudo-ECL. Input cabling should be chosen with the same impedance as the ECL inputs. Output lines are AC-coupled with approximately 0.8 Vpp amplitude.

The ECL-02 card uses two separate optical wavelengths, one for each channel, typically in an uplink configuration for both channels. (Consult Focal for other possible configurations.) Both channels may be combined on a separate fiber than that used by the FMB-X-2.5 card or, by using CWDM wavelengths, tapped on to the existing fiber used by the FMB-X-2.5, which requires internal or external fiber jumpers. External access is configured for either the front panel fiber bushings or through the small panel cutouts for passing a fiber directly through to an internal bushing. Internal jumpers, if used, are connected to bushings on the ECL card and routed through the bottom of the rack to the FMB-X-2.5 card.

Typically, on factory installed systems, internal jumpers are routed inside the rack to connect the ECL optical signals into the FMB-X-2.5 fiber. ECL-02 cards installed in field systems after shipment usually use a single external fiber jumper from the FMB-X-2.5 card to the top bushing or cut-out on the ECL card, with a second fiber leaving the bottom bushing or cut-out to carry the combined FMB-X-2.5/ECL optical signals to the sea cable. When used in this fashion, the ECL card bypass typically adds < 2.5 dB loss to the FMB flux budget. Dual FMB-X-2.5 systems must use internal fiber jumpers for ECL optical integration.

Table 6.1-1 below shows the switch settings for the ECL configurations. The ECL link supports data rates from 30-150 Mbps.

Table 6.1-1: ECL-02R/C Configuration Switch Settings

Channel 1 Switch	Channel 2 Switch	ECL-02R		ECL-02C	
		SINGLE ENDED INPUT, 75 OHM (Reson 81XX)	DIFFERENTIAL INPUT, 50 OHM (Klein, EM2000/3000)	SINGLE ENDED OUTPUT, 75 OHM (Reson 81XX)	DIFFERENTIAL OUTPUT, 50 OHM (Klein, EM2000/3000)
SW1:1	**SW6:1**	CLOSED	CLOSED	OPEN	OPEN
SW1:2	**SW6:2**	OPEN	CLOSED	OPEN	OPEN
SW2:1	**SW7:1**	CLOSED	OPEN	N/A	N/A
SW2:2	**SW7:2**	CLOSED	OPEN	N/A	N/A
SW3:1	**SW8:1**	OPEN	CLOSED	N/A	N/A
SW3:2	**SW8:2**	OPEN	CLOSED	N/A	N/A
SW4:1	**SW5:1**	OPEN	OPEN	CLOSED	CLOSED
SW4:2	**SW5:2**	OPEN	OPEN	OPEN	CLOSED
SW9:1	**SW11:1**	N/A	N/A	OPEN	CLOSED
SW9:2	**SW11:2**	N/A	N/A	OPEN	CLOSED
SW10:1	**SW12:1**	N/A	N/A	OPEN	CLOSED
SW10:2	**SW12:2**	N/A	N/A	OPEN	CLOSED

CLOSED = ON, OPEN = OFF, N/A = NOT APPLICABLE

Figure 6.1-2 is a view of the PCBA showing the location of the switches. Circuit 1 corresponds to the switch at the pin 1 end of the DIP package. Pin 1 is marked by a rectangular pad on the PCB and a "1" on the DIP package itself.

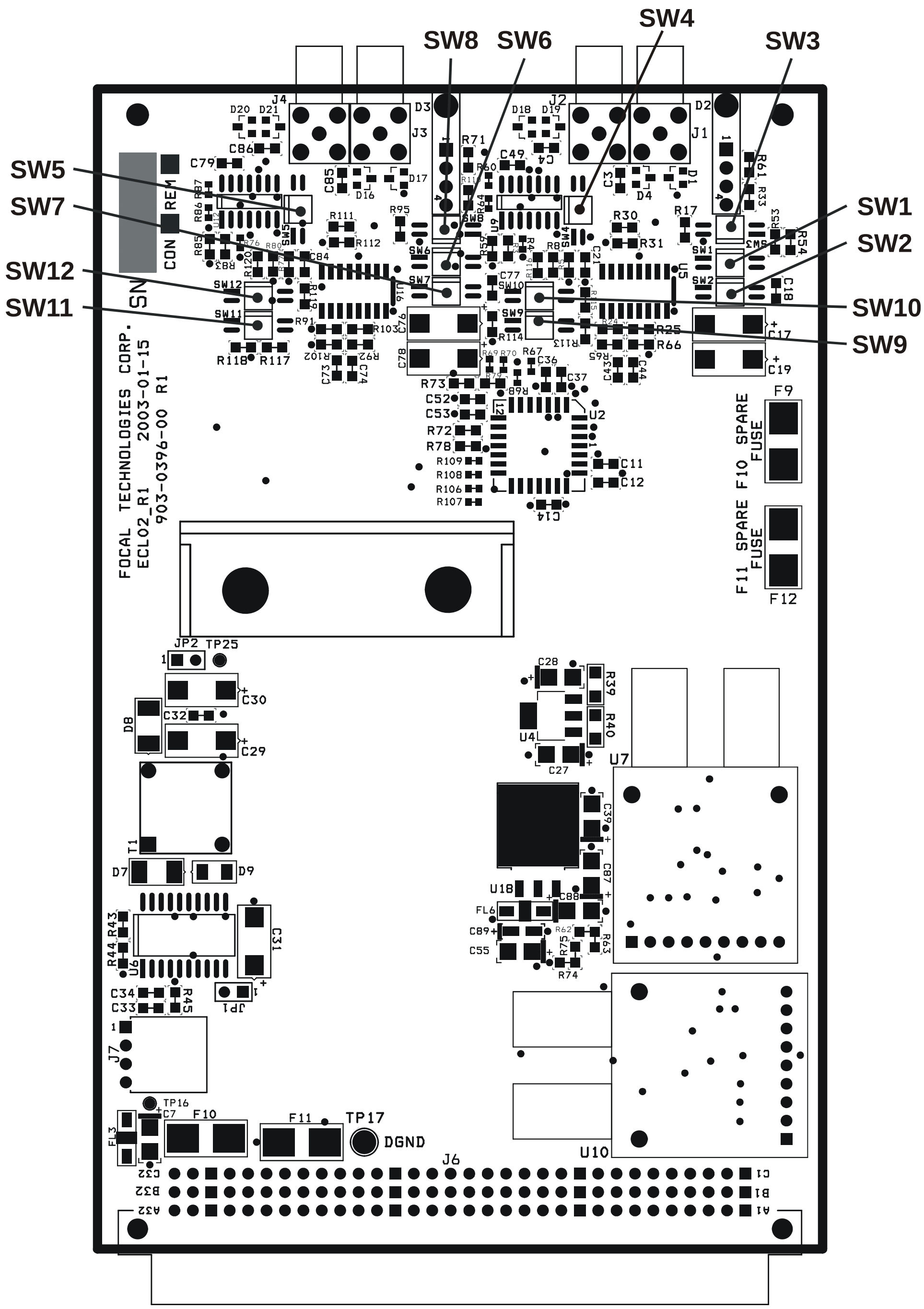


Figure 6.1-2: ECL-02 PCBA

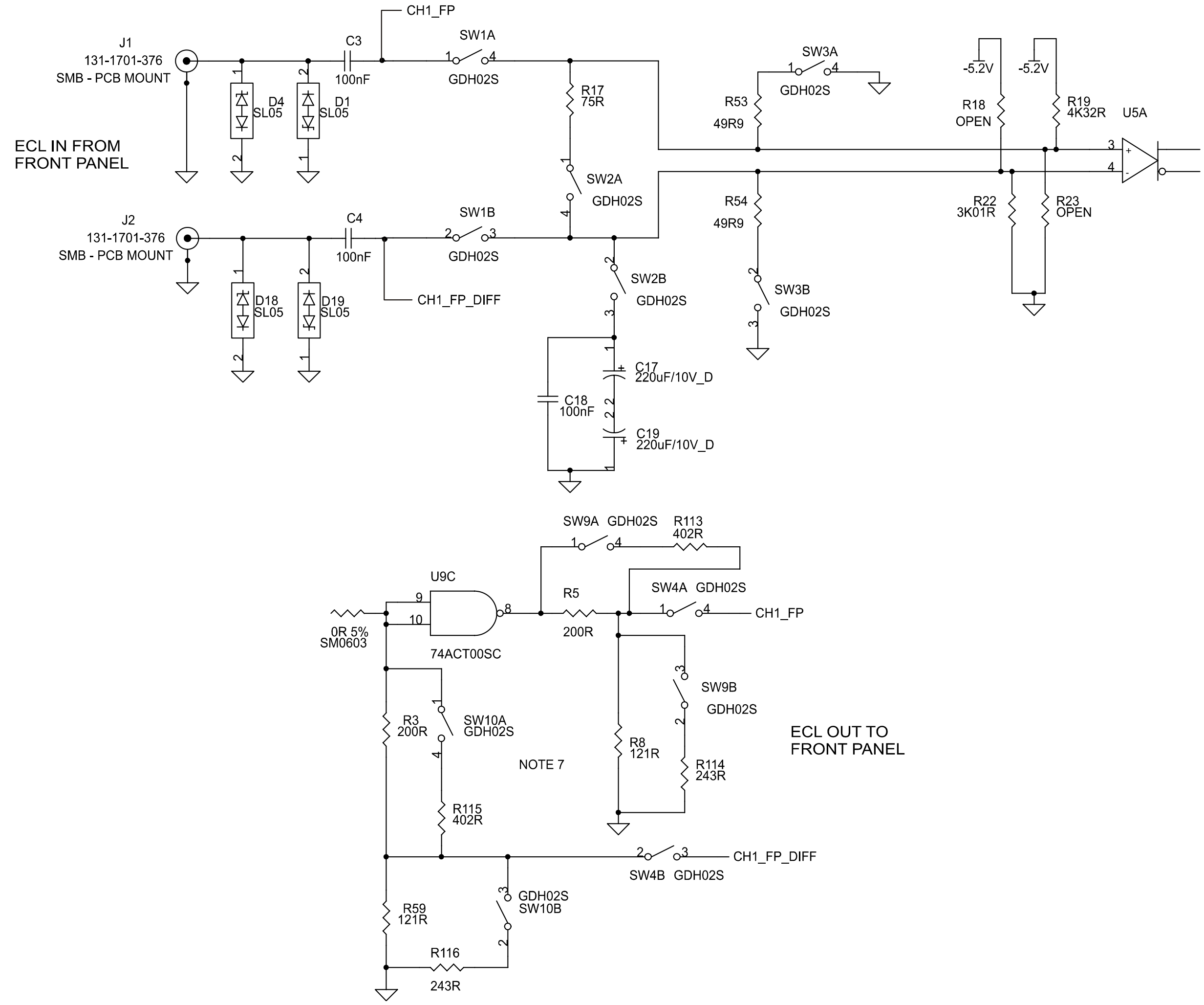


Figure 4.11-3: ECL-02 Input Schematic (Top) and Output Schematic (Bottom)

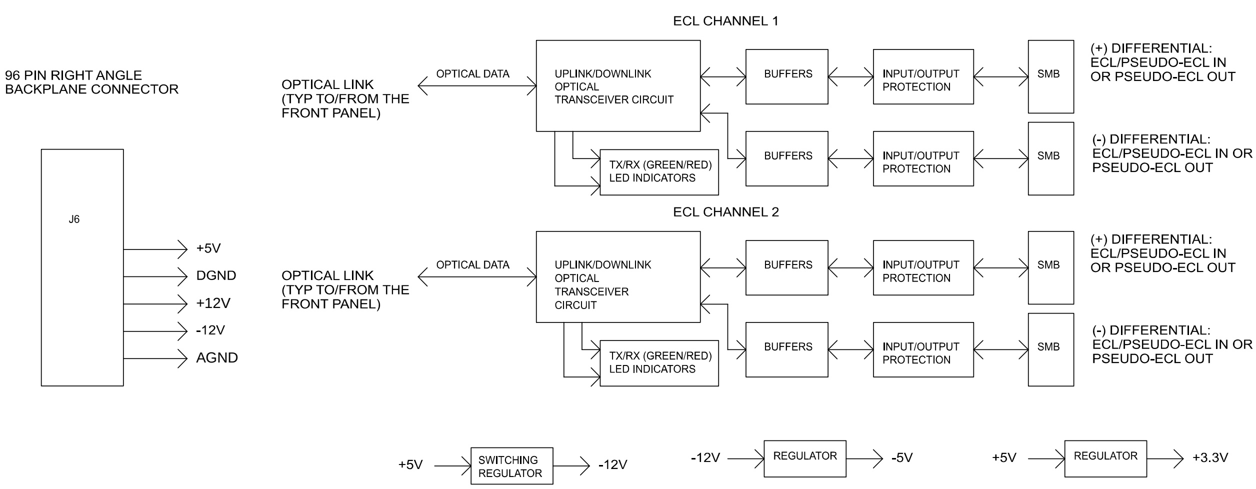


Figure 4.11-4: ECL-02 Block Diagram

6.2 EIB-10/100 Ethernet Interface Board

Card P/N 903-5044-XX

The EIB-10/100 Ethernet Interface Board provides three RJ-45 ports of 10Base-T (10 Mbps) or 100Base-TX (100 Mbps) Ethernet inputs to an internal switching hub (switch). Each port auto-negotiates the data rate and duplex mode of the input.

The EIB-10/100 Ethernet Board is available in two versions, one is electrical and the other is optical. This section provides information about the optical version of the EIB-10/100. For information about the electrical version of the card, refer to section 5.5. A front panel view of the card in Figure 6.2-1 shows pin and LED locations on the RJ-45 jacks.

Unlike simple repeating hubs, which copy all incoming packets on one port to all other ports, switching hubs have the ability to store and forward packets while controlling the flow of packets through each port independently. Unicast packets are forwarded to only one port, greatly improving network efficiency.

The optical version of the EIB-10/100 may be installed in any data card slot or in a standalone mode with a small enclosure. The optical link itself is full-duplex 100Base-FX Ethernet protocol, which operates collision free over long fiber links of up to 10 km or more, limited only by optical power budget. This card operates on its own set of optical wavelengths. Typically, the cards use CWDM wavelengths to allow integration on the same fiber used by the FMB-X-2.5 cards, though they may also be run over separate fibers using standard 1310/1550 nm wavelengths.

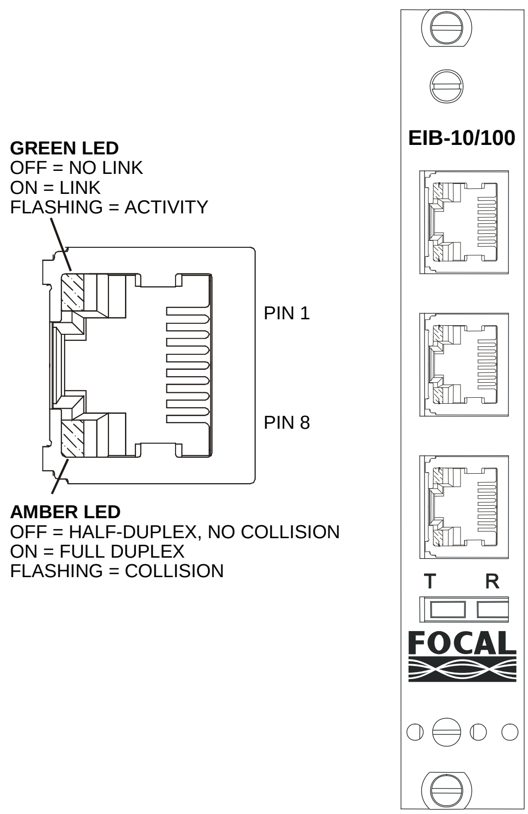


Figure 6.2-1: EIB-10/100 Front Panel

6.2.1 Input/Output

The front panel Input/Output ports, RJ-45 pin assignments and front panel LEDs of the optical and electrical versions of the EIB-10/100 card are the same. Please refer to section 5.5.1 of this manual for more details.

6.2.2 Configuration Settings

The configuration settings of the optical and electrical versions of the EIB-10/100 card are the same. Please refer to section 5.5.2 of this manual for more details.

6.2.3 Flow Control

The flow control performed by the EIB-10/100 card is the same for both versions of the card (optical and electrical). Please refer to section 5.5.3 of this manual for more details.

6.2.4 Optical Configuration

Most optical versions of the EIB-10/100 card are CWDM-based modules identified with the wavelength of the CWDM laser as a suffix, e.g. EIB-10/100-1470 has a 1470 nm CWDM laser. The CWDM laser allows the card to be integrated in a "pure" CWDM system, where all cards use CWDM components, or with standard 1310/1550 nm FMBs, which may be used with 1470 nm and 1490 nm wavelengths only.

Each EIB-10/100 optical card has two available optical ports, common and bypass, that allow the card to be "daisy chained" to other optical cards, such as FMB-X-2.5 cards. Common and bypass ports are accessible either through notches in the front panel, via internal jumpers routed underneath the cards, or from an adjacent optical access panel with fiber optic bushings.

The position of the EIB-10/100 card in the "optical chain" determines whether the bypass port is needed. If the EIB-10/100 is at the end of the chain, the bypass port is not used. This is typically the case when combined with CWDM-based FMBs. If the EIB-10/100 is not at the end of the optical chain, the common port is attached to the upstream end (closer to the umbilical) and the bypass is connected to the downstream end (further from the umbilical). This is typically the case when combining the EIB-10/100 with 1310/1550 nm FMBs.

Figure 6.2-2 shows the CWDM optical connections on the EIB-10/100 cards. Typical bypass loss is less than 2.5 dB for wavelengths passed through the EIB-10/100 to other cards, such as FMB-X-2.5 cards. When integrated with an FMB-X-2.5 card at the factory, optical jumpers are internally routed between the FMB-X-2.5 and the EIB-10/100. When integrated with an FMB-X-2.5 in the field, optical jumpers may be routed externally between the front panel bushings of the FMB-X-2.5 and an enclosed, standalone version of the EIB-10/100.

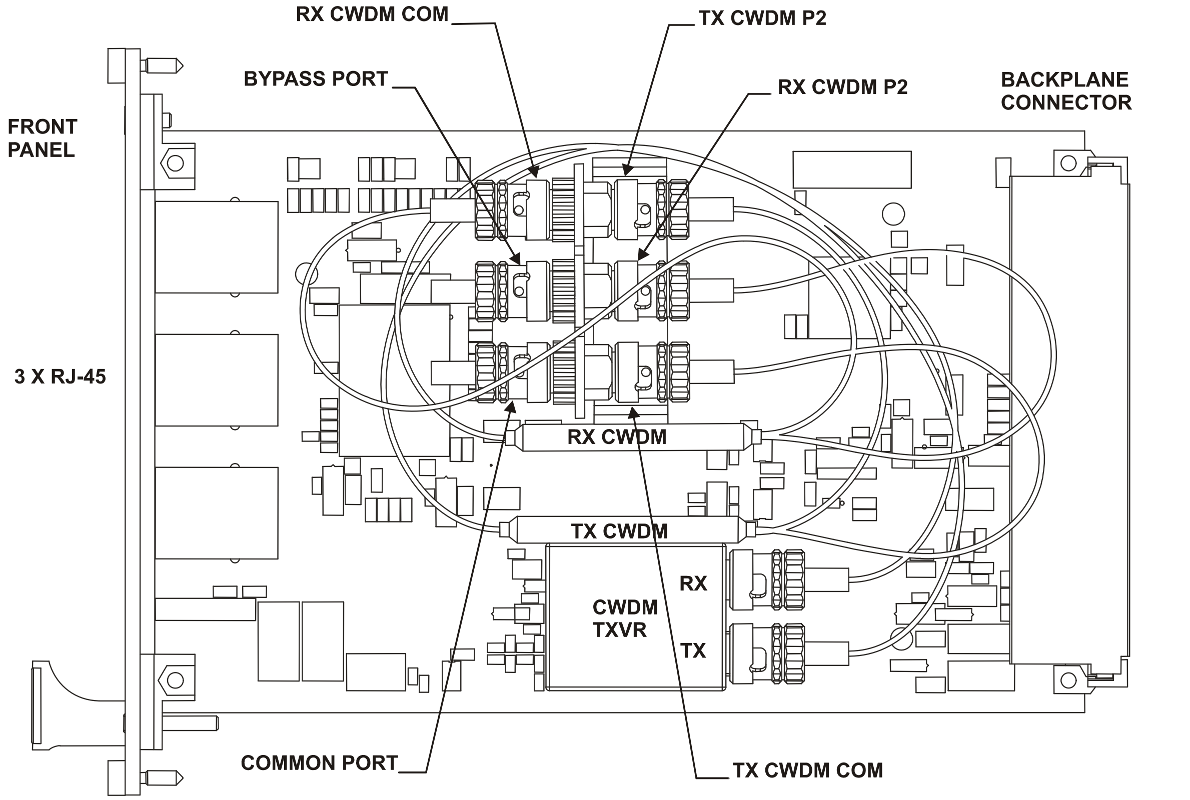


Figure 6.2-2: EIB-10/100 Optics Configuration

6.3 GBES 4 Port Gigabit Ethernet Switch Board

Card P/N 903-5087-XX

The GBES (Quad Gigabit Ethernet Switch) interface board is a media converter card for fiber optic transmission of Gigabit Ethernet between the remote and console modules. The GBES card operates as a 4-port switch, eliminating the need for external switches prior to conversion of the electrical Ethernet links to optical signals. A front panel view of the card in Figure 6.3-1 shows pin and LED locations on the RJ-45 jacks.

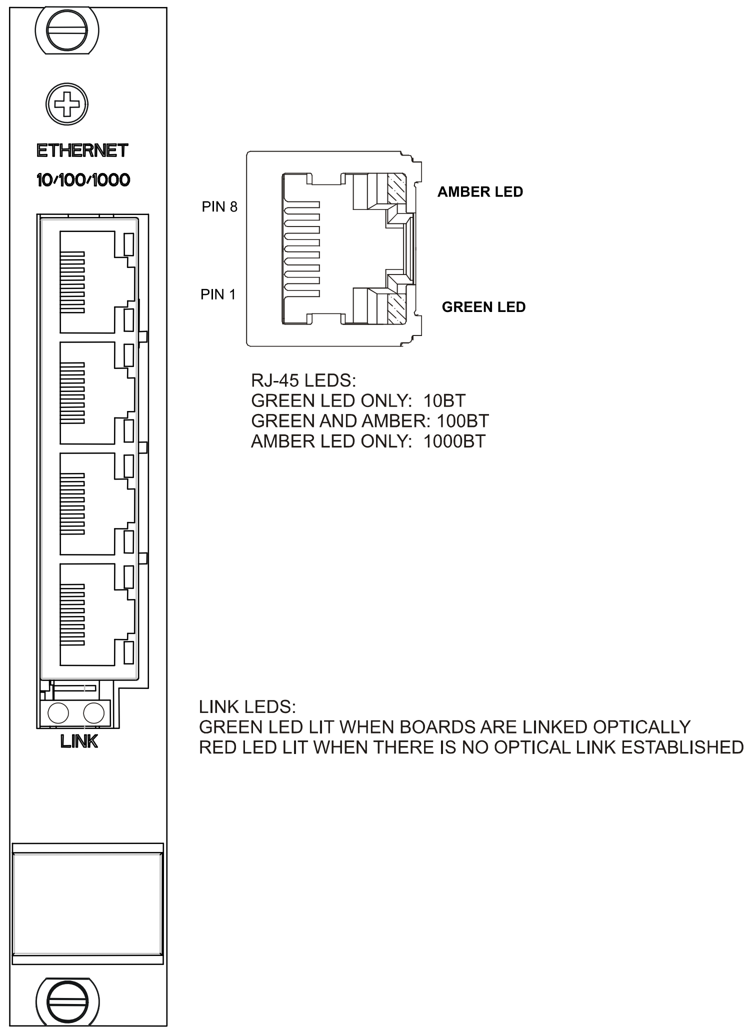


Figure 6.3-1: GBES Front Panel

6.3.1 Input/Output

The GBES media converter card is used to transmit up to four copper ports of 10/100/1000 Mbps Ethernet traffic over a bidirectional optical link via an on-board SFP optical transceiver. Packet traffic on the optical link is shared among the four copper ports, and the maximum aggregate throughput of the GBES card is 1 Gbps in each uplink and downlink direction. Standard flow control procedures are used by the switch to throttle back incoming packets when buffers are full, which may or may not be relevant to specific applications, e.g. by causing delays in packet deliveries.

Ethernet connections are made using standard RJ-45 jacks with standard Gigabit Ethernet pinouts. The copper interface meets or exceeds the IEEE 802.3ab standard. External cables should meet or exceed Cat 5e EIA/TIA 568A/B specifications.

GBES cards in a Model 903 system use a CWDM optical channel wavelength (e.g. 1471 nm) for an uplink and a separate CWDM channel (e.g. 1491 nm) as a downlink.

Optical output power of the GBES card is typically > -4 dBm at the LC bushing of the on-board SFP transceiver. Optical sensitivity of the GBES card is typically < -28dBm, also at the on-board SFP transceiver. However, overall flux budget of any optical link in the system is specified as 20 dB minimum, accounting for losses in CWDMs and connectors.

Diagnostics can be retrieved from the GBES through the Backplane -X and the FMB-X-2.5 diagnostic ports. The diagnostics information consists of the switch settings, optical link status, SFP diagnostics and RJ45 port link status.

6.3.2 Configuration Settings

A side view of the GBES card is given in Figure 6.3-2. Default switch settings for the GBES card are given in Table 6.3-1. Note that both switches are for factory use only and should never be changed from the default positions.

Table 6.3-1: GBES Switches Default Settings

SWITCH 1				
	SW1:1	**SW1:2**	**SW1:3**	**SW1:4**
DEFAULT	OFF	ON	OFF	X
SWITCH 2				
	SW2:1	**SW2:2**	**SW2:3**	**SW2:4**
DEFAULT	OFF	ON	X	X

X = DON'T CARE

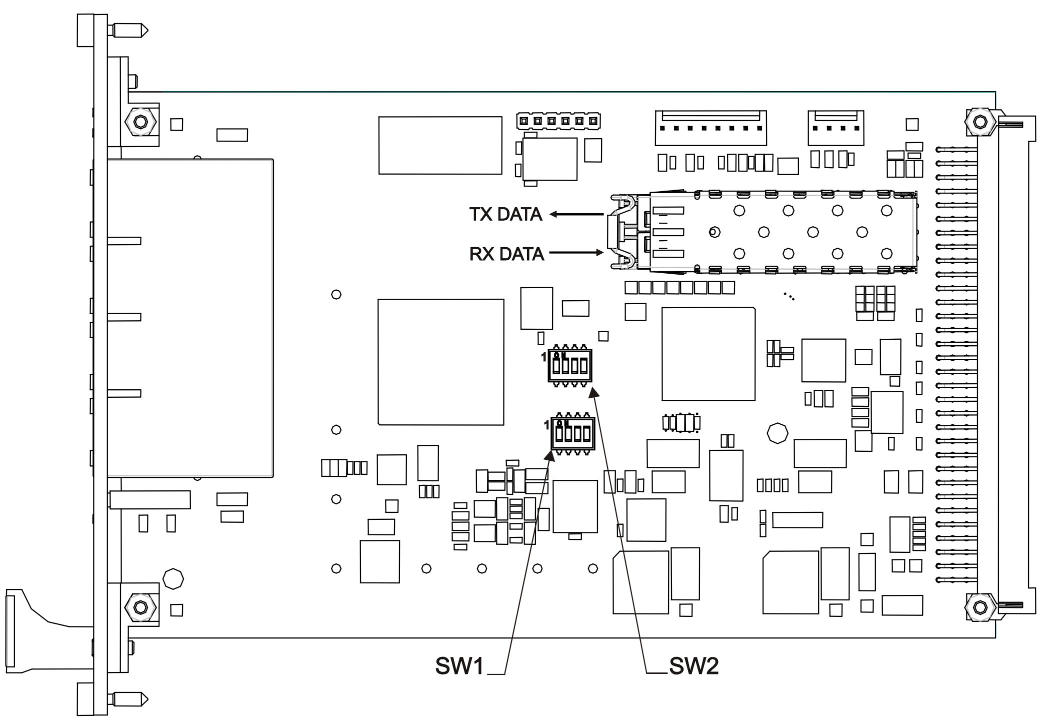


Figure 6.3-2: GBES Side View

6.4 HD-SDI Video Board

Card P/N 903-5060-XX

The HD-SDI video board is a media converter card for fiber optic transmission of one high speed, high-definition digital video signal between the remote and console modules. The HD-SDI board is designed to receive and transmit signals that conform to the SMPTE 292M specification.

The HD-SDI card is a Model 907 PC/104 form-factor card mounted on a Model 907 Eurocard adaptor board. The adaptor board provides the necessary power supply regulation and optical bushings to connect the 907 card to a 903 system. The 907-HDV (HD-SDI) media converter card mounted on the 907-EURO (Eurocard adaptor) uses an SFP transceiver with a high data rate to support the 1.5 Gbaud signals.

6.4.1 Input/Output

The HD-SDI-R card is configured for digital video input at the remote unit; the HD-SDI-C card is configured for digital video output at the console unit. The HD-SDI cards may be installed in any data or media converter slot. Typically slots H and I are used for media converter cards only, which get power from the backplane but transmit and receive optically.

At the remote (subsea) end, the camera signal is input at SMB jack J1, as shown in the figure below. At the console (surface) end, the HD-SDI monitor or signal processing equipment is attached to jack J3. A front panel view of the card shown in Figure 6.4-1 indicates the location of the external LED connector.

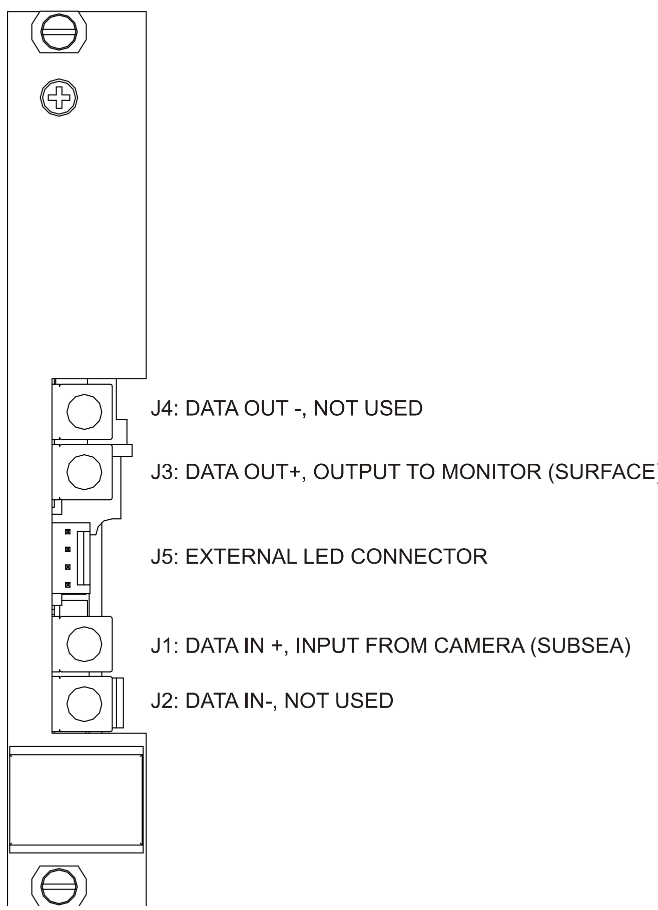


Figure 6.4-1: HD-SDI Front Panel

Because of the high bandwidth of the HD-SDI signal, any external cabling and connectorization must adhere to proper RF practices. For example, 75-ohm cabling and connectors should be used throughout the entire link. Any connectors or cables with the wrong impedance, for example with straight wired pins and/or no shielding, will cause reflections and signal degradation. Shielded coaxial cables and connections are recommended throughout the wiring chain.

The LEDs on the 907-HDV board are not visible at the front panel once the card is mounted on the 907-EURO. For this purpose, a connector (J5) is provided for attaching external LEDs. The pinout details and LED connections are described in Appendix A – Connector Part Numbers and Pin Assignments.

6.4.2 Configuration Settings

The HD-SDI card can be configured to support generic ECL and PECL (Positive Emitter Coupled Logic) formats. The extra SMB connectors (J2 and J4) are used when the board is configured for differential ECL inputs and outputs.

Switch SW1 sets the receiver equalization for the remote card (see Figure 6.4-2). For HD-SDI operation, both SW1 switches (SW1A and SW1B) must be ON and SW2A switches must be OFF. Switch SW2 sets the slew rate limit, which is generally enabled only for non-HD-SDI signals. For ECL and PECL operation, both SW1 switches (SW1A and SW1B) must be OFF and SW2A must be ON.

Table 6.4-1 and Table 6.4-2 show SW1 and SW2 options respectively.

Table 6.4-1: SW1 Options

Equalizer Options	SW1A	SW1B	Card Operation
Enable receive equalizer SMPTE-292M/259M (default)	ON	ON	HD-SDI
Bypass receive equalizer (not used)	OFF	OFF	ECL and PECL*

Table 6.4-2: SW2 Options

Slew Rate Mode	SW2A	SW2B	Card Operation
Data Out/Slew Rate Min	ON	X	ECL and PECL*
Data Out/Slew Rate Max SMPTE-292M / 259M (default)	OFF	X	HD-SDI

X = DON'T CARE

* Please contact Focal for more information about ECL and PECL operation of the HD-SDI card.

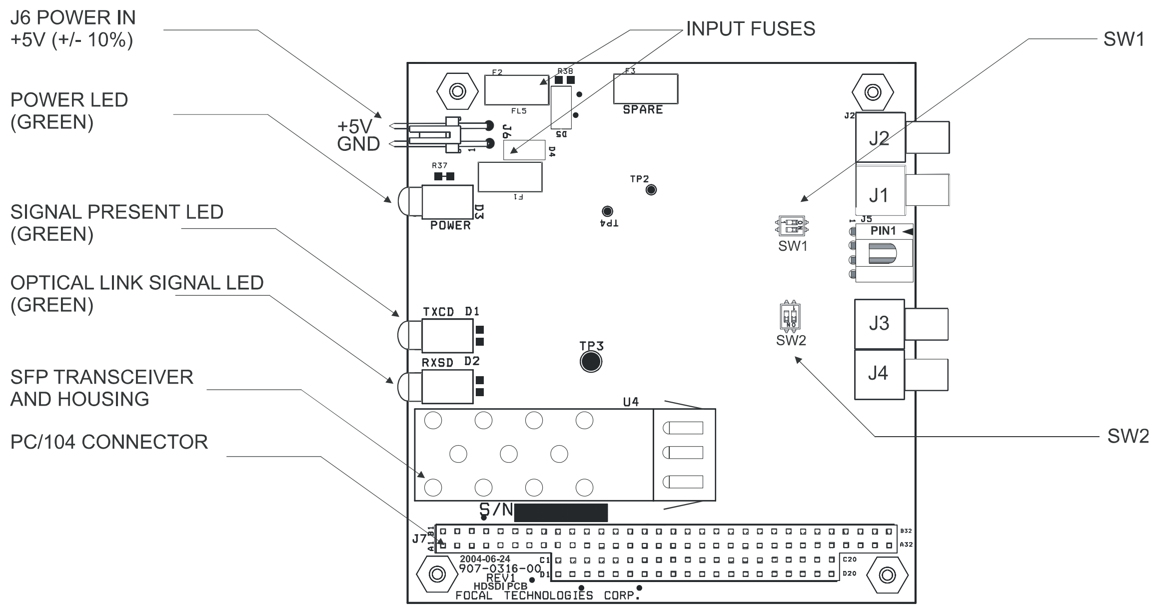


Figure 6.4-2: 907-HDV (HD-SDI) Media Converter Card

HD-SDI cards use a single CWDM optical channel wavelength (e.g. 1611 nm) for an uplink. If configured for bidirectional ECL/PECL operation, two separate CWDM wavelengths are used.

Optical output power of the HD-SDI card is typically > -4 dBm at the optical access bushing shown in the figure below. Optical sensitivity of the HD-SDI card is typically < -28dBm at the on-board SFP transceiver. Overall flux budget of any optical link in the system is specified for at least 20dB, accounting for losses in CWDMs and connectors.

A side view of HD-SDI card is shown below.

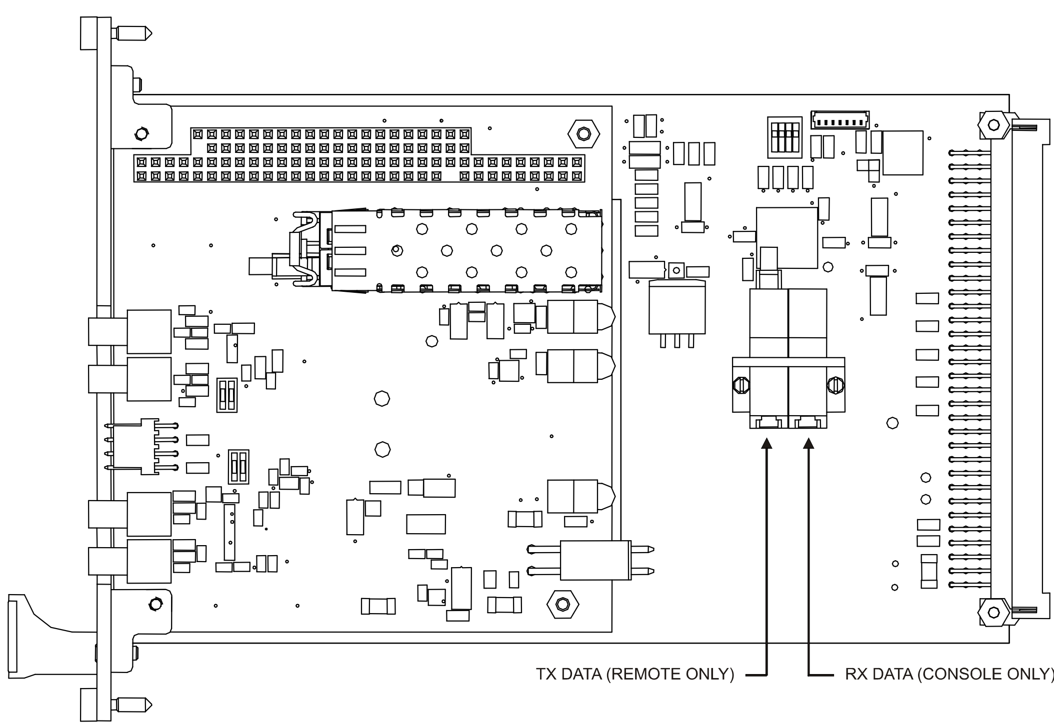


Figure 6.4-3: HD-SDI Card Side View

7.0 Fiber Optics

7.1 Safety

Lasers used in the Model 903 are Class I laser products. No control measures or warning labels are required, although any needless exposure of the eye should be avoided as a matter of good practice and fiber connectors should never be viewed with optical magnification unless all sources are disconnected.

7.2 System Design

The Model 903 fiber optic transmission system contains all the necessary transmitters, receivers, and couplers, including WDMs, to provide a single fiber optic interface to a user’s cable or umbilical. A block diagram of a typical system is provided in the following figure. The system is designed to work with up to two fiber optic rotary joints and up to 10 km of SMF-28 singlemode fiber, depending on the fiber's bandwidth. Front panel connectors are typically ST-PC but other options are available.

System design consists largely of preparing a flux budget as provided in the example in Table 7.2-1. System losses in decibels (dB) are summed and subtracted from the optical budget as calculated from the difference between the transmitter launch power and the receiver’s sensitivity. Some margin, typically 3-6 dB, should be allocated for temperature and aging effects as well as degradation of the external cable and connectors. For long singlemode cables (e.g. > 6 Km), an additional 1-2 dB should be allowed for dispersion.

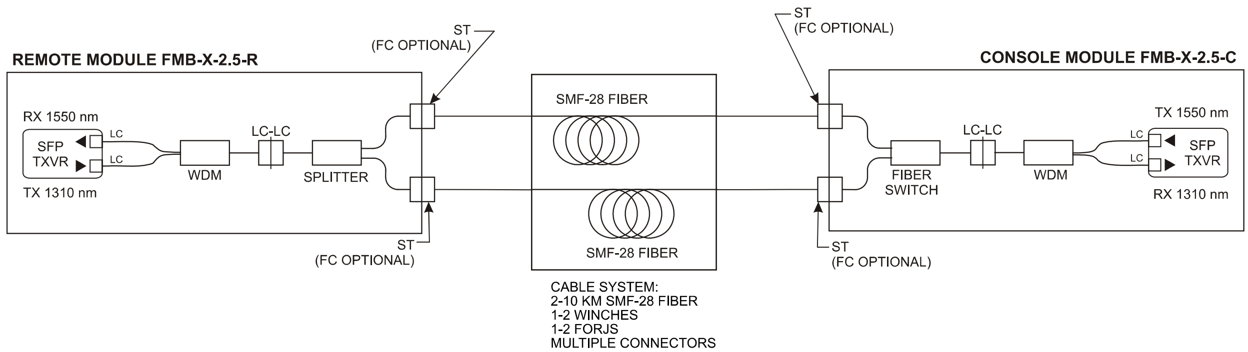


Figure 7.2-1: Block Diagram of Model 903 Fiber Optic Transmission System

The standard Model 903 has an optical power budget of at least 20 dB for the uplink and downlink. Typical values are closer to 24 dB for both directions, especially for short cables. Internal WDMs, switches, splitters, and connectors are already accounted for and the full 20 dB budget is available between the front panel connectors.

Return loss or back reflection is a consideration when lasers are used in high bit rate systems. For the Model 903, the use of low return loss PC finish connectors is required for proper operation. Expanded beam connectors with air gaps should be avoided. Total system return loss should be kept greater than 25 dB to maximize flux budget.

Kinks, tight bends, or microbending in umbilicals and tethers may cause excessive loss at 1550 nm. Ensure that any measurements of insertion loss are conducted at both 1310 nm and 1550 nm. In some cases, measurements at 1310 nm may be fine while losses at 1550 nm are excessive.

Table 7.2-1: Typical ROV System Flux Budget

Fiber Loss	0.4 dB/km @ 1310 nm, 0.3 dB/km @ 1550 nm
Connector (ST/PC)	0.3 dB/conn
FORJ Loss (Max.)	4.0 dB

LINK	**VIDEO/DATA (Uplink)**	**DATA (Downlink)**
Optical Data Rate	2.5 GBaud	2.5 GBaud
Direction	ROV to Surface (Remote to Console)	Surface to ROV (Console to Remote)
Wavelength	1310 nm	1550 nm

Typical Output Power at Front Panel Connector	**-3.0**	**1.0**	**dBm**
Losses:			
Connector	-0.3	-0.3	dB
Connector	-0.3	-0.3	dB
TMS FORJ	-4.0	-4.0	dB
Connector	-0.3	-0.3	dB
Connector	-0.3	-0.3	dB
Cable (for 10 km length)	-4.0	-3.0	dB
Connector	-0.3	-0.3	dB
Connector	-0.3	-0.3	dB
Winch FORJ	-4.0	-4.0	dB
Connector	-0.3	-0.3	dB
Connector	-0.3	-0.3	dB
Total Losses	**-14.4**	**-13.4**	**dB**
Received Power	**-17.4**	**-12.4**	**dBm**
Dispersion Penalty	-1.0	-1.0	dB
Required Sensitivity at Front Panel Connector (Far End)	**-18.4**	**-13.4**	**dBm**
Typical sensitivity at front panel connector (Far End)	-28.0	-28.0	dBm
Available Margin	9.6	14.6	dB

7.3 Fiber Handling Guidelines

1. Observe the bend radius of fiber optic cables at all times

When mounting, disassembling, or reassembling the cards, ensure that no fibers are subjected to bends in excess of those held by the natural routing of the fibers. The minimum bend radius of the fibers should generally be no less than 25 mm, though single loops may be less than this – as low as 15 mm – without damaging the fibers. Keep in mind that allowable values are dependent on the type of fiber and the environment, and cable manufacturers typically specify the minimum bend radius. Avoid even temporary bends with a radius less than 25 mm, which may induce cracks that affect long-term reliability of the fibers.

2. Ensure fiber optic components are of the same type

All jumpers, cables, connectors, couplers, and Fiber Optic Rotary Joints (FORJs) used in the external optical system connecting the remote to console fiber multiplexer board (FMB) must use the same type of fiber. All components in the fiber link should be singlemode, typically Corning SMF-28 (9/125 µm) or equivalent. A single mismatched jumper in the system may cause intermittent or persistent optical link errors. Do not rely on cable jacket or connector colors alone to determine the type of optical fiber.

3. Use clean connectors

It is critical to ensure all fiber connectors are clean and free of dirt and debris. Even a small amount of dirt or fluid contaminant may degrade link performance, and most reported optical link problems are due simply to poor or contaminated optical connections.

- Keep protective dust covers on bushings, turrets and fiber connectors when not in use.
- Do not touch the white ceramic ferrules of the connectors with bare hands or objects, other than cleaning materials.
- Prior to making a fiber connection, clean the barrel and tip of the ferrule using a suitable solvent, such as reagent grade isopropyl alcohol, and a lint free optics cleaning tissue, such as *Kimwipes® EX-L*. Carefully dab any dirt or debris off the face of the ceramic ferrules. Excessive dirt may need to be cleared with pressurized air from a can prior to wiping the ferrule to avoid scratching the fiber itself. Do not used air from a compressor as it may be contaminated with oil.
- During mating or unmating of fiber connectors with bushings, keep the connector aligned as straight as possible. Avoid side loading the ceramic ferrule, which can crack the internal alignment sleeve in the bushing.
- Ideally each fiber connector should be inspected with a handheld fiber microscope prior to final assembly to ensure there are no scratches, pits, debris, or fluid contamination on the fiber face.

> **NEVER** look into the end of a fiber when it is plugged into a transceiver or active fiber, especially when using a magnifying instrument, such as a fiber microscope.

Figure 7.3-1 shows an LC connector which is a small form-factor fiber optic connector that uses a 1.25 mm ferrule and incorporates a push-and-latch design similar to an RJ-45 connector. Figure 7.3-2 shows an ST fiber optic connector that uses a 2.5 mm ferrule. The ST connector is latched into place by twisting to engage a spring-loaded bayonet socket.

Figure 7.3-1: LC connector

Figure 7.3-2: ST Connector

4. **Maintain good optical connections**

- Ensure connectors are well secured in the bushing and are not side loaded.
- Never clamp down on fiber. For example, when securing the fiber to a PCB, do not use a tight string, clamps or any mechanical mean to tightly bind the fiber. Local stress on the fiber increases loss and may break the fiber. Hard epoxies should also be avoided when securing fibers on a PCB.
- Never use the fiber to pick up or support the weight of the device to which it is attached.
- Follow ESD guidelines for handling electrostatic sensitive devices, such as cards with electro-optical devices.
- SFP optical transceivers typically have a transmit and receive optical bushing (LC type), which requires dual fiber operation. The transmit side (Tx) and the receiver side (Rx) of an SFP is shown in Figure 7.3-3.

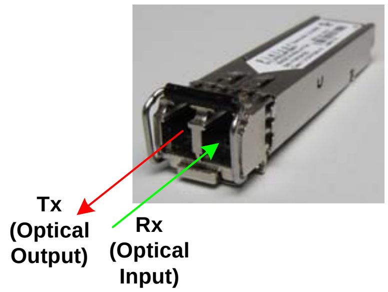


Figure 7.3-3: SFP Transceiver

5. **Maintain proper optical power levels**

Optical receivers will experience errors if the received optical power is too low. Ensure the total optical losses of the components in the external cable system (jumpers, cable, connectors, couplers, FORJ, etc.) are less than the specified optical power budget of the Model 903 system used. A calibrated optical power meter should be used for any detailed measurements or trouble-shooting.

Optical receivers can also saturate and experience errors if the received optical power is *too high*, especially when using high power transceivers. Use a 5 or 10 dB fixed attenuator in line with each fiber during bench tests or with short, low loss links to ensure a minimum level of attenuation is present. A variable optical attenuator (VOAT) can also be used for testing. In some high power systems, receivers can actually be damaged by excessive optical power, so a fixed attenuator is recommended even with a VOAT.

8.0 Installation and Operation

8.1 Mounting

The console module is a sub-rack intended to be mounted with the side flanges. Extender pieces, which are available separately, may be used for mounting to a standard 19" equipment rack. Refer to Figure 8.1-1 for spacing and dimensions of a typical Model 903 console card cage. Modules are also available in 19” 3U racks.

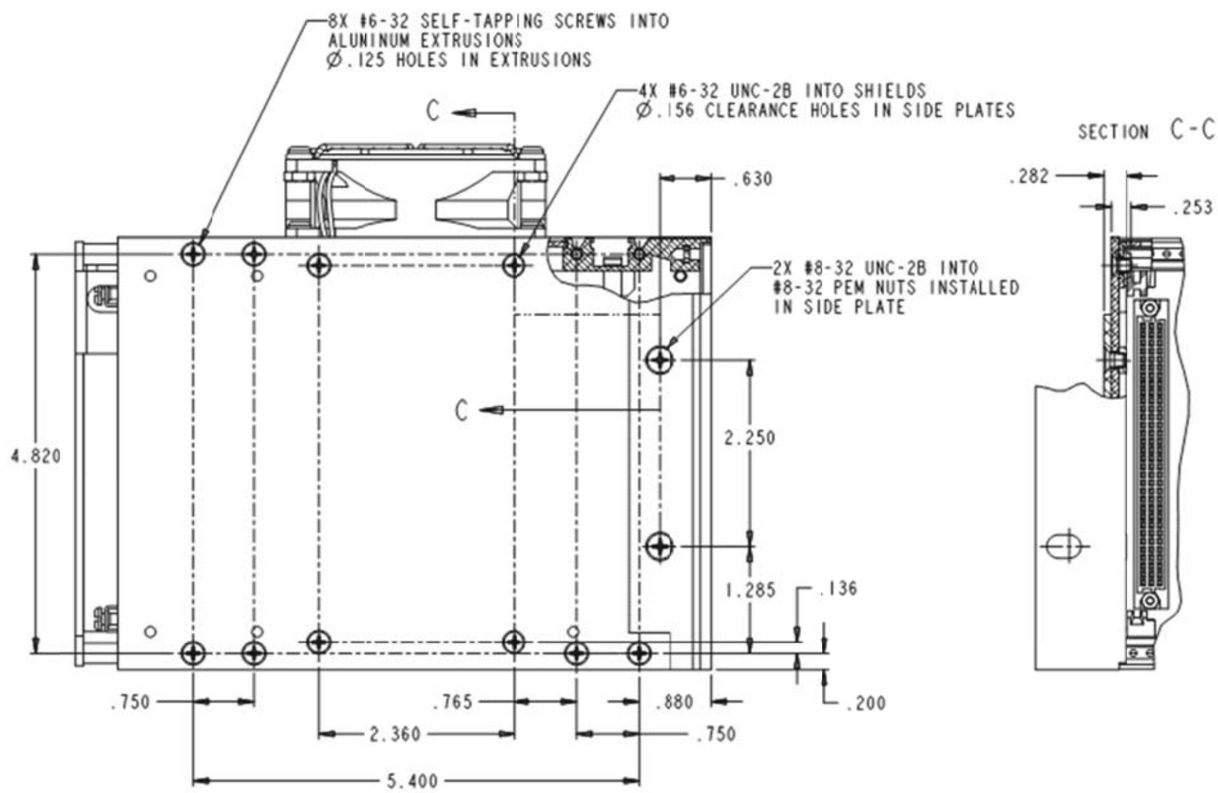


Figure 8.1-1: Side View of Typical Model 903 Console Card Cage

The remote module should be mounted to a frame in the ROV electronics pressure case. Side flanges, supplied separately, may be used. The four PEM nuts installed on each side plate, per Figure 8.1-2 and installation drawings, allow for other mounting arrangements. If the PEM nuts are used, ensure mating hardware does not extend past the PEM nut threads, as this may cause interference or damage to internally mounted cards.

The boards and backplane adhere to the Eurocard standard and can be installed in a user-supplied rack of this type with the appropriate Model 903 backplane. (A Model 903 backplane “-X” must be used — standard VME backplanes are not compatible.)

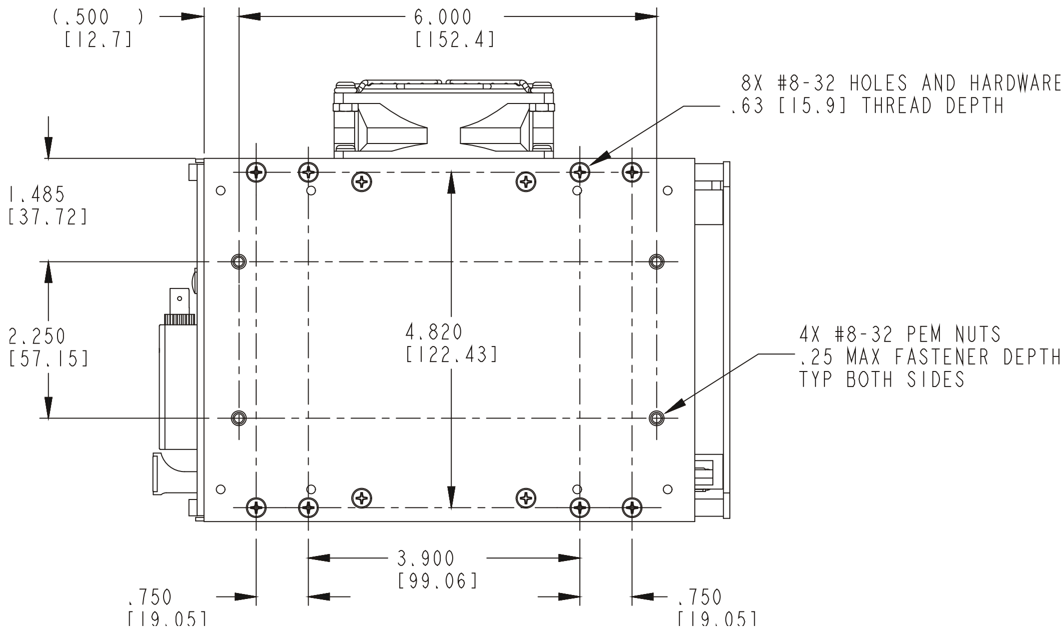


Figure 8.1-2: Side View of Typical Model 903 Remote Card Cage

8.2 Cooling

Forced air cooling of the Model 903 modules is necessary to maintain the warranty. Modules used inside enclosures such as ROV electronics cases, must be cooled using forced convection. Air cooling extends the ambient temperature range of operation and lifetime of the active components.

Each remote and console unit has a DC fan located on the top of the module. The fan is connected to DC power (MOLEX: 22-01-3027) on the backplane board. Fans can be removed as long as other devices are present to provide the same circulation and forced air cooling.

8.3 Diagnostics

Model 903 system diagnostics is available via the 10/100 Mbps Ethernet port (RJ-45) of the FMB-X-2.5 cards as Modbus TCP/IP or through an embedded web server. Diagnostic packets are handled as low priority and must be pulled by an external computer. When accessed, diagnostic packets use up less than 0.1 % of the Ethernet channel capacity. Diagnostic information can also be obtained via the RS-232 port (3.5 mm stereo jack) of the FMB-X-2.5. The RS-232 port on the FMB-X-2.5 is for diagnostic purposes only and is provided for backwards compatibility with old FMB systems and for advanced configuration of the 903 system.

Typical system diagnostic information includes the following:

- System power supply voltages at both the remote and console modules
- Temperature on the board surface of each FMB-X-2.5
- Condition of the two optical links between the two modules (including transmitted and received optical power)
- Presence of valid data and composite video signals at both the console and remote ends of the system.

Please refer to the FMB-X-2.5 diagnostics manual (P/N: 903-0622-00) for further details on the diagnostic capabilities of the Model 903 system.

8.4 Bench Test

BASIC LINK OPERATION

1. Basic operation of the uplink (remote to console) and downlink (console to remote) can be verified in a bench test simply by connecting the test jumper and the 5 or 10 dB attenuator supplied between a bushing on the remote FMB-X-2.5 turret and a bushing (F1 or F2 on dual fiber versions) on the console FMB-X-2.5. The fiber switch, if present, should either be in automatic mode or manually switched to the correct bushing.

2. A green "Link" LED on the console FMB-X-2.5 indicates a valid uplink and is lit when data frames are being transmitted from the remote end. A green "Link" LED on the remote FMB-X-2.5 indicates a valid downlink and is lit when data frames are being transmitted from the console end.

3. A red “Link” LED indicates either insufficient received optical power or loss of frame synchronization. Frame synchronization must be re-established before valid data frames are transmitted.

4. Loss of both the uplink and downlink — “Link” and “FO-RX” LEDs are red at both ends — suggests a problem with the optics between the two modules, such as a bad connector. (All optical connectors should be cleaned before use.)

Do not attempt to connect the high optical power FMBs directly with an ordinary fiber jumper. A minimum loss of 5 to 10 dB is required between the front panels of the console and remote units when using the high optical power FMBs to ensure the receivers are not saturated or damaged.

FLUX BUDGET TEST

1. To verify the uplink (remote to console) flux budget, measure the 1310 nm transmit power of the remote FMB-X-2.5 by connecting one of two bushings directly to a calibrated optical power meter (PM) using a short, low loss singlemode jumper. Ensure that the optical power meter is set for 1310 nm.

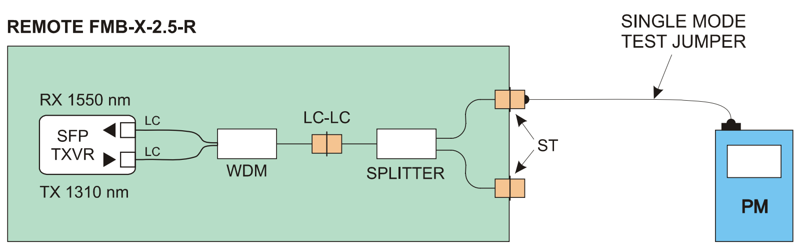


Figure 8.4-1: Flux Budget Test Setup – Transmit Optical Power Measurement

2. With the test jumper included, install a singlemode variable optical attenuator (VOAT) between the remote and console FMBs with a minimum 5 -10 dB loss. Adjust the VOAT until a “Link” LED on either one of the modules starts flickering or turns red, then reduce the loss to the point where both “Link” LEDs are solid green. (Alternatively, video signal quality can be used as a measure of link threshold, since black speckles will start to appear when the optical link is marginal.) Use of a fixed attenuator with the VOAT is recommended to avoid accidentally setting the loss too low. The following figure shows a setup example.

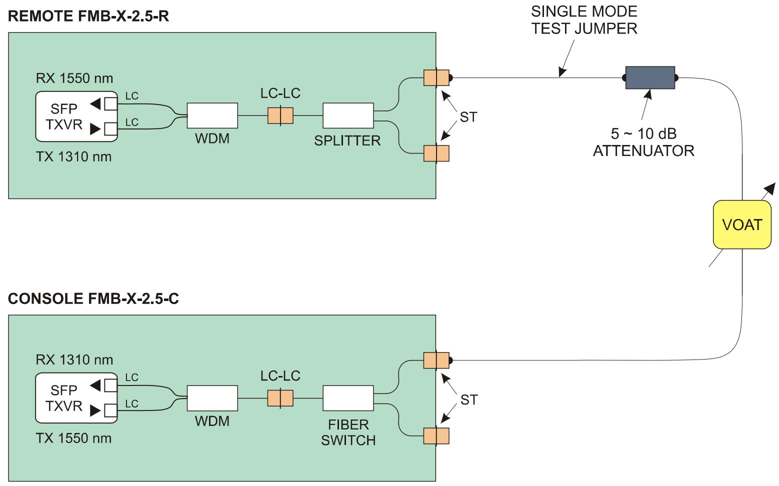


Figure 8.4-2: Flux Budget Test Setup – Link Threshold Measurement

3. Disconnect the end of the VOAT that is connected to the console FMB-X-2.5 and measure the optical power received (received sensitivity) by connecting that end of the VOAT to the optical power meter. The difference between this value and the transmit power previously measured is an estimate of flux budget. (Add a spool of fiber with the VOAT to simulate dispersion over long cables.)

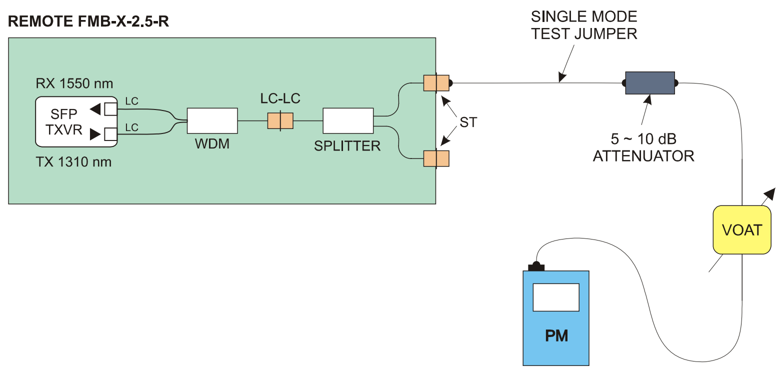


Figure 8.4-3: Flux Budget Test Setup – Received Sensitivity Measurement

4. Repeat steps 1-3 with connections reversed for the 1550 nm downlink (console to remote), ensuring the optical power meter is set for 1550 nm. Typically, the 1310 nm uplink fails before the 1550 nm downlink, so the test will only determine a worst case for the 1550 nm link. If an exact measurement of the 1550 nm flux budget is required, use external WDMs to isolate the 1310 nm and 1550 nm links on separate fibers.

   The following equations can be used to calculate the uplink and downlink flux budget (available power to make a fiber optic connection).

Up_FB [dB] = Rem_Tx_Pwr [dBm] – Con_Rx_Pwr [dBm]	**Down_FB [dB] = Con_Tx_Pwr [dBm] – Rem_Rx_Pwr [dBm]**
Where:	*Where:*
Up_FB [dB] = Uplink (remote to console) flux budget.	*Down_FB [dB] = Downlink (console to remote) flux budget.*
Rem_Tx_Pwr [dBm] = Measured transmit optical power at the remote end (power meter set for 1310 nm).	*Con_Tx_Pwr [dBm] = Measured transmit optical power at the console end (power meter set for 1550 nm).*
Con_Rx_Pwr [dBm] = Measured received optical power at the console end.	*Rem_Rx_Pwr [dBm] = Measured received optical power at the remote end.*

Example:

1310 nm Uplink Flux Budget (Up_FB)	1550 nm Downlink Flux Budget (Down_FB)
Rem_Tx_Pwr = -3.0 dBm	Con_Tx_Pwr = +1.0 dBm
Con_Rx_Pwr = -26 dBm	Rem_Rx_Pwr = -23 dBm
Up_FB = -3.0 dBm - (-26 dBm) = **23 dB**	**Down_FB =** +1.0 - (-23 dBm) = **24 dB**

The Model 903 1st or 2nd generation diagnostics software is also helpful during bench testing. Presence of data errors on the program's display screen may be used instead of the “Link” LEDs to determine the receiver thresholds. This provides a more accurate flux budget, since as received power drops, errors occur in the data frames before synchronization is lost. By default the FMB-X-2.5 cards are calibrated at the factory when a new 903 system is shipped and no calibration should be required, but if a calibration is deemed necessary then please consult the 903-0622-00 diagnostic manual.

When the Model 903 is initially turned on or when the optical connection is initially made, the uplink and downlink transmitters send synchronization frames to ensure reliable transmission before sending actual data frames. In the event that either the uplink or downlink is lost or exhibits significant frame errors, the multiplexer will revert both links to synchronization frames until reliable transmission is re-established. If, for example, the fiber jumper between the two modules is momentarily disconnected, the uplink and downlink transmitters will send synchronization frames until the connection is remade. When sufficient optical power is present, synchronization (lock) occurs within 3 milliseconds. Both data and synchronization frames are transmitted with a nominal 50% duty cycle allowing accurate and consistent measurements of optical power regardless of which frame type is active.

8.5 Maintenance

The unit requires no routine maintenance or calibration for the specified performance. Maintenance of the units is limited to cleaning the various components using the methods described below.

The outer surfaces of the modules can be cleaned using a damp cloth. Do not use solvents or damage to painted surfaces may result.

Dust or dirt on the cards can be blown off using compressed air. If severe contamination of the cards should occur, they can be removed and cleaned using distilled water. Cards must be thoroughly dried before reapplying power.

In order to maintain optical performance, it is necessary to ensure the fiber optic connectors are kept clean. Use a suitable solvent, such as acetone or isopropyl alcohol, and a lint free cloth to carefully wipe any dirt off the face of the ceramic ferrules prior to making a connection. Always replace dust caps on the Model 903 fiber optic bushings when removing connectors. If bushings are left open, they should be cleared of dust with compressed air prior to connection.

8.6 Model 903 Board Handling

The Model 903 includes several densely populated Printed Circuit Board Assemblies (PCBAs). Although these boards are all conformally coated, care must still be taken while handling the boards to ensure the PCBAs are kept clean and free from electrostatic discharge.

BOARD REMOVAL AND INSTALLATION

Model 903 boards are each held in place by two slotted screws through the front panel. Cards are held in place within the rack by standard Eurocard card guides and 96-pin backplane connectors. Since the Model 903 is designed to operate in environments with vibration present, the connectors used to mate the PCBAs to the backplane have a strong mating force.

To remove a board, completely undo the lower slotted screw from the chassis and loosen the upper holding screw, leaving its threads partially engaged. Using the handle on the front panel, pull on the board slowly and firmly until the backplane connector releases. The partially engaged screw will prevent you from pulling the card out abruptly once the mating force of the backplane connector is overcome. Now undo the remaining screw and gently slide the board straight out of the chassis, being careful not to flex the board or snag components on adjacent cards. When handles are not available on the front panels, a screwdriver may be used to carefully pry the panel away from the rack until the backplane connector releases.

To install a card, ensure that the board is in both the top and bottom card guides and then push the card in and mate it with the backplane connector. Tighten both the top and bottom screws to hold the card in the chassis.

GENERAL HANDLING

Care must always be taken during the handling of PCBAs to ensure product integrity. The following guidelines should be adhered to in working with PCBAs:

- Always handle boards by the edges and do not touch any connectors or gold tabs.
- Handle boards at an ESD safe workstation with a clean surface.
- Never stack PCB assemblies on top of one another.

Special Considerations for FMB-X-2.5, EIB-10/100 (optical version) and ECL-02 Cards

Several Model 903 boards have both electrical and optical components that require an even greater amount of care during handling. Along with the points stated above, the following guidelines should also be followed for the fiber multiplexer boards assemblies:

- Ensure fibers are not crimped or moved away from their intended routes
- If the assembly is set down, always place the boards bottom side down.
- Ensure any disconnected optical connectors are cleaned immediately prior to reconnection.
- Do not allow fiber bends with an equivalent loop diameter less than 25 mm, even momentarily.
- If internal fiber jumpers are used, ensure the card is removed only part way until the internal jumpers can be disconnected before removing the card fully.

More information about fiber handling is provided in section 7.3 of this document.

APPENDICES

APPENDIX A - CONNECTOR PART NUMBERS AND PIN ASSIGNMENTS

CONNECTOR PART NUMBERS

Card	Location on Model 903	Mfr. Name	On-Board P/N [Description]	Mating P/N [Description]
FMB-X-2.5	Diagnostics Connector	Stewart (+ others)	Standard RJ-45 Jack	Standard RJ-45 Plug with CAT 5e cable
		CUI (+others)	Standard 3.5 mm (1/8") stereo jack	Standard 3.5 mm (1/8") stereo plug
	Fiber Bushings	Molex	106152-1000 [FC-FC Bushing] or 106110-1000 [ST-ST Bushing]	Standard FC/PC Connector or Standard ST/PC Connector
VIB-X	Video Input / Output Connectors	Johnson	131-1701-376 [SMB Jack, RA]	131-1403-116 [SMB Plug Connector (RA)]
DIB-232	Data Connector	Wago	733-363 [3-pin RA Header]	733-103 [3-pin Connector]
DIB-232-16	Data Connector	AMP (+ others)	5748394-6 [62-pin RA D-Sub Hdr., Female]	180-062-102L001 (mate), 207473-1 (RA shell)
DIB-485	Channels 1, 2 and 3	Wago	733-362 [2-pin RA Header]	733-102 [2-pin Connector]
	Channels 4 and 5	Wago	733-364 [4-pin RA Header]	733-104 [4-pin Connector]
CIB-10	Control I/O Connector	AMP	5748482-5 [44-Pin HD-22 RA Hdr. Female D-Sub]	1658672-1 [44-pin HD-22 Male D-Sub (or equivalent)]
EIB-10/100 (Electrical / Optical)	Ethernet Connectors	Stewart (+ others)	Standard RJ-45 Jack	Standard RJ-45 Plug with CAT 5e cable
AIB-4	Data Connectors	Wago	733-364 [4-pin RA Header]	733-104 [4-pin Connector]
907-232E	Data Connectors	Molex	43045-0800 [8-pin Dual Row Connector]	43025-0800 Microfit with Crimp Terminals 43030-0007
907-485E				
ECL-02	ECL Connectors	Johnson	131-1701-376 [SMB Jack, RA]	131-1403-116 [SMB Plug Connector (RA)]
GBES	4 Port Gigabit Ethernet Connectors	Stewart (+ others)	Quad RJ-45 Jack (10/100/1000 Mbps)	Standard RJ-45 Plug with Cat 6 or Cat 5e cable
HD-SDI	Video Input/output Connectors	Amphenol, Johnson	142146-75 [SMB Jack, RA]	131-8403-101 [SMB Plug Connector (RA)]
Backplane -X	Backplane Power Terminals	Keystone	8191	Standard #6 Ring Lug
DC-DC Converter Module	1 x DC Input	Molex	26-60-5020 [2-pin, 0.156" pin RA Header]	09-50-8023 [shell], 08-50-0106 [crimp pins]
	1 x DC Output	Molex	26-60-5060 [6-pin, 0.156" pin RA Header]	09-50-8063 [shell], 08-50-0106 [crimp pins]

Note: The parts listed in this appendix might become obsolete. Please contact Focal for advice on replacement parts.

CONNECTOR PIN ASSIGNMENTS

Board	Connector	Signal Type	Pin #	Designation
FIBER MULTIPLEXER BOARD (FMB)				
FMB-X-2.5 (Remote & Console)	3.5 mm (1/8") stereo jack	RS-232 Diagnostic Port	1 (Tip) 2 (Middle) 3 (Base)	RX Input Into FMB TX Output From FMB Ground
	RJ-45	Ethernet Diagnostic Port	1 2 3 4, 5 6 7 8 Body	RX+ RX- TX+ N/C TX- N/C 0V Shield
VIDEO CARDS				
VIB-X	SMB	Video	Core Shield	Video Signal Ground
DATA CARDS				
DIB-232	3-pin WAGO	RS-232 (DCE)	1 2 3	Ground Receive (RX) Transmit (TX)
DIB-232-16	62-Pin D-Sub Connector (Female)	RS-232	21, 20, 41 19, 18, 39 62, 61, 40 60, 59, 38 16, 15, 36 14, 13, 34 57, 56, 35 55, 54, 33 11, 10, 31 9, 8, 29 52, 51, 30 50, 49, 28 4, 3, 25 2, 1, 23 46, 45, 24 44, 43, 22	Ch1 RS-232 In, Out, Gnd Ch2 RS-232 In, Out, Gnd Ch3 RS-232 In, Out, Gnd Ch4 RS-232 In, Out, Gnd Ch5 RS-232 In, Out, Gnd Ch6 RS-232 In, Out, Gnd Ch7 RS-232 In, Out, Gnd Ch8 RS-232 In, Out, Gnd Ch9 RS-232 In, Out, Gnd Ch10 RS-232 In, Out, Gnd Ch11 RS-232 In, Out, Gnd Ch12 RS-232 In, Out, Gnd Ch13 RS-232 In, Out, Gnd Ch14 RS-232 In, Out, Gnd Ch15 RS-232 In, Out, Gnd Ch16 RS-232 In, Out, Gnd
DIB-485	2-pin WAGO	RS-485	1 2	+ TX/RX - TX/RX
	4-pin WAGO	RS-422	1 2 3 4	+ RX - RX + TX - TX
		RS-485	1 2 3 4	+ TX/RX - TX/RX N/C N/C
		TTL (Channel 5 Only)	1 2 3 4	TTL In N/C TTL Out ISOGND

Board	Connector	Signal Type	Pin #	Designation
CIB-10	HD-22, 44-Pin D-Sub Connector (Female)	TOR Input [TOR Output]	1 [11]	Channel 1 +In [+Out]
			2 [12]	Channel 2 +In [+Out]
			3 [13]	Channel 3 +In [+Out]
			4 [14]	Channel 4 +In [+Out]
			5 [15]	Channel 5 +In [+Out]
			6 [31]	Channel 6 +In [+Out]
			7 [33]	Channel 7 +In [+Out]
			8 [35]	Channel 8 +In [+Out]
			9 [37]	Channel 9 +In [+Out]
			10 [39]	Channel 10 +In [+Out]
			16 [26]	Channel 1 -In [-Out]
			17 [27]	Channel 2 -In [-Out]
			18 [28]	Channel 3 -In [-Out]
			19 [29]	Channel 4 -In [-Out]
			20 [30]	Channel 5 -In [-Out]
			21 [32]	Channel 6 -In [-Out]
			22 [34]	Channel 7 -In [-Out]
			23 [36]	Channel 8 -In [-Out]
			24 [38]	Channel 9 -In [-Out]
			25 [40]	Channel 10 -In [-Out]
			41 [42]	Shield [Shield]
			43-44	N/C
EIB-10/100 (Electrical Version)	RJ-45	Ethernet 10Base-T or 100Base-TX	1	RX+
			2	RX-
			3	TX+
			4, 5	N/C
			6	TX-
			7	N/C
			8	0V
			Body	Shield
907-232E	8-pin Molex	RS-232	1	GND_A
			2	RX_A
			3	TX_A
			4	N/C
			5	GND_B
			6	RX_B
			7	TX_B
			8	N/C
907-485E	8-pin Molex	RS-485	1,2	N/C
			3	485+_A
			4	485-_A
			5,6	N/C
			7	485+_B
			8	485-_B
		RS-422	1	422RX+_A
			2	422RX-_A
			3	422TX+_A
			4	422TX-_A
			5	422RX+_B
			6	422RX-_B
			7	422TX+_B
			8	422TX-_B

Board	Connector	Signal Type	Pin #	Designation
		TTL (Channel 1 Only)	1 2 3 4 5,6,7,8	TTL In N/C TTL Out TTL GND N/C
AIB-4 Plug-In Modules				
AIB-232	4-pin WAGO	RS-232 (DCE)	1 2 3 4	ISOGND Receive (RX) Transmit (TX) N/C or Chassis
AIB-485	4-pin WAGO	RS-485	1 2 3 4	+ TX/RX - TX/RX N/C N/C
		RS-422	1 2 3 4	+ RX - RX + TX - TX
		TTL	1 2 3 4	TTL In N/C TTL Out ISOGND
AIB-ARCNET	4-pin WAGO	Tritech Sonar ARCNET	1 2 3 4	Chassis LAN+ LAN- N/C
AIB-HYDRO	4-pin WAGO	Hydrophone, Analog Signals	1 2 3 4	Chassis (Optional) N/C - Signal (GND on output) + Signal
AIB-MS900	4-pin WAGO	MS900 Analogue Sonar	1 2 3 4	Chassis (Optional) N/C Sonar Data Sonar Data
AIB-CANBUS	4-pin WAGO	CAN Bus	1 2 3 4	CAN H CAN L GND Shield
MEDIA CONVERTERS				
ECL-02	SMB	ECL, PECL, Pseudo	Core Shield	ECL Signal Ground
EIB-10/100 (Optical Version)	RJ-45	Ethernet 10Base-T or 100Base-TX	1 2 3 4, 5 6 7 8 Body	RX+ RX- TX+ N/C TX- N/C 0V Shield

Board	Connector	Signal Type	Pin #	Designation
GBES	RJ-45 Connector Remote Front Panel and Console 6U Enclosure Rear Panel	Ethernet 1000 Mb/s	1 2 3 4 5 6 7 8 Body	BI_DA+ BI_DA- BI_DB+ BI_DC+ BI_DC- BI_DB- BI_DD+ BI_DD- Shield
HD-SDI	SMB Remote and console	HD-SDI	Core Shield	Serial Data (1.5 Gbps) Ground
	External LED connector (Pull-up resistors supply ANODE pins)	3.3VDC with 267 ohm pull-up	1 2 3 4	Carrier Detect LED Anode (+) Carrier Detect LED Cathode (-) Optical Link LED Anode (+) Optical Link LED Cathode (-)
POWER MODULE				
DC-DC Converter	2-pin Molex	DC Power Input	1 2	+VDC In GND
	6-pin Molex	DC Power Output	1 2 3 4 5 6	DGND +5 V -12 V AGND +12 V N/C

Note: RX refers to inputs into the card in question. TX refers to outputs from the card in question.

APPENDIX B - FUSES

MODEL 903 FUSE PROTECTION

REMOTE MODULE RACK

Qty.	PSU/Fan	Fuse Part Number	Rating	Fuse Type	Manufacturer	Comments
1	120 VAC 240 VAC	GMD-1-R	1 A	Metric Time Delay	Bussmann	Located at the top of the module on the backplane, this fuse protects the primary AC or DC voltage input.
	24 VDC	GMD-2-R	2 A			
	48 VDC	GMD-1.5-R	1.5 A			
	DC-DC Converter Module	GMD-3-R	3 A			Fuse located on the DC-DC module board mounted on back cover plate.
2	12VDC Fan	miniSMDC050F-2	0.5A	Resettable	Raychem	SMT fuse on back-plane underneath back cover plate. Used for 12VDC fans.

CONSOLE MODULE RACK

Qty.	PSU/Fan	Fuse Part Number	Rating	Fuse Type	Manufacturer	Comments
1	120 VAC 240 VAC	GMD-1-R	1 A	Metric Time Delay	Bussmann	Located at the top of the module on the backplane, this fuse protects the primary AC or DC voltage input.
	24 VDC	GMD-2-R	2 A			
	48 VDC	GMD-1.5-R	1.5 A			
2	12VDC Fan	miniSMDC050F-2	0.5A	Resettable	Raychem	SMT fuse on back-plane underneath back cover plate. Used for 12VDC fans.

Card Type	Card	Fuse Qty.	Fuse P/N	Current Rating	Comments
FMB	FMB-X-2.5	1	0452003	3.0A	SMT fuse to protect on-board +5VDC (F3)
		2	0452.500	0.5A	SMT fuse to protect on-board +/-12VDC (F1/F2)
Video	VIB-X	1	0452003	3.0A	SMT fuse to protect on-board +5VDC (F1)
		1	0452001	1.0A	SMT fuse to protect on-board -12VDC (F2)
Data	DIB-232	1	0452.500	0.5A	SMT fuse to protect on-board +5VDC (F12)
		11	0451.250	0.25A	SMT fuse (with fuse holder) for input/output RS-232 protection (F1-F6, F8-F11). Spare on-board fuse (F7)
	DIB-232-16	1	0452001	1.0A	SMT fuse to protect on-board +5VDC (F1)
	DIB-485	1	0452001	1.0A	SMT fuse to protect on-board +5VDC (F15)
		15	0451.250	0.25A	SMT fuse (with fuse holder) for input/output RS-485 protection (F1-F14). Spare on-board fuse (F16)
	CIB-10	1	0452.500	0.5A	SMT fuse to protect on-board +5VDC (F1)
		1	0452.500	0.5A	SMT fuse to protect on-board -12VDC (F2)
	EIB-10/100 (Electrical Version)	1	0452003	3.0A	SMT fuse to protect on-board +5VDC (F1)
	AIB-4	1	0452001	1.0A	SMT fuse to protect on-board +5VDC (F17)
		2	0452.500	0.5A	SMT fuse to protect on-board +/-12VDC (F19/F20)
		15	0451.250	0.25A	SMT fuse (with fuse holder) for i/o protection (F1-F16). Spare on-board fuse (F18).
	907-232E	1	0452002	2.0A	SMT fuse to protect on-board +5VDC (On 907 daughtercard)
		1	0452003	3.0A	SMT fuse to protect Eurocard adaptor board
	907-485E	1	0452002	2.0A	SMT fuse to protect on-board +5VDC (On 907 daughtercard)
		1	0452003	3.0A	SMT fuse to protect Eurocard adaptor board
Media Converter	ECL-02	1	0452003	3.0A	SMT fuse to protect on-board +5VDC (F10)
		1	045201.5	1.5A	SMT fuse to protect on-board -12VDC (F11)
	EIB-10/100 (Optical Version)	1	0452003	3.0A	SMT fuse to protect on-board +5VDC (F1)
	GBES	1	0452003	3.0A	SMT fuse to protect on-board +5VDC
	HD-SDI	1	0452001	1.0A	SMT fuse to protect on-board +5VDC (On 907 daughtercard)
		1	0452003	3.0A	SMT fuse to protect Eurocard adaptor board

NOTES:

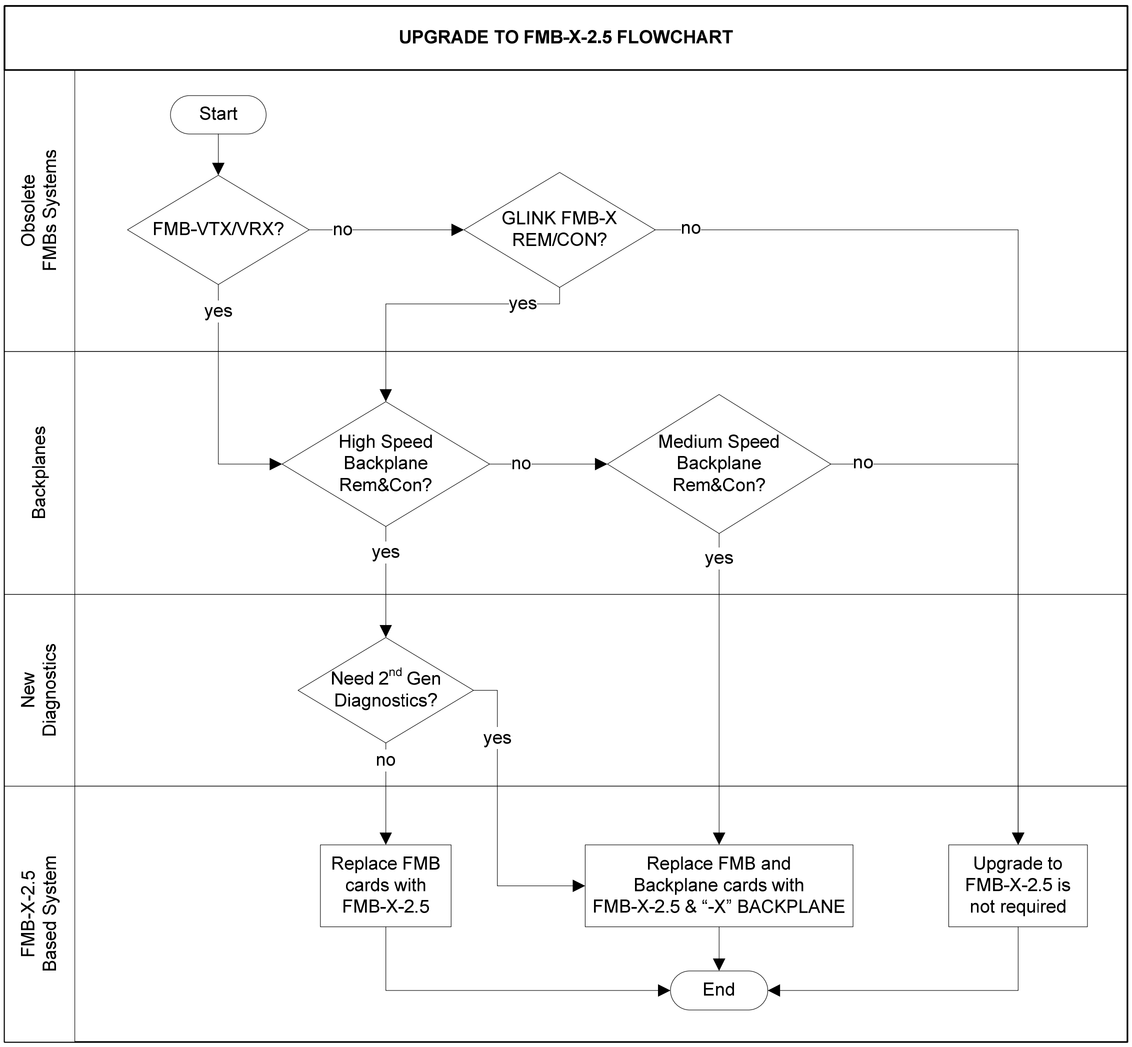
1. SMT = Surface Mount Technology
2. All 250mA, fast-response fuses are installed in SMT fuse holders. Remove fuses gently with a small pair of needle-nose pliers and slowly lift directly upwards. All power supply rail protection fuses are soldered directly to the PCB and, if blown, should only be replaced by the factory during repair of the board.
3. 451 and 452 type fuses are manufactured by Littelfuse.
4. 452 type SMT fuses are time delay fuses.
5. 451 type SMT fuses are fast acting fuses.
6. The parts listed in this appendix might become obsolete. Please contact Focal for advice on replacement parts.

APPENDIX C – GUIDELINES TO UPGRADE TO FMB-X-2.5 SYSTEMS

FMB-X-2.5 & "-X" BACKPLANES

The FMB-X-2.5 is not backwards compatible with the FMB-VTX, FMB-VRX or GLINK FMB-X cards. Both remote and console FMBs must be replaced with the FMB-X-2.5 when upgrading. All FMB-X-2.5 cards operate at 2.5 Gbaud on uplink (1310 nm) and downlink (1550 nm) and are compatible with existing video cards, data cards, and high speed racks. In the case of medium speed racks, the FMBs and backplanes must be changed out.

Upgrade Flowchart



The FMB-X-2.5 cards provide many general improvements including the following:

- Replacement of obsolete SONET optical transmitters and receivers with "pluggable" SFP transceivers
- Elimination of all electrical harnesses to reduce wiring and improve reliability
- Improvement of fiber management and assembly for ease of production and maintenance
- Use of a common motherboard for both remote and console FMB-X-2.5 to reduce cost
- Addition of diagnostics LEDs to allow easier troubleshooting
- Addition of audible tone for loss of optical link when the fiber switch changes fibers
- Addition of a built-in Ethernet port (100 Mbps link)

The table below shows typical FMB-X-2.5 replacements for singlemode, dual fiber systems:

Table 1: FMB-X-2.5 Cross-Reference

FMB-X-2.5 P/N	FMB-X-2.5 Card ID	Replaces P/N	Old FMB Card ID	Old FMB Description
903-5082-00	FMB-X-2.5R-SMST-DF (2.5G FMB-X REMOTE)	903-5021-02	FMB-VTX-01-ST-DF	Remote FMB/FMB-X, SMF, ST Conns., High Speed, Dual Fiber (Splitter)
		903-5072-00	FMB-XRH-SMST-DF	
		903-5004-00*	FMB-VTX-21-ST-DF	Remote FMB/FMB-X, SMF, ST Conns., Medium Speed, Dual Fiber (Splitter)
		903-5072-01*	FMB-XRM-SMST-DF	
903-5083-00	FMB-X-2.5C-SMST-DF (2.5G FMB-X CONSOLE)	903-5022-00	FMB-VRX-00-ST-DF	Console FMB/FMB-X, SMF, ST Conns., High Speed, Dual Fiber (Switch)
		903-5073-00	FMB-XCH-SMST-DF	
		903-5005-00*	FMB-VRX-20-ST-DF	Console FMB/FMB-X, SMF, ST Conns., Medium Speed, Dual Fiber (Switch)
		903-5073-01*	FMB-XCM-SMST-DF	

* FMB-X-2.5 cards are not compatible with medium speed backplanes. Backplanes must be changed to "-X" backplane versions.

With the higher 2.5 Gbaud optical data link available, FMB-X-2.5 samples all of the data channels as if they were in the high speed slot of an old system. Furthermore, the RJ-45 Ethernet jack on the FMB-X-2.5 is permanently enabled with support for both 10 and 100 Mbps Ethernet traffic through the optical link with no loss in the number of regular data channels. Video channels from slots A and B are 10-bit resolution at all times.

A cross-reference of typical replacement backplanes is given in the table below. When upgrading existing medium speed systems to FMB-X-2.5 cards, the medium speed backplanes must be replaced with -X compatible backplanes shown. When upgrading high speed systems to FMB-X-2.5 cards, the old backplanes may be used, but the newer backplanes support added diagnostics features.

Table 2: "-X" Backplane Cross-Reference

Backplane Size	Backplane Type	Module	Old Backplane P/N	New "-X" Backplane P/N
12 HP	Medium Speed	Remote	903-0266-00	903-7212-00
16 HP	High Speed		903-0260-01	903-7207-00
28 HP			903-0203-01	903-7217-00
32 HP			903-7202-00	903-7216-00
36 HP			903-0203-00	903-7218-00
28 HP	Medium Speed	Console	903-0236-51	903-7213-00
36 HP	High Speed		903-0203-00	903-7218-00
44 HP			903-0225-00	903-7210-00

In addition to the standard RS-232 diagnostics available from the stereo jack, the FMB-X-2.5 also provides more detailed diagnostics through a command mode via the stereo jack and through a WEB server and MODBUS TCP/IP via the Ethernet port.

FMB-X-2.5 FUNCTIONAL DIFFERENCES

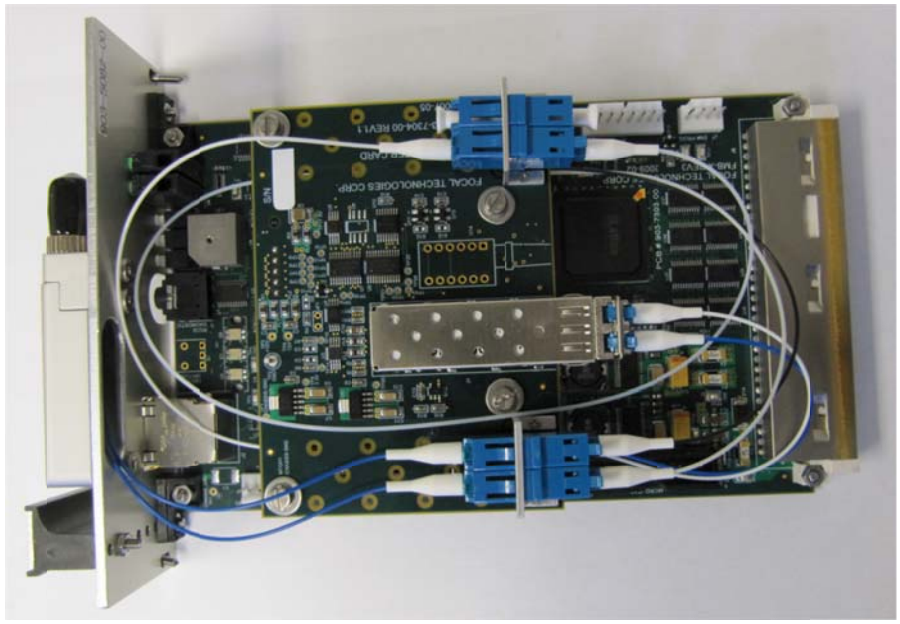
In addition to the differences in the optical data rates, there are some functional differences between the FMB-X-2.5 cards and the obsolete FMB cards (FMB-VTX/VRX and GLINK FMB-X), as summarized in the table below:

Table 3: FMB-VTX/VRX, GLINK FMB-X versus FMB-X-2.5 Functionality

Function	FMB-VTX/VRX	GLINK FMB-X	FMB-X-2.5
Video Digitization	9-bit video on high speed systems 8-bit video on medium speed systems		10-bit video on all channels
Ethernet Port	Not available	10 Mbps optical throughput, but disables data slot 4 on backplane (Front panel RJ-45 is 10/100 Mbps compatible)	100 Mbps optical throughput with no loss of any other data channels (Front panel RJ-45 is 10/100 Mbps compatible)
Diagnostics Formats	Diagnostics is RS-232 format only, available at front panel DB-9 on console FMB-X only	Diagnostics is RS-232 format only, available at front panel stereo jack on console FMB-X	Diagnostics is RS-232 format at front panel stereo jack or Ethernet format at front panel RJ-45 jack
High Speed Data Slot	Supports 1 high speed data slot and 3 low speed data slots		All data slots are high speed, allowing higher data rates on RS-485 channels, for example.
Optical Data Rates	1.375 Gbaud uplink, high speed systems 687 Mbaud uplink, medium speed systems 172 Mbaud downlink, all systems		2.5 Gbaud on both uplink and downlink
Compatibility	Not Applicable	Backwards compatible with FMB-VTX/VRX using GLINK.	This is not backwards compatible with any FMB-VTX/VRX or FMB-X using GLINK.

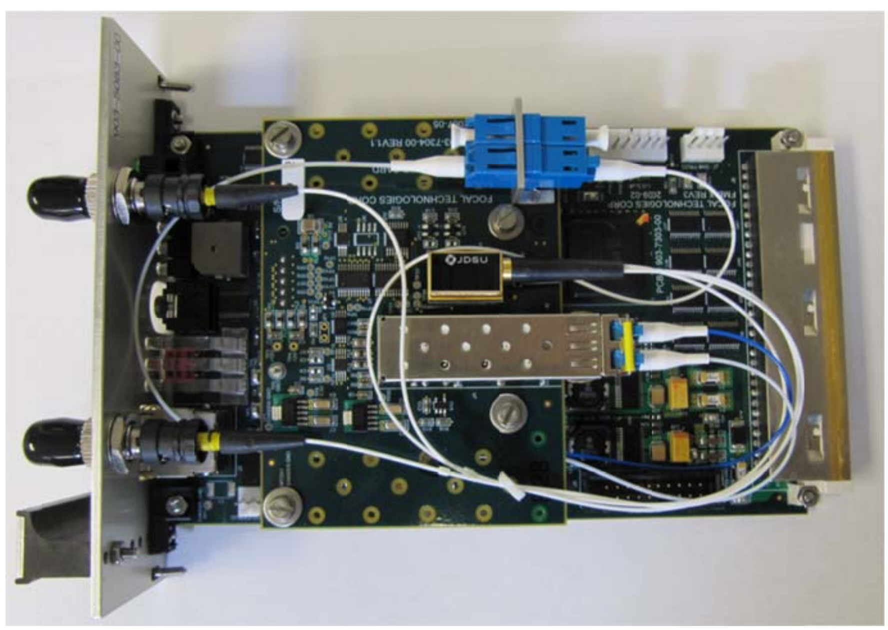
FMB-X-2.5 REMOTE AND CONSOLE PHOTOS

FMB-X-2.5 Remote Front Panel View



FMB-X-2.5 Remote – Top View

FMB-X-2.5 Console Front Panel View



FMB-X-2.5 Console – Top View

APPENDIX D – OBSOLETE SYSTEMS

D. GLINK FMB-X Fiber Multiplexer

This section is provided as a reference only for 903 systems using GLINK FMB-X systems. Information about the FMB-VTX and FMB-VRX cards can be found in the 903-0602-00 user's guide.

Please refer to Appendix C for guidelines to upgrade to FMB-X-2.5 systems.

D.1 Remote GLINK FMB-X

Card P/N 903-5072-XX

Note: This card is obsolete and can no longer be ordered. Use the FMB-X-2.5 card for new designs.

The front panel view of the remote GLINK FMB-X is shown in the following figure. Redundant ST fiber connectors are accessible on the right angled turret. An internal splitter provides roughly equal power output levels on both ST connectors. Output power should be greater than -6 dBm at 1310 nm (uplink). Receive sensitivity at the turret should be better than -26 dBm at 1550 nm (downlink).

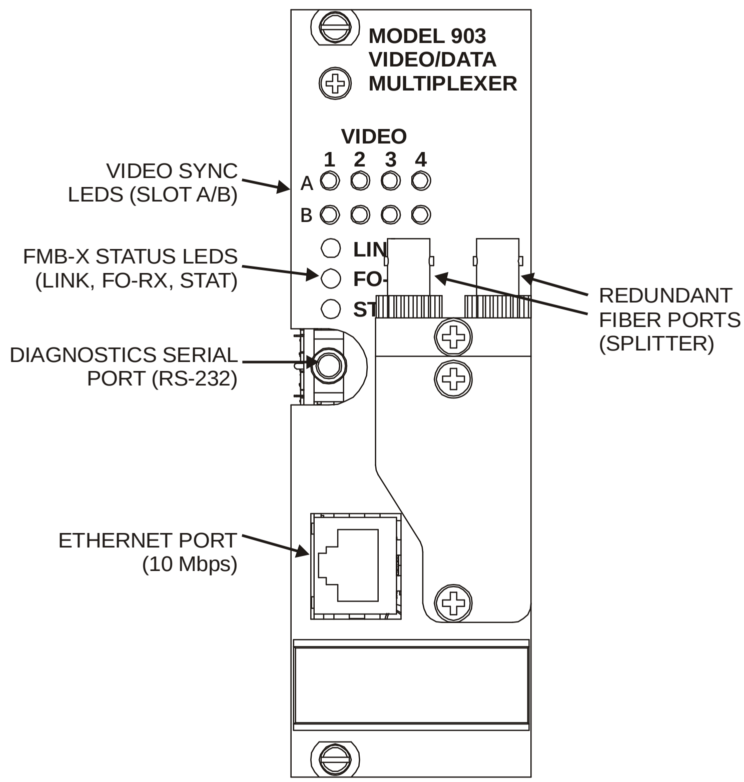


Figure D.1-1: Remote GLINK FMB-X Front Panel View

LEDs on the front panel match those described in the console GLINK FMB-X section and allow direct monitoring of the optical link status (LINK), optical receive power (FO-RX), and the status (STAT) of the on-board diagnostics. See the console GLINK FMB-X section for more details.

Diagnostics available at the 3.5 mm (1/8") stereo jack of the remote GLINK FMB-X are RS-232 format and are compatible with the standard Model 903 Diagnostics Software. Remote diagnostics are transmitted to the console module and typically monitored by the DB-9F RS-232 port on the console FMB-VRX or the 3.5 mm stereo jack RS-232 port in the console GLINK FMB-X.

A plan view of the remote GLINK FMB-X is shown in the figure below. The 1310/1550 nm singlemode WDM coupler and 1 x 2 splitter are not visible. Both are mounted on the underside of the optical daughtercard below the two dual LC bushings shown.

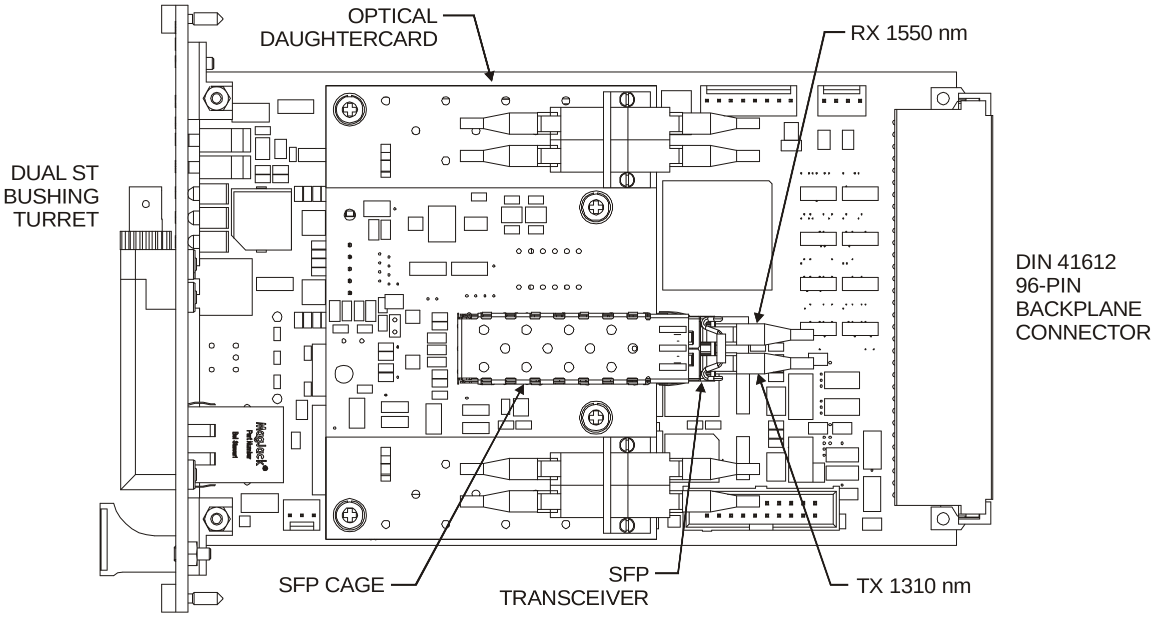


Figure D.1-2: Remote GLINK FMB-X Plan View

D.2 Console GLINK FMB-X

Card P/N 903-5073-XX

Note: This card is obsolete and can no longer be ordered. Use the FMB-X-2.5 card for new designs.

The front panel view of the console GLINK FMB-X is shown in the following figure. Redundant ST fiber connectors are accessible as straight bushings on the front panel marked "F1" and "F2". An internal fiber switch chooses one of the fibers for the optical link, either automatically or manually via the front panel switch. Output power should be greater than -2 dBm at 1550 nm (downlink). Receive sensitivity at the front panel should be better than -28 dBm at 1310 nm (uplink).

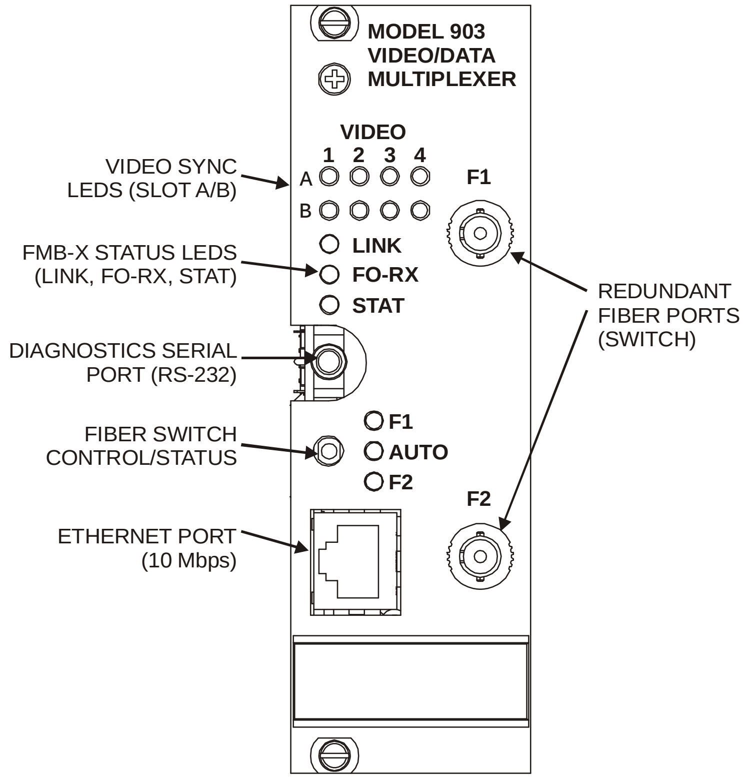


Figure D.2-1: Console GLINK FMB-X Front Panel

The description of the LEDs on the front panel of the Console FMB-X card is shown in the Table below.

Table D.2-1: Console GLINK FMB-X Front Panel LEDs

LED	Description
VIDEO	VIDEO LEDs are green when sync is present on each video channel from slot A and slot B in the rack.
LINK	LINK LED is green when a valid optical link is being received and red if no link is present.
FO-RX	FO-RX LED is green when the received optical power is well above threshold. This LED will change to orange (warning), indicating low margin, or red (alarm), indicating low optical power. Problems with optical power should be investigated using the diagnostic software and/or fiber optic power meters.

LED	Description
STAT	STAT (Status) LED is green when on-board diagnostic readings are within tolerance. The STAT LED is orange (warning) if any of the on-board diagnostic readings are close to an alarm state. The STAT LED is red (alarm) if any of the on-board diagnostic readings are outside of the specified range, in which case the diagnostic software should be used to troubleshoot the problem. Monitored signals included temperature and all major voltage rails (+12V, -12V, +5V, and +3.3V). An alarm state exists if any voltage is worse than ±20% of nominal value or temperature is > +80C. A warning state exists if any voltage is worse than ±10% of nominal value or temperature is > +75C, but the reading is not in an alarm state.
F1/F2	F1/F2 LEDS indicate which fiber is active, per the marked ST bushings. The active fiber is shown by the green LED.
AUTO	AUTO LED is green when the fiber switch is in automatic mode, as determined by the toggle switch position.

Diagnostics are available at the 3.5 mm (1/8") stereo jack in RS-232 format compatible with the standard Model 903 Diagnostics Software. Wiring for the RS-232 connections is shown in the Table below, where TXD/RXD are relative to the connected PC.

Table D.2-2: RS-232 Diagnostic Port Connections

Stereo Jack Pin	DB-9F pin	Function
1 (Tip)	3	TXD
2 (Middle Ring)	2	RXD
3 (Base Ring)	5	SIG GND

The fiber switch may be placed in automatic mode or forced to fiber F1 or F2 using the front panel toggle switch. In automatic mode, the GLINK FMB-X tests both fibers on initial power up and chooses the one with the highest optical power. This will stay locked until the switch is forced to the other fiber, via the toggle switch, or link is lost on the active fiber. The LED by F1 is green when that fiber is active – the same applies to F2. The LED marked “AUTO” is green when in automatic switching mode.

When the optical link is lost, the switch will toggle automatically at roughly once per second between F1 and F2. This will continue for up to 10 toggles. If no link is found, the switch will return to the original fiber it was on before the link failure and wait for a link. While no link exists after this hunting period, all of the fiber switch LEDs are red.

The GLINK FMB-X sounds a continuous audible alarm when an optical link fails, even if the other fiber has a valid link. This identifies a fiber fault to the operator which otherwise might not be noticed, as the switchover from one fiber to the other is often seamless. The alarm can be turned off by briefly forcing the toggle switch to the active fiber in manual mode and then back to the automatic setting.

A plan view of the console GLINK FMB-X is shown below. The 1310/1550 nm singlemode WDM coupler is not visible, and is mounted on the underside of the optical daughtercard below the dual LC bushings shown.

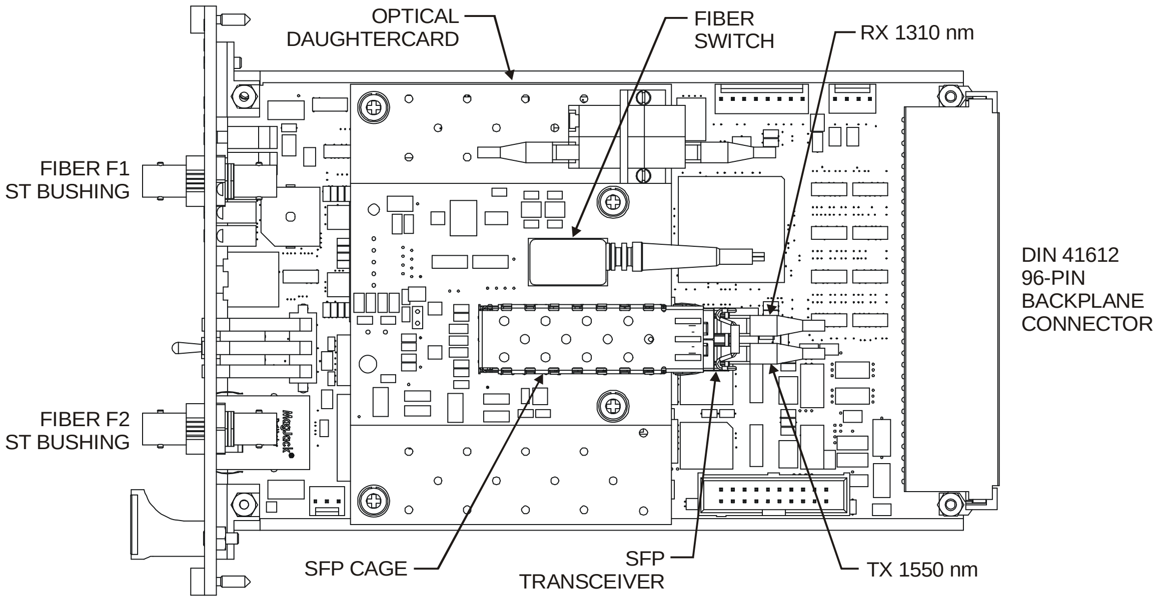


Figure D.2-1: Console GLINK FMB-X Plan View