Moog Components Group, Halifax Operations
Focal Technologies Corporation
77 Frazee Avenue
Dartmouth, Nova Scotia, Canada B3B 1Z4
Tel: 1-902-468-2263 • Fax: 1-902-468-2249
Email: focal@moog.com • www.moog.com/marine

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

Report No.:	903-0628-00
Revision:	1
Author(s):	A. Cabrera
Date of Issue:	June 19, 2014

REVISION HISTORY

Rev	Details of Revision	Author(s)	Date (yyyy-mm-dd)
1	Initial release (based on 903-0624-00)	ACC	2014-06-19

REFERENCE DOCUMENTS

Document Number	Document Title/Description
903-0623-00	Model 903 Fiber Optic Video/Data Multiplexer User's Guide
903-0622-00	Model 903 FMB-X-2.5 Diagnostics Manual
903-0611-00	Model 903 Video/Data Multiplexer Software Manual
903-8xxx-xx	903 Installation Drawings

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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
CWDM	Coarse Wavelength Division Multiplexer
DIB	Data Interface Board
ECL	Emitter Coupled Logic
EIA	Electronic Industries Association
ESD	Electrostatic Discharge
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
MC	Media Converter
MDI/MDIX	Automatic medium-dependent interface crossover
MMF	Multimode Fiber
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)
SMF	Singlemode Fiber
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 4-8 broadcast quality composite video channels, up to 64 digital channels, and additional bidirectional optical channels for high-speed sonar, digital video, or 10/100/1000 Mbps Ethernet links.

The high density version of the Model 903 has been optimized for very high multiplexing density in an extremely compact, low power package capable of delivering high quality video end-to-end. It supports up to 8 video channels of uncompressed, digitized composite video as well as up to 8 RS-232 channels and 8 plug-in modules, which may be selected from a range of modules including RS-232, RS-485/422/TTL, analog sonar (MS900), hydrophones, Tritech sonar ARCNET and CAN Bus.

This user's guide provides complete information on the design, configuration, installation and operation of Model 903 High Density (HD) multiplexer systems. All 903-HD systems presented in this document are based on the new FMB-X-2.5 and –X backplane boards. System specific information can be found in the 903-8xxx-xx installation drawings provided with your system.

This manual and the appropriate reference documents should be reviewed prior to installation or reconfiguration of the multiplexer.

Card or PCB assembly numbers are given in the titles of the corresponding sections of the manual.

- Card assembly numbers refer to a complete printed circuit board assembly (PCBA) plus front panel, optics, and assembly hardware, and are in the 903-00XX-XX and 903-5XXX-XX series.
- PCBA numbers apply to populated boards alone, such as backplanes and AIB plug-in modules, and are in the 903-02XX-XX series.

Appendices include the following information:

APPENDIX A – CONNECTOR PART NUMBERS AND PIN ASSIGNMENTS
APPENDIX B – FUSES
APPENDIX C – INSTALLATION DRAWINGS
APPENDIX D – ISOLATION, PROTECTION, AND GROUNDING
APPENDIX E – BACKPLANE PIN CONFIGURATIONS
APPENDIX F – CARD & SYSTEM PHOTOS

2.0 System Overview

This document contains information about 903 high density systems based on FMB-X-2.5 boards (fiber multiplexer boards with optical link running at 2.5 Gbaud).

A high density multiplexer system consists of a Model 903-HD high density remote module (vehicle or ROV end) and a standard Model 903 console module (surface or shipboard end). The console module is provided completely packaged in a Eurocard rack integrated with a power supply and all necessary optical components. (Eurocard PCB dimensions are 100 x 160 mm.) The remote module is provided as a complete rack, including backplane, fan, and a data I/O box.

The high density remote modules can be provided in 12 HP or 16 HP racks depending on the number of video and data channels required.

The standard console modules can be provided in 42 HP or 50 HP racks. Note that 4HP corresponds to a slot width of 0.8 inches or roughly 20 mm.

2.1 Multiplexer Systems

There are two types of 903 high density systems that are covered by this document. One type is the 4VID system which includes 4 composite/analog video channels and the other type is the 8VID system with 8 composite/analog video channels. The following table provides a summary of the signal types supported by these systems.

Table 2-1: Model 903-HD Systems – Signal Types Supported

System		Card Rack		Number of Signal Types Supported			
Type	End	P/N [Type]	Width (HP)	Serial Data		Composite (Analog) Video	Ethernet
				RS-232 (Dedicated)	AIB Plug-In cards* (Reconfigurable)		10/100M
4VID	Remote	903-0004-03 [CBP-100-XR]	12	4	4	4	1
	Console	903-0007-07 [CBP-121-XC]	42	-	8		
8VID	Remote	903-0005-12 [CBP-200-XR]	16	8	8	8	1
	Console	903-0007-06 [CBP-241-XC]	50	-	16		

* AIB Plug-In supported signal types include: RS-232, RS-485, RS-422, TTL, Tritech Sonar ARCNET, Hydrophone/Analog, MS-900 Analog Sonar and CAN Bus (see section 4.3.1 for more details).

The figure below shows the I/O ports and optical connections of a 903-HD 4VID system.

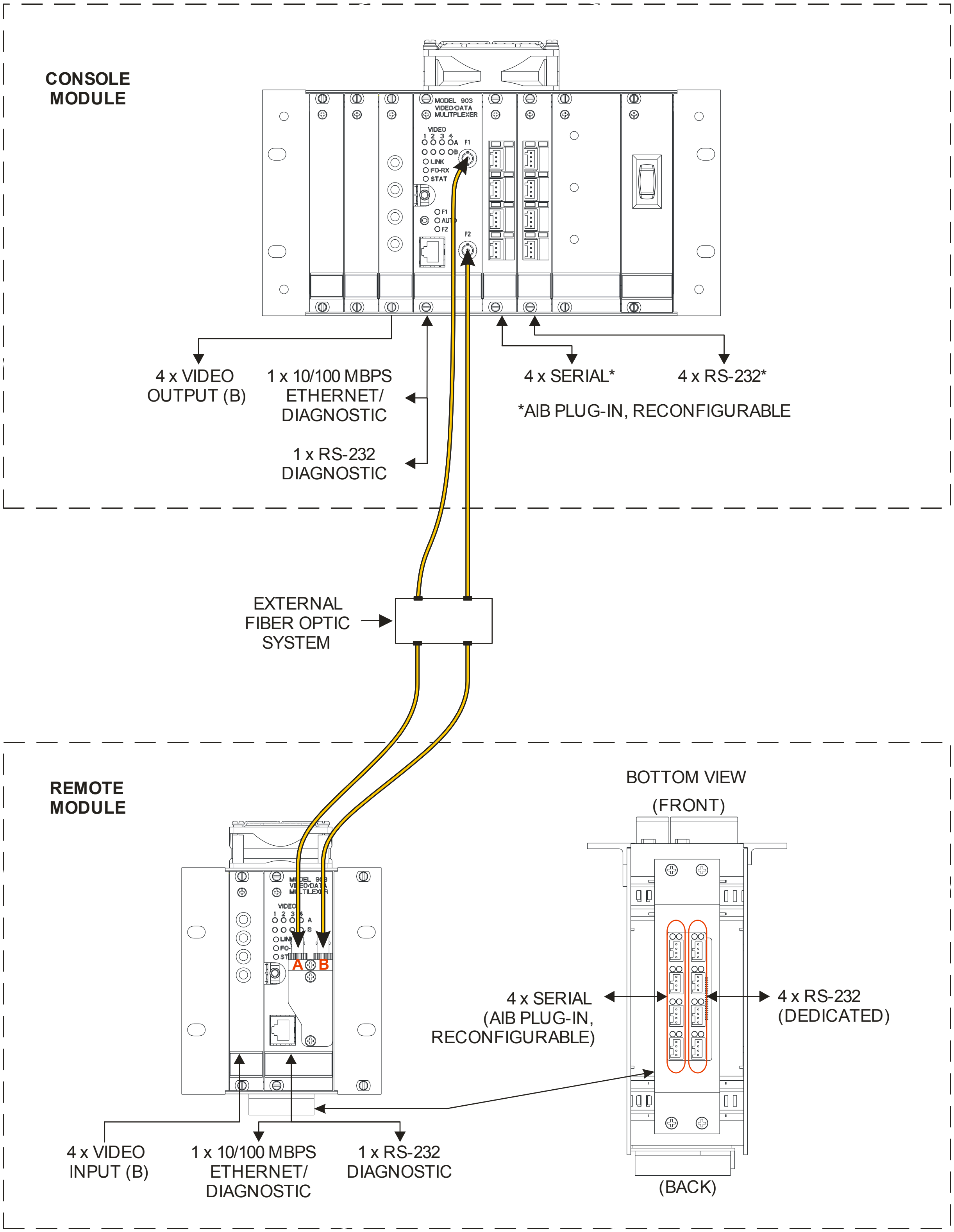


Figure 2-1: Model 903-HD Multiplexer – I/O Ports (4VID System)

The figure below shows the I/O ports and optical connections of a 903-HD 8VID system.

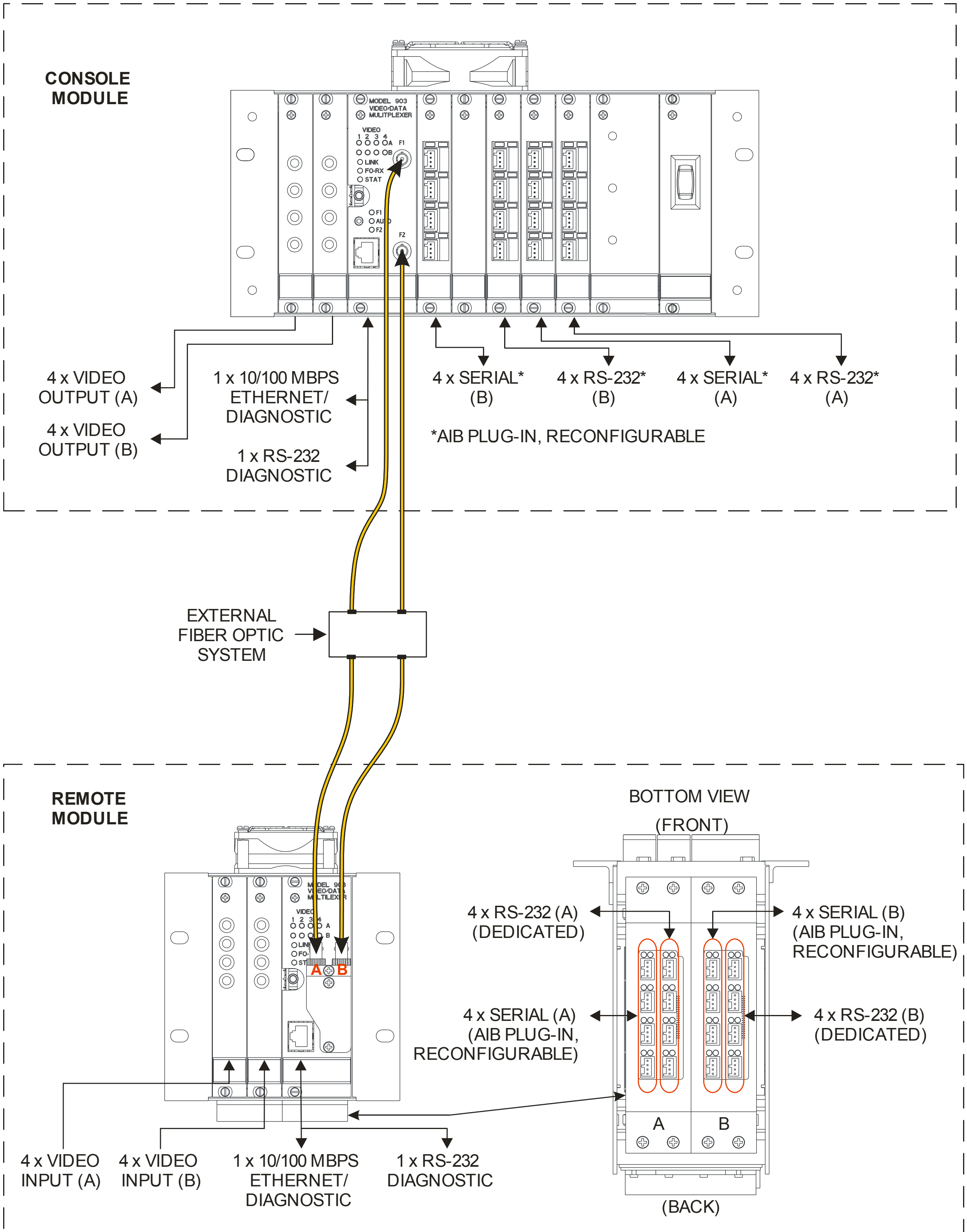


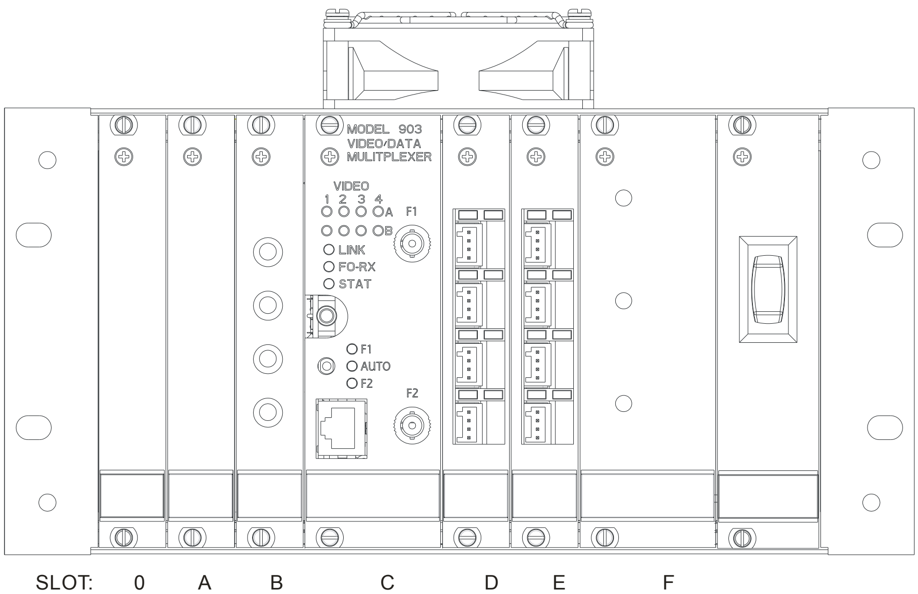
Figure 2-2: Model 903-HD Multiplexer – I/O Ports (8VID System)

2.2 Rack Configuration

This section provides information about the remote and console module configuration of the 4VID and 8VID systems covered in this document. Slots in each rack are referenced by letter, per the installation drawings 903-8xxx-xx.

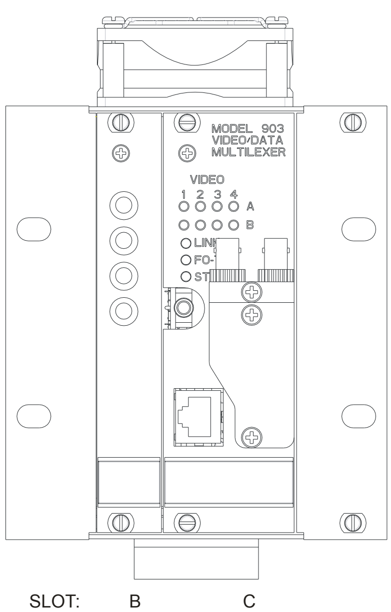
2.2.1 4VID Console and Remote Modules

The 4VID console and remote front panel views are shown in the figure below. This figure also shows a brief description of each card and the card's slot position/letter. Note that the as-installed configuration may differ if cards, such as the AIB-plugins, have been changed to accommodate new interface requirements. More details can be found in the 903-8xxx-xx installation drawings.



Console

SLOT	DESCRIPTION
0	BLANK PANEL, 4HP ASSEMBLY
A	BLANK PANEL, 4HP ASSEMBLY
B	VIB-X-C, CONSOLE 4x VIDEO OUTPUT CARD
C	FMB-X-2.5C, FIBER MULTIPLEXER BOARD
D	AIB-4 WITH 4x AIB PLUG-IN MODULES
E	AIB-4 WITH 4x AIB PLUG-IN MODULES
F	POWER SUPPLY
CAGE	CBP-121-XC, 42 HP



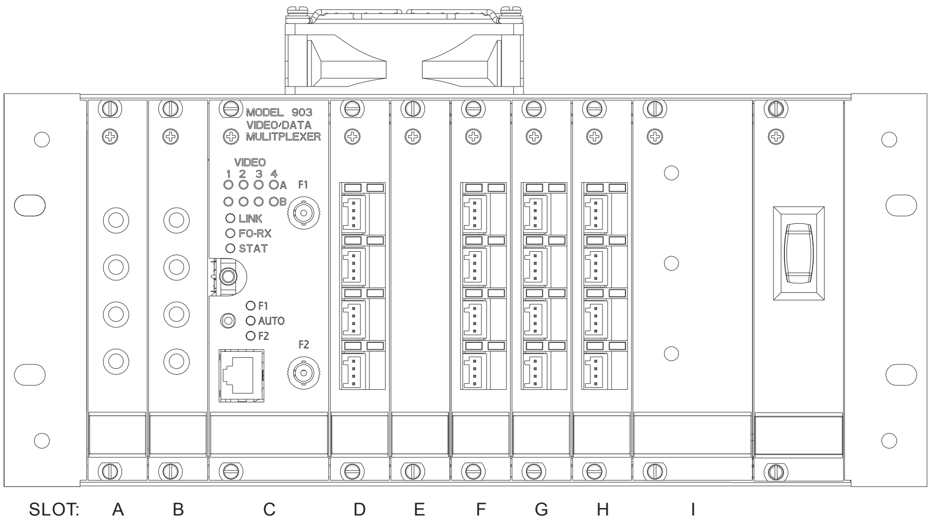
Remote

SLOT	DESCRIPTION
B	REMOTE HIGH DENSITY CARD
C	FMB-X-2.5R, FIBER MULTIPLEXER BOARD
CAGE	CBP-100-XR, 12 HP

Figure 2-3: Model 903-HD Mux Front Panel View – Card Configuration (4VID)

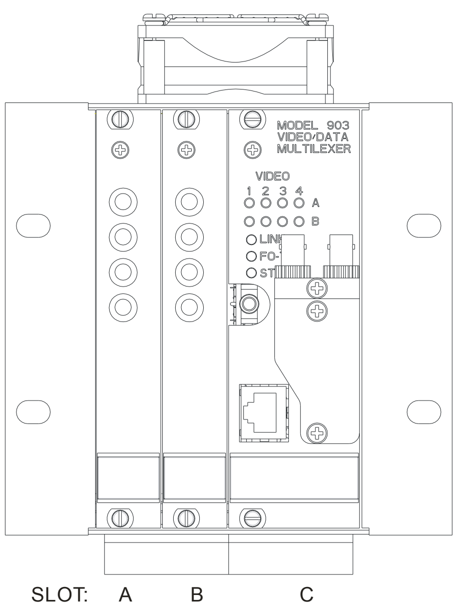
2.2.2 8VID Console and Remote Modules

The 8VID console and remote front panel views are shown in the figure below. This figure also shows a brief description of each card and the card's slot position/letter. Note that the as-installed configuration may differ if cards, such as the AIB-plugins, have been changed to accommodate new interface requirements. More details can be found in the 903-8xxx-xx installation drawings.



Console

SLOT	DESCRIPTION
A	VIB-X-C, CONSOLE 4x VIDEO OUTPUT CARD
B	VIB-X-C, CONSOLE 4x VIDEO OUTPUT CARD
C	FMB-X-2.5C, FIBER MULTIPLEXER BOARD
D	AIB-4 WITH 4x AIB PLUG-IN MODULES
E	BLANK PANEL, 4HP ASSEMBLY
F	AIB-4 WITH 4x AIB PLUG-IN MODULES
G	AIB-4 WITH 4x AIB PLUG-IN MODULES
H	AIB-4 WITH 4x AIB PLUG-IN MODULES
I	POWER SUPPLY
CAGE	CBP-241-XC, 50 HP



Remote

SLOT	DESCRIPTION
A	REMOTE HIGH DENSITY CARD
B	REMOTE HIGH DENSITY CARD
C	FMB-X-2.5R, FIBER MULTIPLEXER BOARD
CAGE	CBP-200-XR, 16 HP

Figure 2-4: Model 903-HD Mux Front Panel View – Card Configuration (8VID)

2.2.3 Channel Mapping

2.2.3.1 4VID Remote-to-Console Channel Mapping

The following figure shows the remote-to-console channel mapping of a 903-HD 4VID system.

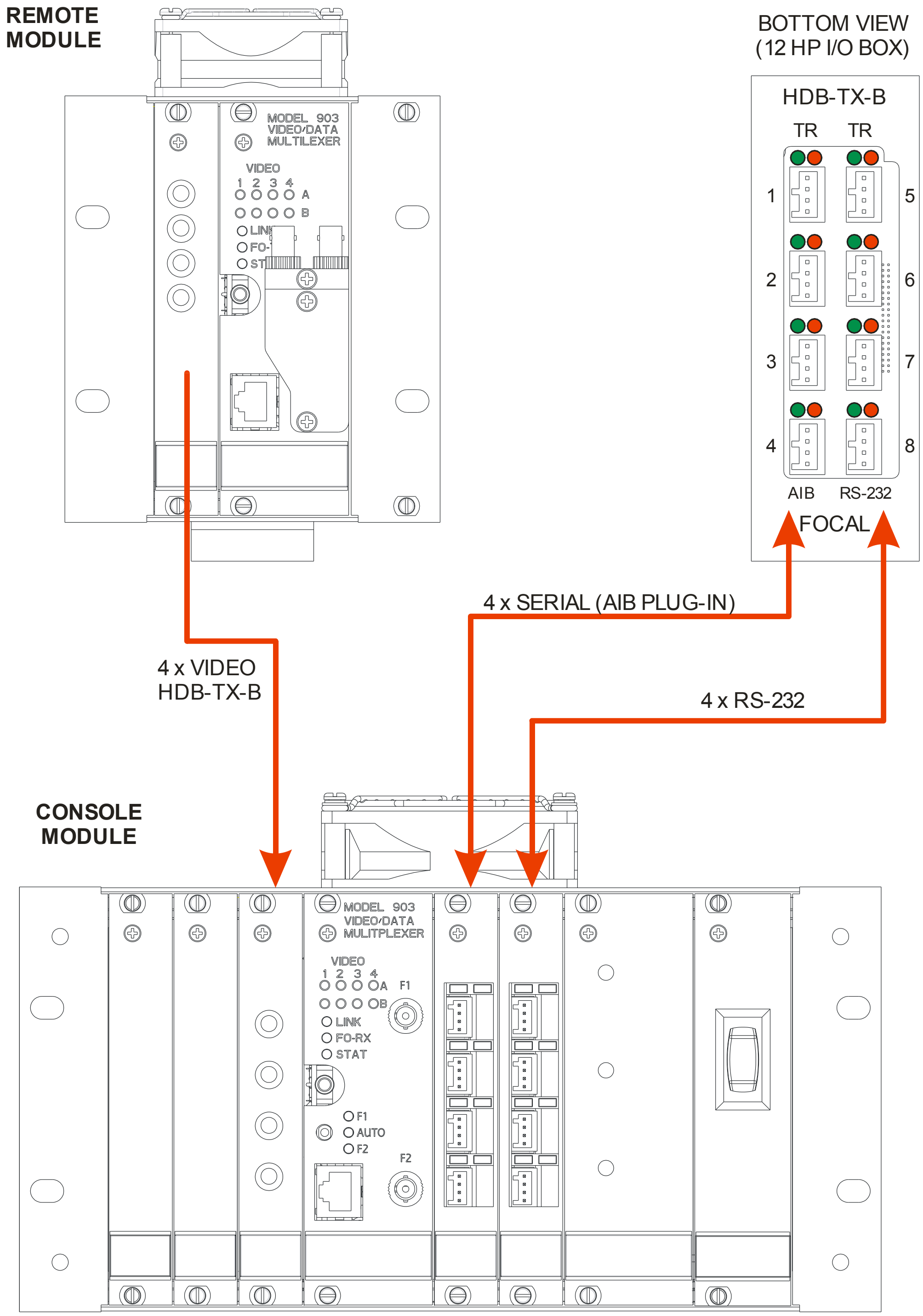


Figure 2-5: Console and Remote Modules (4VID) Showing Slot Pairings for Video and Data

A complete mapping of remote to console channels of a 4VID system is given in the following table.

Table 2-2: Typical Remote-to-Console Channel Mapping (4VID System)

Remote Module			Console Module			Typical Configuration
Slot	**Card Type**	**Signal Type & Channel @ Remote**	**Signal Type & Channel @ Console**	**Card Type**	**Slot**	
B	HDB-TX-B*	Video Input (B) CH 1-4	Video Output (B) CH 1-4	VIB-RX	B	All channels NTSC/PAL, 10-bit video.
		SERIAL I/O CH 1-4	SERIAL I/O CH 1-4	AIB-4 with AIB Plug-Ins	D	4 x RS-485 @ 115 Kbaud
		RS-232 I/O CH 5-8	RS-232 I/O CH 1-4	AIB-4 with AIB Plug-Ins	E	4 x RS-232 @ 115 Kbaud
C	FMB-X-2.5R-SMST-DF	Optical Video/Data Mux with 10/100 Mbps Ethernet and Diagnostic Data Slots: B, C Optical 50/50 Splitter Ports F1/F2	Optical Video/Data Mux with 10/100 Mbps Ethernet and Diagnostic Data Slots: B, C, D, E Auto/Manual Fiber Sw Ports F1/F2	FMB-X-2.5C-SMST-DF	C	FMB transports all video & data to/from cards in the specified slots. 2.5 Gbaud (Uplink/Downlink) F1=F2=Same Optical Data

*The data channel mapping and AIB plug-in cards used on the HDB-TX-B for a 4VID system is as follows:

HDB-TX-B Data Channel Mapping				
Remote		**Console**		
I/O-Box B Channels		**AIB-4 Channels**		**Slot**
4x SERIAL (AIB Plug-In)	1	1	4x SERIAL (AIB Plug-In)	D
	2	2		
	3	3		
	4	4		
4x RS-232	5	1	4x AIB-232	E
	6	2		
	7	3		
	8	4		

2.2.3.2 8VID Remote-to-Console Channel Mapping

The following figure shows the remote-to-console channel mapping of a 903-HD 8VID system.

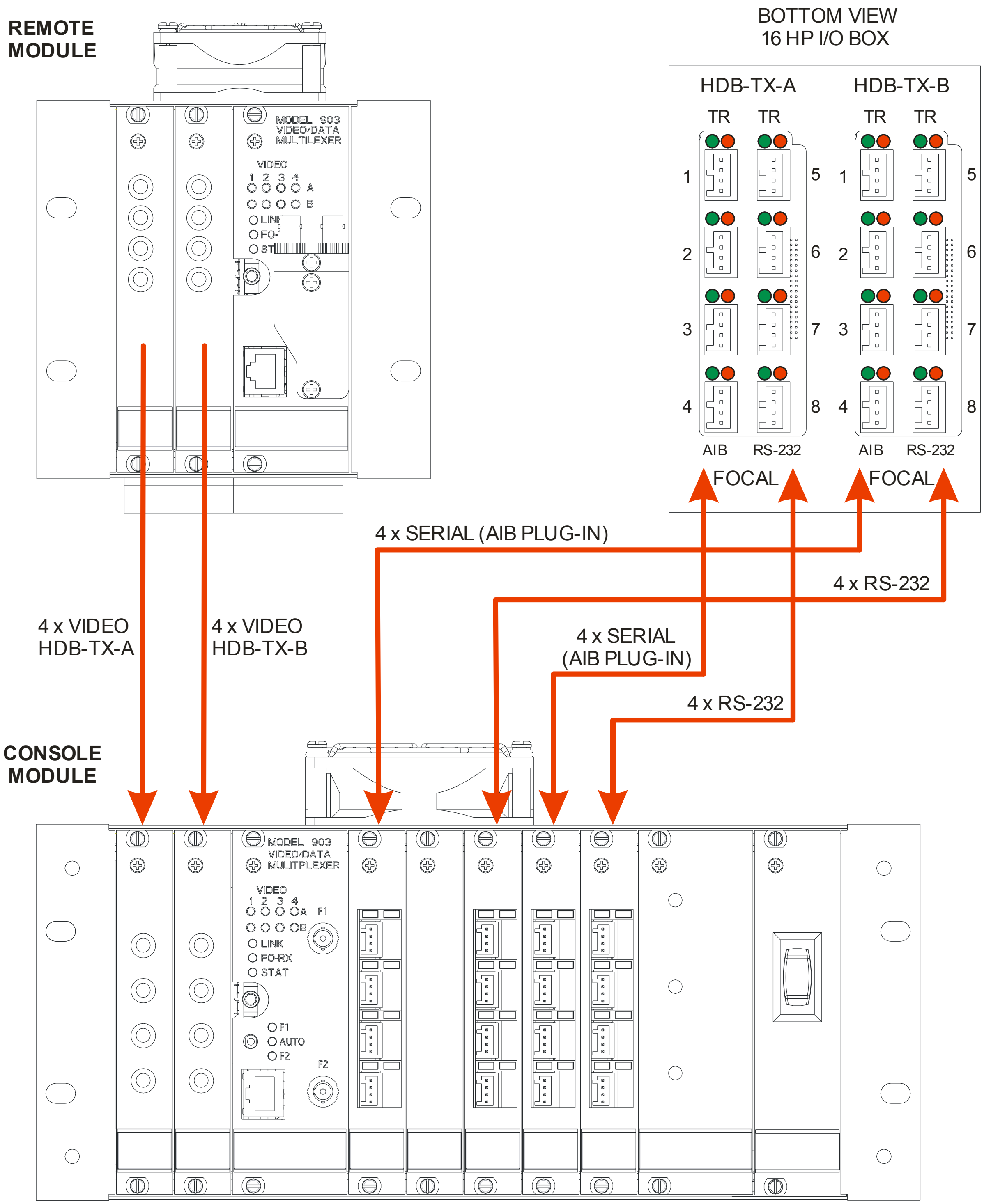


Figure 2-6: Console and Remote Modules (8VID) Showing Slot Pairings for Video and Data

A complete mapping of remote to console channels of an 8VID system is given in the following table.

Table 2-3: Typical Remote-to-Console Channel Mapping (8VID System)

Remote Module			Console Module			Typical Configuration
Slot	**Card Type**	**Signal Type & Channel @ Remote**	**Signal Type & Channel @ Console**	**Card Type**	**Slot**	
A	HDB-TX-A*	Video Input (A) CH 1-4	Video Output (A) CH 1-4	VIB-RX	A	All channels NTSC/PAL, 10-bit video.
		SERIAL I/O CH 1-4	SERIAL I/O CH 1-4	AIB-4 with AIB Plug-Ins	G	4 x RS-232 @ 115 Kbaud
		RS-232 (A) I/O CH 5-8	RS-232 I/O CH 1-4	AIB-4 with AIB Plug-Ins	H	4 x RS-232 @ 115 Kbaud
B	HDB-TX-B*	Video Input (B) CH 1-4	Video Output (B) CH 1-4	VIB-RX	B	All channels NTSC/PAL, 10-bit video.
		SERIAL I/O CH 1-4	SERIAL I/O CH 1-4	AIB-4 with AIB Plug-Ins	D	4 x RS-485 @ 115 Kbaud
		RS-232 (B) I/O CH 5-8	RS-232 I/O CH 1-4	AIB-4 with AIB Plug-Ins	F	4 x RS-232 @ 115 Kbaud
C	FMB-X-2.5R-SMST-DF	Optical Video/Data Mux with 10/100 Mbps Ethernet and Diagnostic Data Slots: A, B, C Optical 50/50 Splitter Ports F1/F2	Optical Video/Data Mux with 10/100 Mbps Ethernet and Diagnostic Data Slots: A, B, C, D, F, G, H Auto/Manual Fiber Sw Ports F1/F2	FMB-X-2.5C-SMST-DF	C	FMB transports all video & data to/from cards in the specified slots. 2.5 Gbaud (Uplink/Downlink) F1=F2=Same Optical Data

*The data channel mapping and AIB plug-in cards used on the HDB-TX-A and HDB-TX-B for an 8VID system is as follows:

HDB-TX-A Data Channel Mapping (Typical)				
Remote		**Console**		
I/O-Box A Channels		**AIB-4 Channels**		**Slot**
4x SERIAL (AIB Plug-In)	1	1	4x SERIAL (AIB Plug-In)	G
	2	2		
	3	3		
	4	4		
4x RS-232	5	1	4x AIB-232	H
	6	2		
	7	3		
	8	4		

HDB-TX-B Data Channel Mapping (Typical)				
Remote		**Console**		
I/O-Box B Channels		**AIB-4 Channels**		**Slot**
4x SERIAL (AIB Plug-In)	1	1	4x SERIAL (AIB Plug-In)	D
	2	2		
	3	3		
	4	4		
4x RS-232	5	1	4x AIB-232	F
	6	2		
	7	3		
	8	4		

2.3 System Expansion

The cards in the 4VID and 8VID systems may be changed to provide a different mix of signal types or increase the number of serial channels.

Please contact the factory prior to any system upgrades or reconfiguration.

2.4 Optical Configuration

The optical configuration of a 4VID and 8VID dual fiber systems is shown in the figure below.

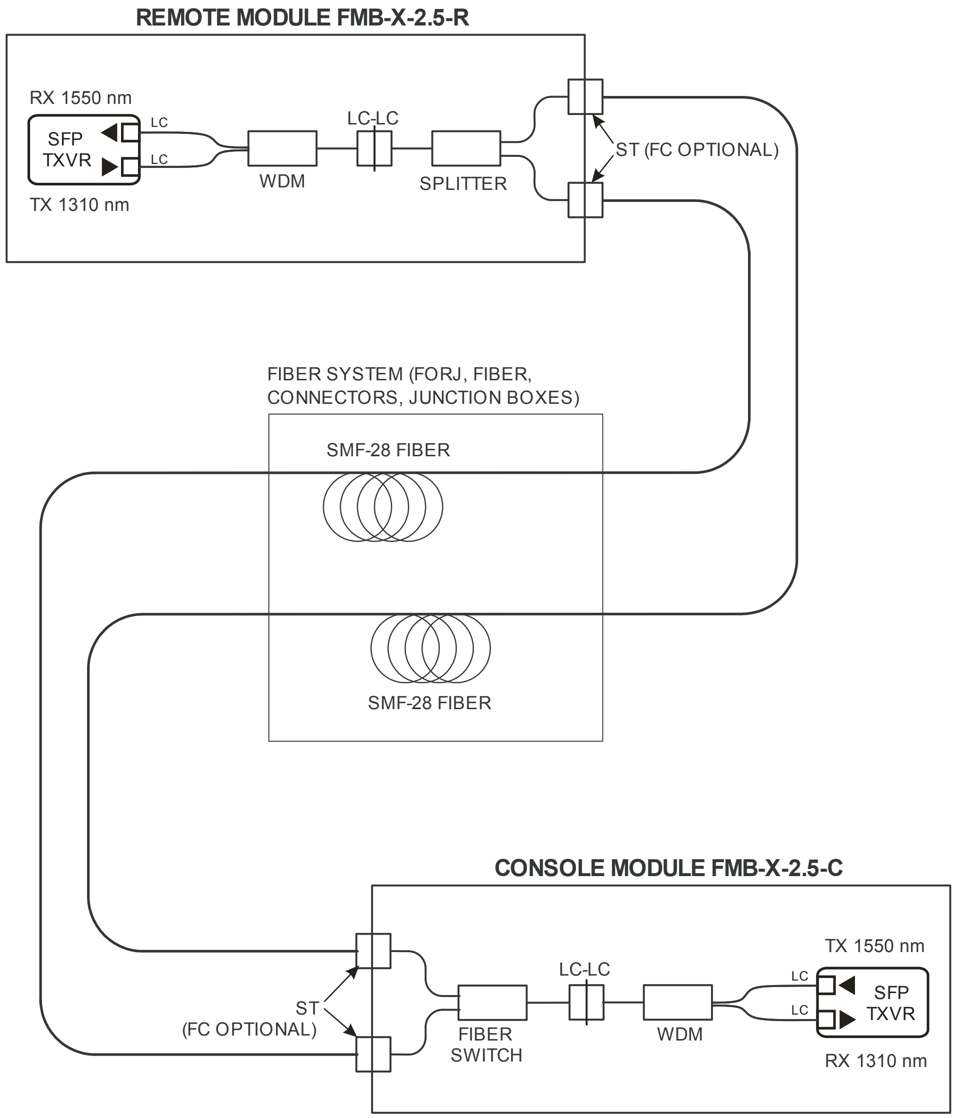


Figure 2-7: Model 903 Dual Fiber Optic Transmission System (4VID, 8VID)

The FMB-X-2.5R card in the remote subrack optically multiplexes the 1310 nm uplink and 1550 nm downlink on the same fiber with a standard 1310/1550 nm WDM. A second 1310/1550 nm WDM at the FMB-X-2.5C card multiplexes the uplink and downlink to the receiver and transmitter respectively.

The remote FMB-X-2.5R includes an optical splitter to provide redundant signals over two separate singlemode fibers. At the console module, one of the two fibers for each link is selected by the fiber switch integrated with the FMB-X-2.5-C located in slot C. Hence the downlink is only present on one fiber at a time.

The fiber switching can be performed automatically or manually, depending on the position of the toggle switch on the front panel of the FMB-X-2.5C card. Refer to section 3.1.2 for more information about the FMB-X-2.5C.

2.5 Backwards Compatibility

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.

Contact factory for more information.

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 the diagnostics manual (P/N 903-0622-00).

Note: The FMB-X-2.5 FPGA-based SERDES optical link is not optically compatible with GLINK-based FMB cards such as FMB-VTX, FMB-VRX or GLINK FMB-X cards. These older cards must be updated in pairs (remote and console). More details about upgrading to FMB-X-2.5 are found in the Model 903 User's Guide 903-0623-00.

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. Typically the output power should be greater than -6 dBm at 1310 nm (uplink) and the receive sensitivity at the turret should be better than -24 dBm at 1550 nm (downlink).

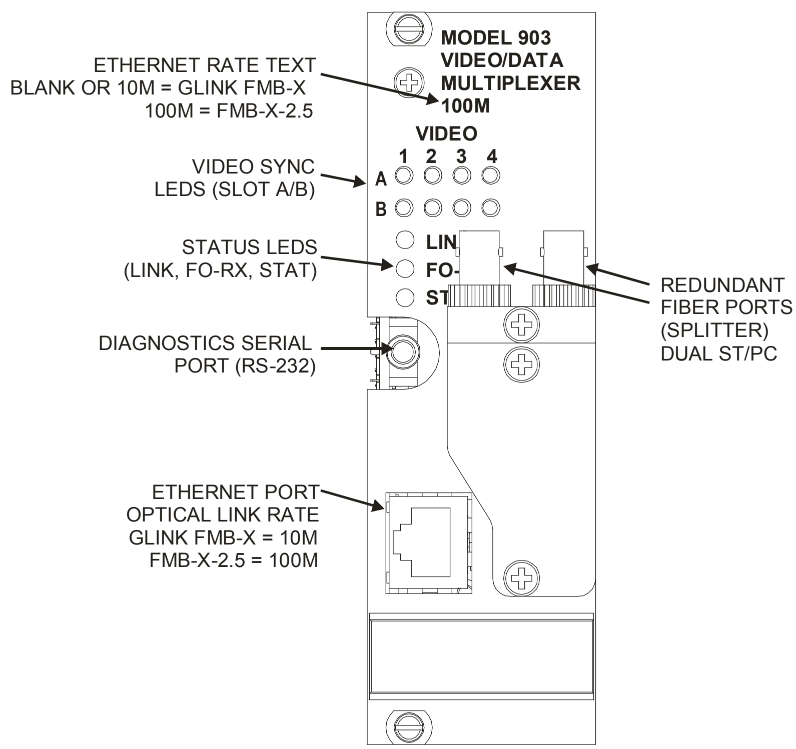


Figure 3-1: Remote FMB-X-2.5 Front Panel View

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. The older GLINK FMB-X supports only 10 Mbps through the multiplexer. The maximum data rate supported by the Ethernet link is indicated on the panel silk screen and is an easy way to differentiate the FMB-X-2.5 (100M) and older FMB-X (10M) cards.

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 and also refer to diagnostics manual 903-0622-00.

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.

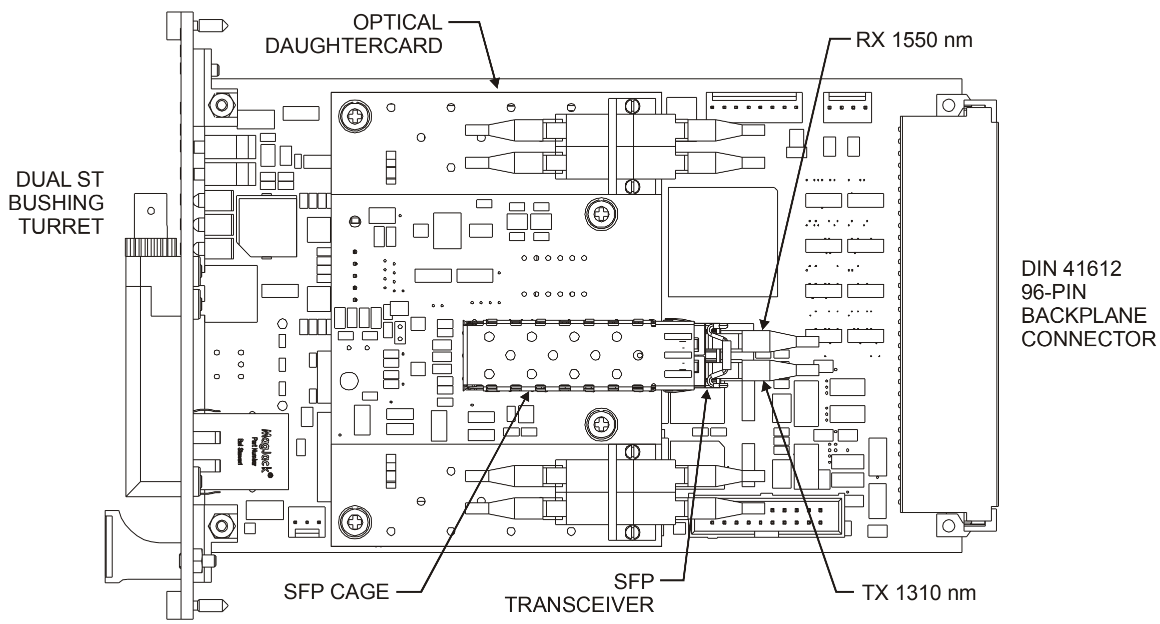


Figure 3-2: Remote FMB-X-2.5 Plan View

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. Typically the output power should be greater than -2 dBm at 1550 nm (downlink) and the receive sensitivity at the front panel should be better than -28 dBm at 1310 nm (uplink).

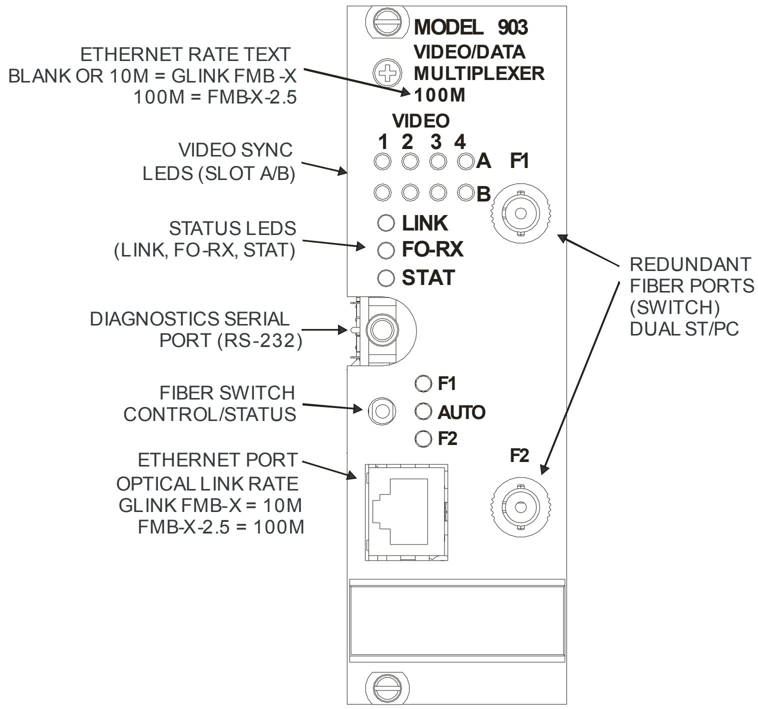


Figure 3-3: Console FMB-X-2.5 Front Panel

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: 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. A valid optical link means that the local FMB is receiving valid data frames from the far end card.
FO-RX	FO-RX LED is green when the received optical power is within specified operating range, i.e. above the minimum sensitivity and below the saturation level. This LED will change to orange (warning) when the receive power is within roughly 2-3 dB of the receiver failing at low power or within roughly 1-2 dB of saturating and failing at high power. The LED will change to red (alarm) when the power level is either too low or too high to provide a reliable optical link, although in some cases the link will still be functional with a higher than normal bit error rate. Warning and alarm thresholds are stored in registers in the SFP transceivers. 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. 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 figure below.

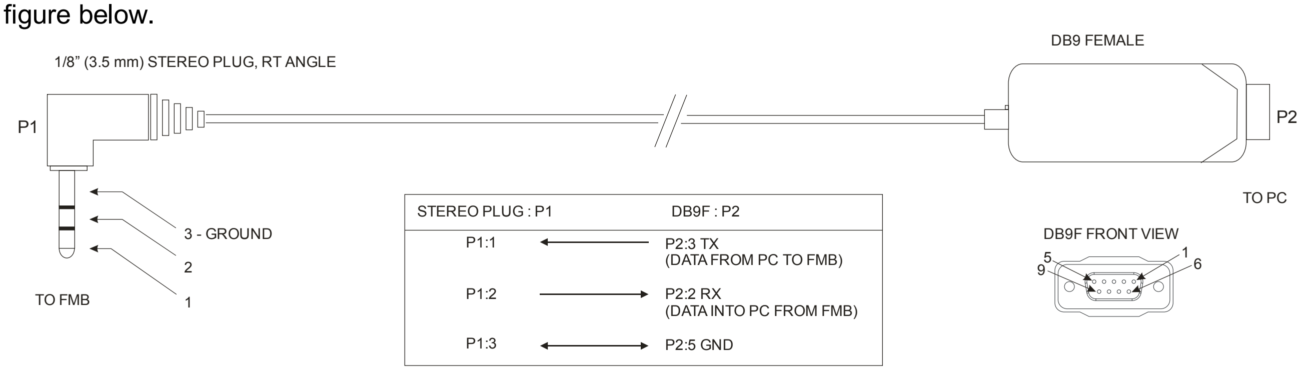


Figure 3-4: FMB-X-2.5 RS-232 Diagnostic Cable: 1/8" (3.5 mm) Stereo to DB9F

The functions described in the figure above are relative to the PC (DB9 side), i.e. TX is data transmitted from the PC to the FMB-X-2.5 and RX 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 (toggle up forces the fiber switch to F1 and toggle down forces it to F2). 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 active fiber is indicated by a green LED next to either F1 or F2. The LED marked "AUTO" is green when in automatic switching mode and off when in manual 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 fault 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.

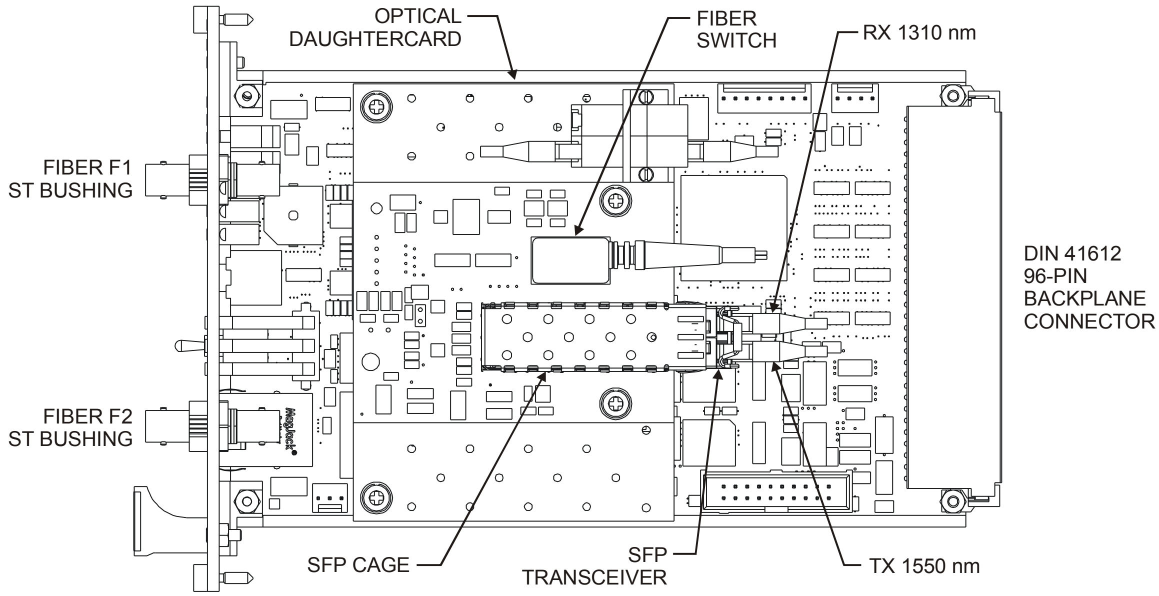


Figure 3-5: Console FMB-X-2.5 Plan View

3.1.3 Configuration Settings

Switch configuration settings for the remote and console FMB-X-2.5 cards are given in the tables below. **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 3-2: 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 3-3: 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 Type) and Racks

BP P/N 903-7212-00 for 4VID 903-HD Remote system
BP P/N 903-7213-00 for 4VID 903 Std. Console system
BP P/N 903-7207-00 for 8VID 903-HD Remote system
BP P/N 903-7210-00 for 8VID 903 Std. Console system

The backplane cards are used to connect all the Model 903 cards and PSU modules together to make up a Model 903 system. There are two main types of backplanes for 903 systems based on FMB-X-2.5 cards. One is the standard -X backplane and the other is the high density -X backplane. Both types of backplanes provide diagnostic capabilities that are used to monitor the overall status of the system.

The following table provides a list of the different backplanes used in the 4VID and 8VID systems. This table also shows a cross reference between the backplane P/Ns and rack P/Ns.

Table 3-4: -X Backplanes Used in 4VID and 8VID Systems

System		-X Backplane						Card Rack	
Name	End	P/N	Type	Width (HP)	Number of Slots			P/N [Type]	Width (HP)
					Video	Data	PSU		
4VID	Remote	903-7212-00	High Density	12	1	0	0	903-0004-03 [CBP-100-XR]	12
	Console	903-7213-00	Standard	28	1	2	1	903-0007-07 [CBP-121-XC]	42
8VID	Remote	903-7207-00	High Density	16	2	0	0	903-0005-12 [CBP-200-XR]	16
	Console	903-7210-00	Standard	44	2	4	1	903-0007-06 [CBP-241-XC]	50

For the 4VID and 8VID systems, each video and data slot occupies a standard 0.8” (4HP=0.8”) width in the card rack. The FMB-X-2.5 and power supply slots are 1.6” (8HP) wide and the front panel power switch on the console modules is 1.2” (6HP) wide. Boards are referenced by location within the rack in relation to the FMB-X-2.5 slot C.

As shown in the table above, the three digits following the CBP- designator (under the “Card Rack” column) represent the number of video, data, and power supply unit (PSU) slots respectively. An “R” in the suffix indicates the remote rack and a “C” in the suffix indicates the console rack.

As shown in the table above, the high density -X backplane uses a proprietary 12HP/16HP design including guided card slots for one or two high density boards (HDB-TX) and one fiber optic multiplexer board (FMB-X-2.5). Each HDB slot takes a 4HP wide card; each FMB-X-2.5 slot takes an 8HP wide card. Note that the high density remote racks do not have a PSU slot and instead they have DC-DC converters mounted on the backplane. These backplanes are single voltage input (+24 VDC).

3.2.1 Standard -X Backplanes

Card P/N: 903-7213-00; 903-7210-00

The standard -X backplanes described in this section are used on the 4VID (BP P/N: 903-7213-00, 28 HP) and 8VID (BP P/N: 903-7210-00, 44 HP) console modules.

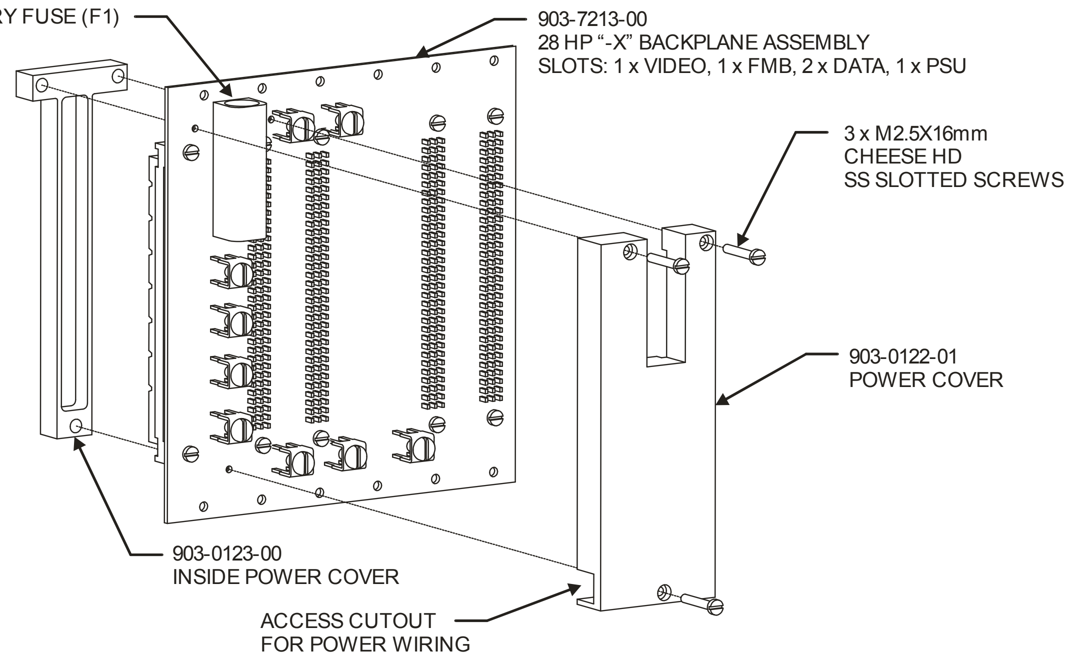
Assembly views of a 28 HP -X backplane PCB (CBP-121-XR/XC) and a 44 HP -X backplane PCB (CBP-241-XR/XC) are given in Figure 3-6 and Figure 3-7 respectively. The bottom side of the backplane faces outwards from the assembly and is accessible by removing the back cover plate. Fuse F1 is a standard replaceable glass cartridge type for the primary power input (fuse value depends on type of power supply). Header J15 is a serial number programming port; 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.

For 230 VAC inputs, typically there are two line connections rather than line and neutral. The neutral wires and terminals should always be assumed to be at high voltage.



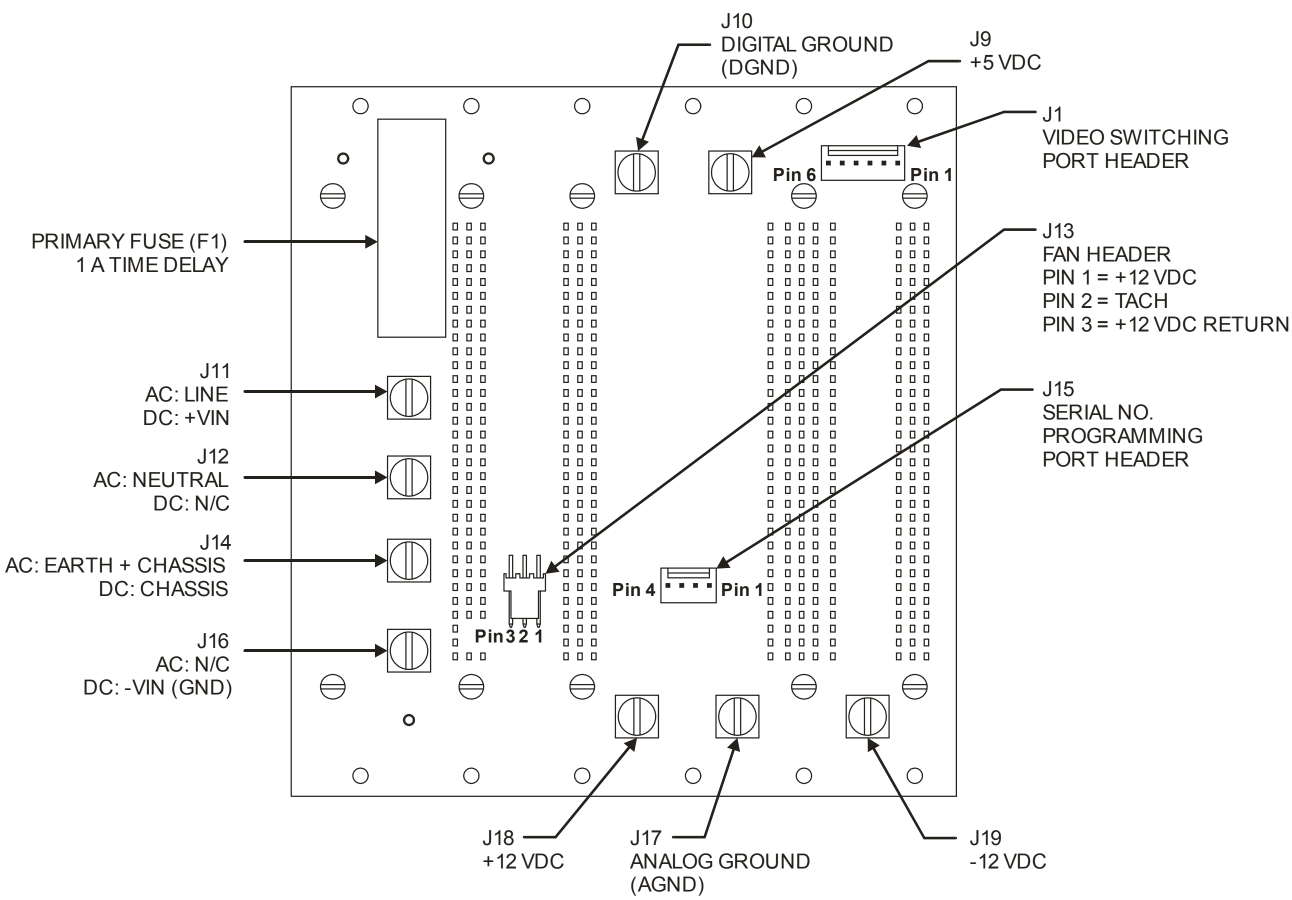


Figure 3-6: 28 HP -X Console Backplane (CBP-121-XC)

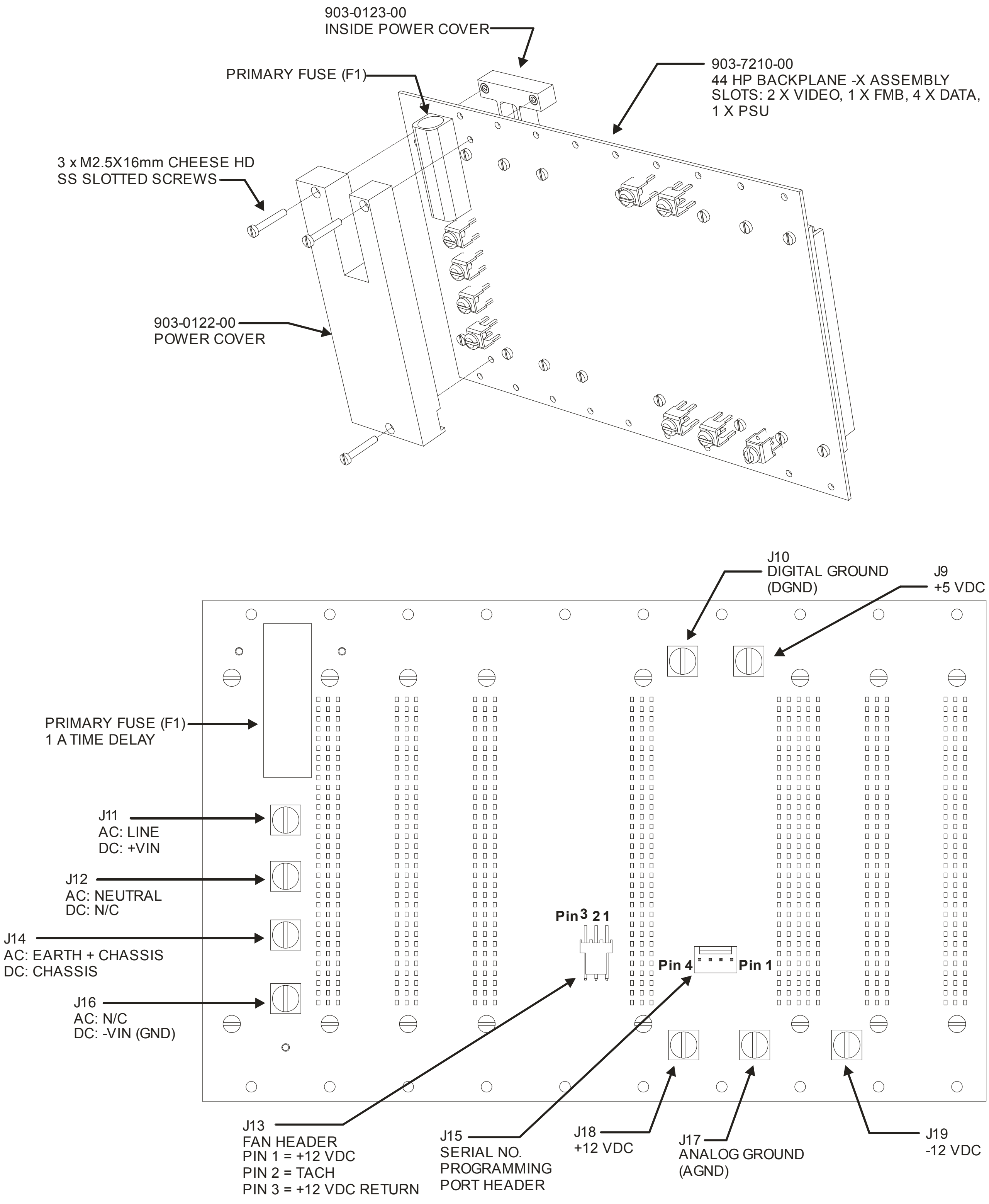


Figure 3-7: 44 HP -X Console Backplane (CBP-241-XC)

3.2.2 High Density -X Backplanes

Card P/N: 903-7212-00 (12 HP BP); 903-7207-00 (16 HP BP)

The high density -X backplanes described in this section are used on the 4VID (12 HP BP P/N: 903-7212-00) and 8VID (16 HP BP P/N: 903-7207-00) remote modules. These backplanes are +24 VDC input.

PCBA views of the 12 HP -X backplane PCB (CBP-100-XR) and the 16 HP -X backplane PCB (CBP-200-XR) are given in Figure 3-8 and Figure 3-9 respectively. These figures show the side that faces outwards from the back of the remote chassis with the plastic cover removed. The J5 header is connected to a 24 VDC fan on the remote rack. Only a single +24 VDC input power is required at J6.

The remote module does not have a power switch. Connection of the remote module power supply to primary supply rails immediately turns the module on. Status of the three internal rail voltages (+5, +12, -12 VDC) is indicated by the diagnostics software.

The primary input to the remote module is protected with a 5 A time delay fuse, F3, located just below the power input J6 connector. This fuse may be replaced, if necessary, with the spare fuse F2 located nearby.

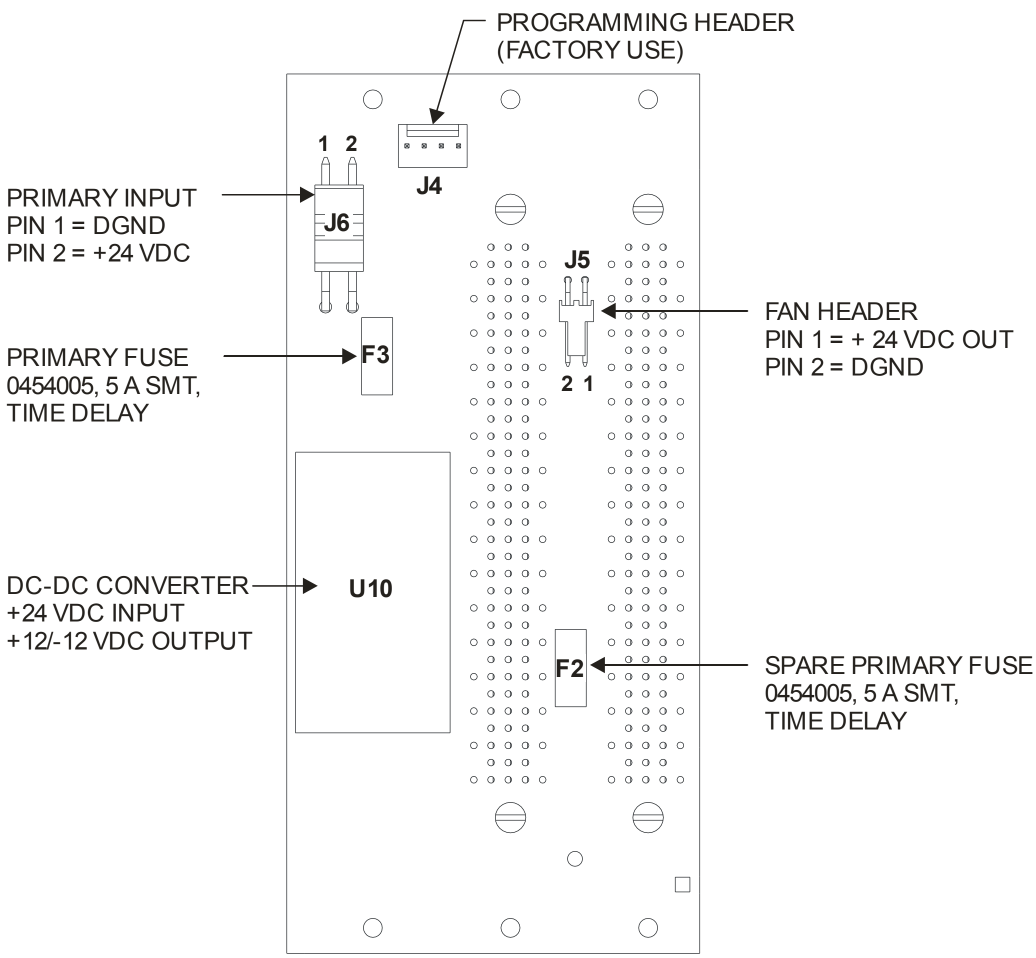


Figure 3-8: 12 HP High Density Remote Backplane PCBA (+24 VDC Input)

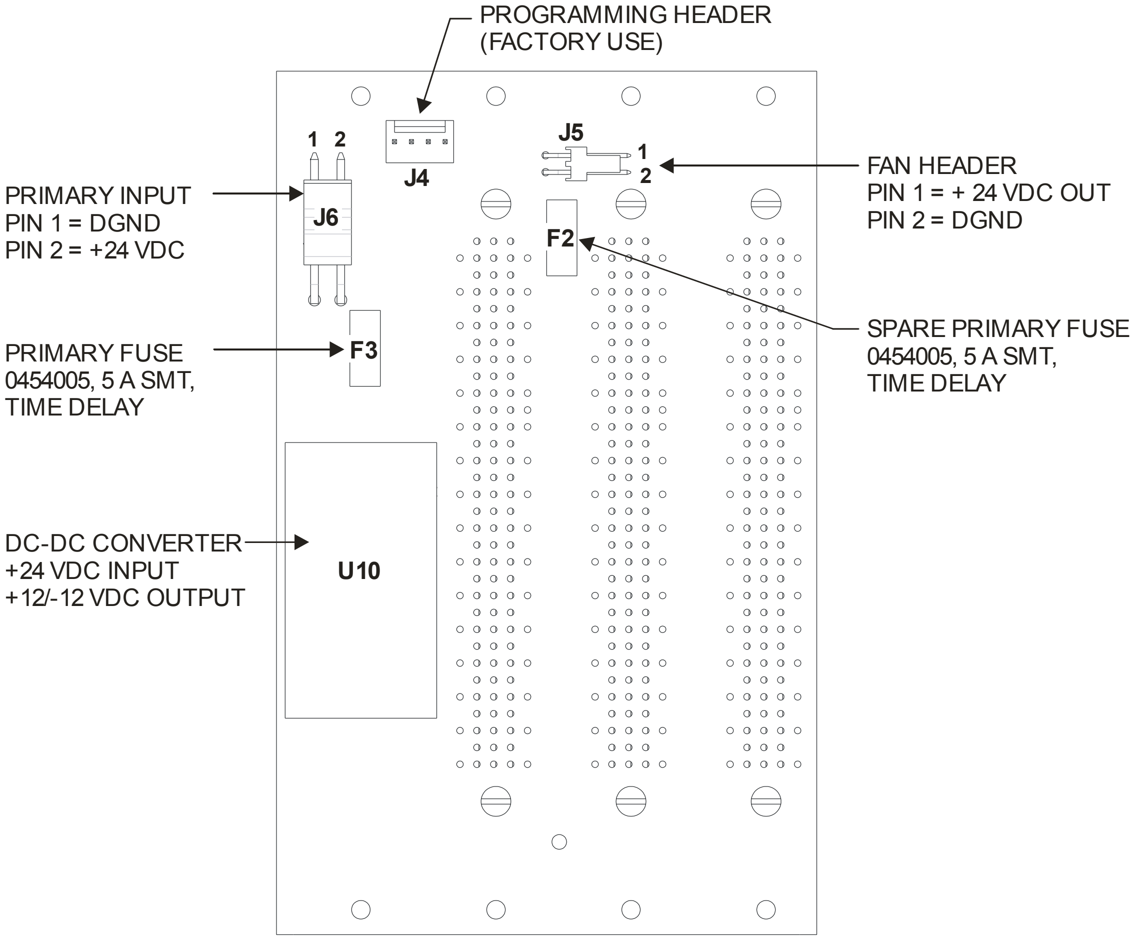


Figure 3-9: 16 HP High Density Remote Backplane PCBA (+24 VDC Input)

3.3 Power Supply

The 4VID and 8VID systems use the power supplies described in the table below.

Table 3-5: Typical Power Supplies for 903 Console and Remote Systems

Power Supply	Description	System End
AC Module (PSU)	115/230 VAC, 60W, 47-63 Hz Auto-ranging	Console
24 VDC	DC-DC Converter, +24 VDC Input, Range 18-36 VDC.	Remote

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.

Console

The 4VID and 8VID console modules use a standard power supply unit (PSU). This PSU is a 3U x 8HP Eurocassette with a 100 mm guiding height.

Current draw from the primary 115 VAC for a typical console module is approximately 0.3 A.

As shown in Figure 3-10, the console modules have 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. The 4VID and 8VID console modules use AC input power and therefore 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.

Remote

Each 4VID and 8VID remote module uses two DC-DC converters that are part of the high density -X backplane. One DC-DC converter (75W) outputs +5 VDC and the other DC-DC converter (10W) outputs ±12 VDC. Each remote module requires +24 VDC input power from a power supply capable of providing 2A. See Figure 3-10 for DC power connector location.

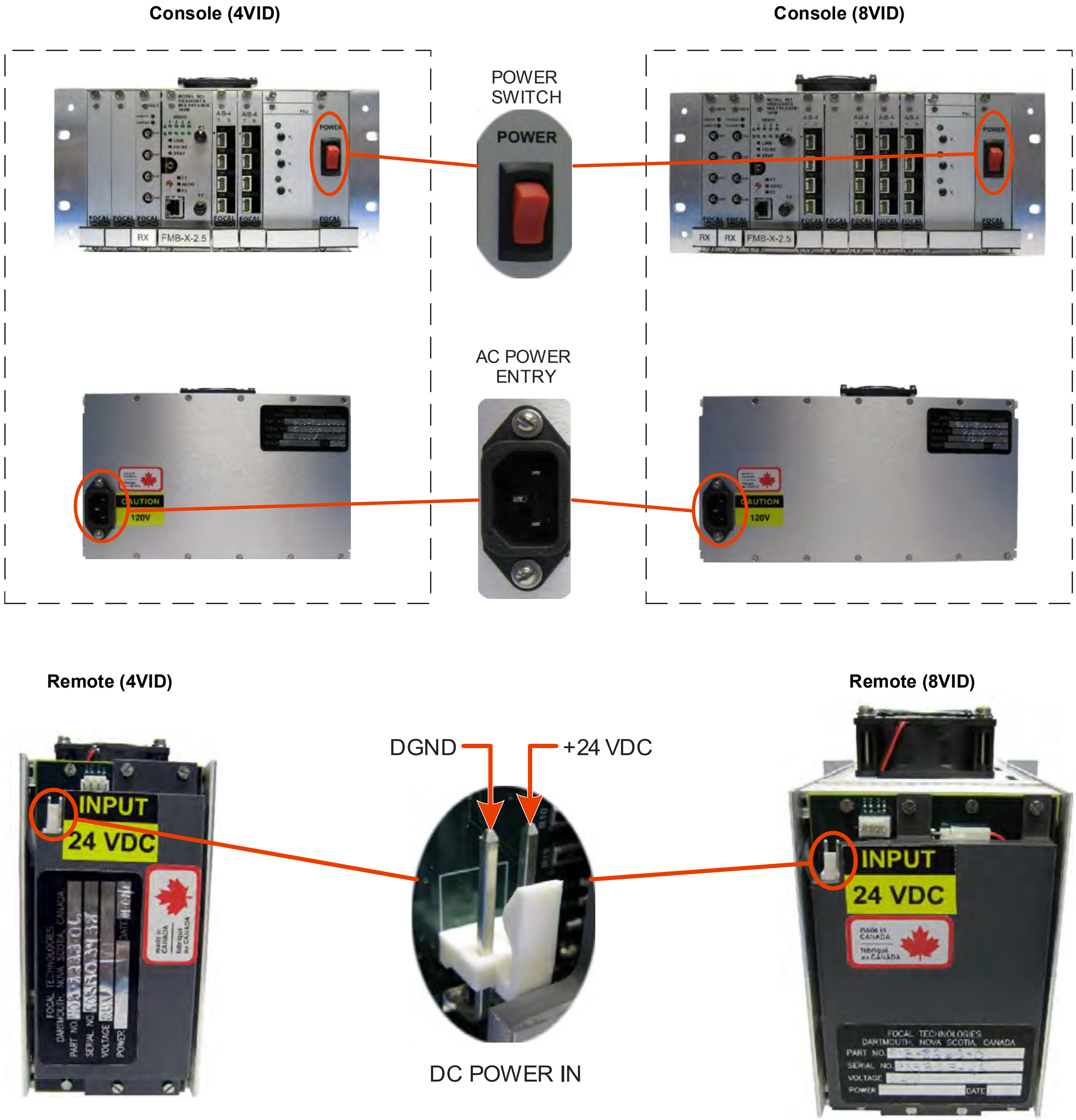


Figure 3-10: Power Connectors Location (4VID and 8VID Systems)

4.0 Interface Cards

Interface cards are part of a 903 system and they consist of the following types:

Video - Video signals are unidirectional. There are video input cards for the remote module and video output cards for the console module.

Data - Data cards are typically bi-directional, with some exceptions.

Optical/Media Converter - Optical/ 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, 100/1000 Mbps Ethernet, and high-speed ECL/PECL data links. The media converter cards can 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.

4.1 High Density Board (HDB-TX)

Card P/N 903-5006-00 (Remote Only)

The remote high density board (HDB-TX) provides interfaces for four video channels, four dedicated RS-232 channels, and four adaptable interface board (AIB) plug-in modules, which are available for a variety of signals, including RS-232, RS-485/422, Tritech ARCNET, hydrophones, CAN bus and analog sonars. Video channels are unidirectional, originating at the remote module; data channels, other than hydrophone signals, are bidirectional.

4.1.1 Video Channels

Each HDB-TX card provides inputs for four standard NTSC or PAL composite video signals brought in through the front panel SMB connectors shown at the top of the panel in the figure below. Video 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. All video inputs are capacitively coupled and protected by transient voltage suppression diodes. External isolation transformers may be used to galvanically isolate the video, but may cause degradation of video quality. The digitizers sample at a fixed frequency of 15.625 MHz with 10 bits of resolution to achieve video transmission quality exceeding EIA-250C end-to-end specifications.

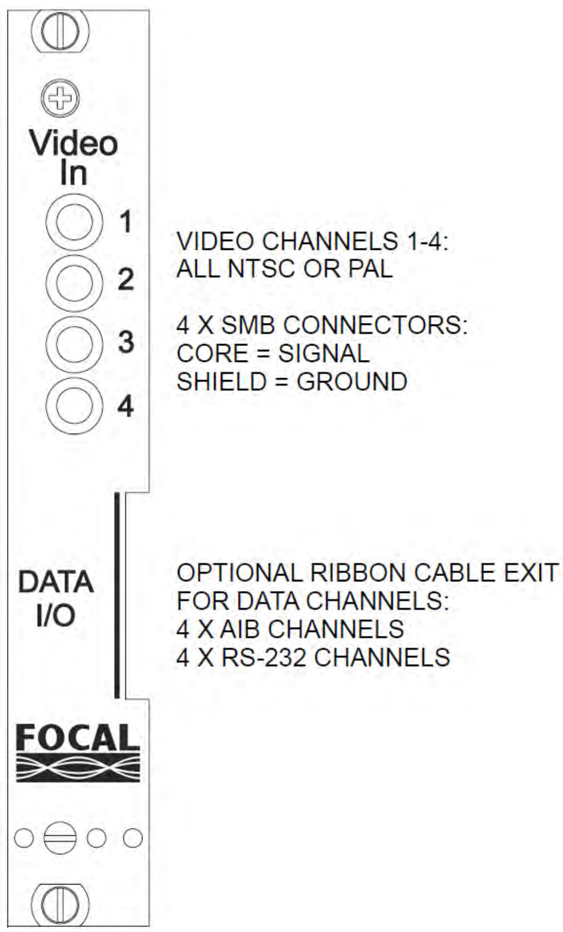


Figure 4-1: Remote High Density Board (HDB-TX) – Front Panel

Notes:

1. All four video channels are configured for composite video support.
2. Dip switch SW1 must have all switches off (default configuration for composite video).

For 4VID and 8VID systems with FMB-X-2.5 and backplane -X cards installed, the diagnostics software at the surface can monitor the status of the HDB-TX card, including card assembly information, such as serial number. A black and white bar test pattern is also available on the HDB-TX remote card through the diagnostic software (command mode). This test pattern is generated in the FPGA and can be output at the front panel as well as to the backplane. Refer to FMB-X-2.5 diagnostics manual (P/N 903-0622-00) for more details.

Note: HDB-TX cards shipped before September 2011 (cards with SN < 10022022) only support LED diagnostics but do not support enhanced diagnostics, which provides card serial number information and a video test pattern generator.

4.1.2 Data Channels

All eight data channels of the HDB-TX card are accessible via a ribbon cable header, J5, located next to the video connectors on the PCB. The mating ribbon cable is routed internally to a data input/output board, typically installed in an I/O-Box located on the bottom of the rack but may also be routed through the slot in the front panel. Figure 4-2 shows the location of the video (J1-J4), data I/O (J5), AIB plug-in (J6-J13) and backplane (J16) connectors. Figure 4-3 shows a block diagram of the high density board.

Four dedicated RS-232 channels are provided on the high density motherboard. External connectors and signal activity LEDs for these channels are located at the I/O-Box. Inputs to the RS-232 channels are non-isolated on the HDB-TX card itself, but are protected by current limiting resistors (1K) and transient voltage suppressors (TVS). Additional isolation for the dedicated RS-232 channels is provided by the I/O-Box, per section 4.1.3. Maximum data rate supported on RS-232 channels is 115.2 kbaud.

Four plug-in sockets located on the main board are compatible with any plug-in module available for the AIB-4 cards. When installing a plug-in module, ensure the white dots on the plug-in module and HDB-TX PCB are aligned. External connectors and signal activity LEDs for these channels are also located at the I/O-Box. Input protection for AIB modules depends on the type of plug-in, but generally includes isolation via opto-couplers or transformers to complement the fuses and transient voltage suppressors located on the data I/O board. Data rates up to 2.5 Mbaud are supported with the RS-485/422 plug-in module.

See section 4.3.1 for details on the AIB plug-in modules.

Installation Notes:

Use small 75 ohm coaxial cable for video connections (e.g. RG-179) terminated in right angled SMB connectors, such as Johnson P/N 131-1403-116. Runs of cable should be kept as short as possible, < 5 m, to minimize high frequency attenuation. For long runs of cable, use a larger 75 ohm cable, such as RG-59, with appropriate adaptors.

When removing the HDB-TX card from the card rack, follow the procedures given in section 6.6. In addition, the board must only be partially removed until the ribbon cable header is accessible. The ribbon cable must then be disconnected prior to fully extracting the card. This procedure must be reversed when reinstalling the card. If the ribbon cable is routed internally, care should be taken to avoid pinching it or snagging it on adjacent cards. In some cases, the adjacent card may need to be partially removed to facilitate card extraction.

A strip of ESD-safe plastic is clipped to the front of each HDB-TX card and extends inside the card, along the ribbon cable. This clip is intended to cover and protect the ribbon cable from damage during installation and removal of the HDB-TX card or adjacent FMB.

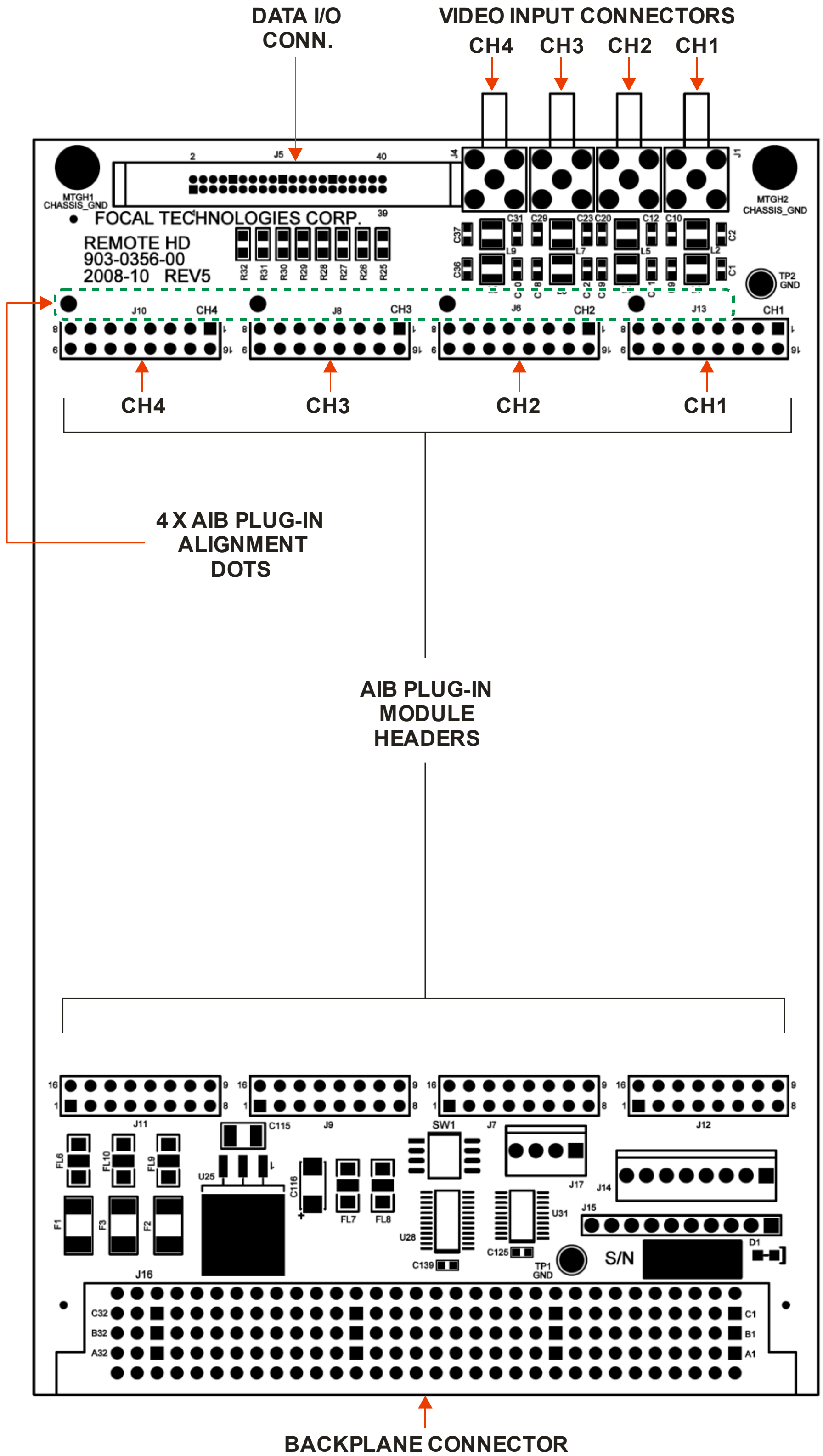


Figure 4-2: HDB-TX PCB and Connector Location

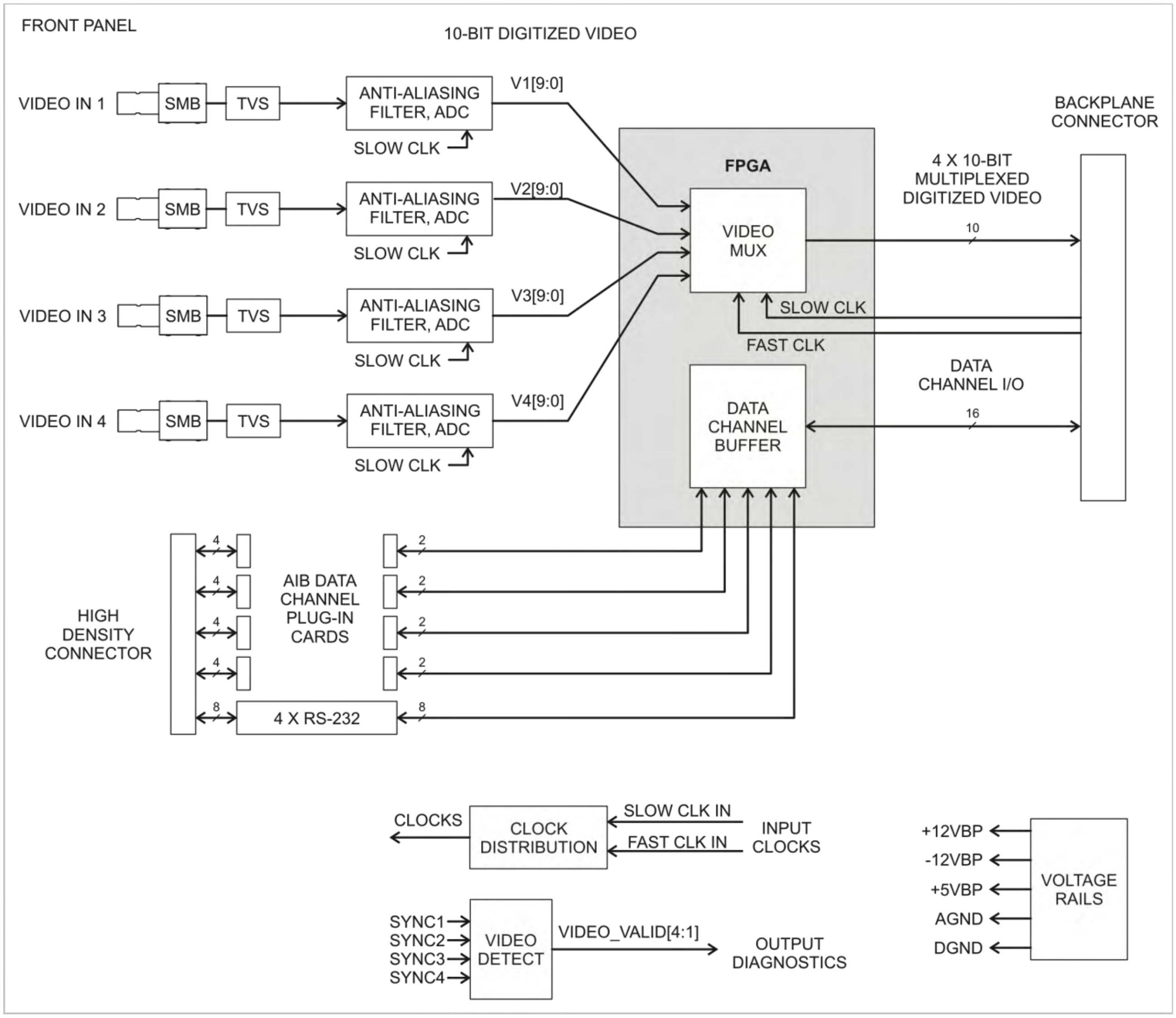


Figure 4-3: HDB-TX Block Diagram

4.1.3 Data Input/Output Module (I/O-Box)

Card P/N 903-6716-01 (I/O-Box B)
Card P/N 903-6716-03 (I/O-Box A)

The high density remote module uses a compact input/output box (I/O-Box) on the bottom of the rack to provide access connectors, signal protection, and signal activity LED indicators for the data channels on the HDB-TX boards.

The figure below shows a front view of the data I/O box for the 12 HP (4VID) and 16 HP (8VID) systems. Note that each column of connectors on the I/O-Box maps to a column of connectors on an AIB-4 card installed in the console module. Also note that the columns marked "RS-232" have four WAGO headers for the dedicated RS-232 channels on the corresponding HDB-TX card. The columns marked "AIB" have four WAGO headers for the AIB plug-in modules installed on the corresponding HDB-TX card. Refer to section 2.2.3 of this document for more details on the channel mapping and AIB plug-in modules used for the 4VID and 8VID systems.

All channels have signal activity LEDs indicating data transfer. Red LEDs, under letter "R", are on when data is being received into the Model 903, while green LEDs, under letter "T", are on when data is being transmitted from the multiplexer. LEDs are active low and are driven by the backplane signals.

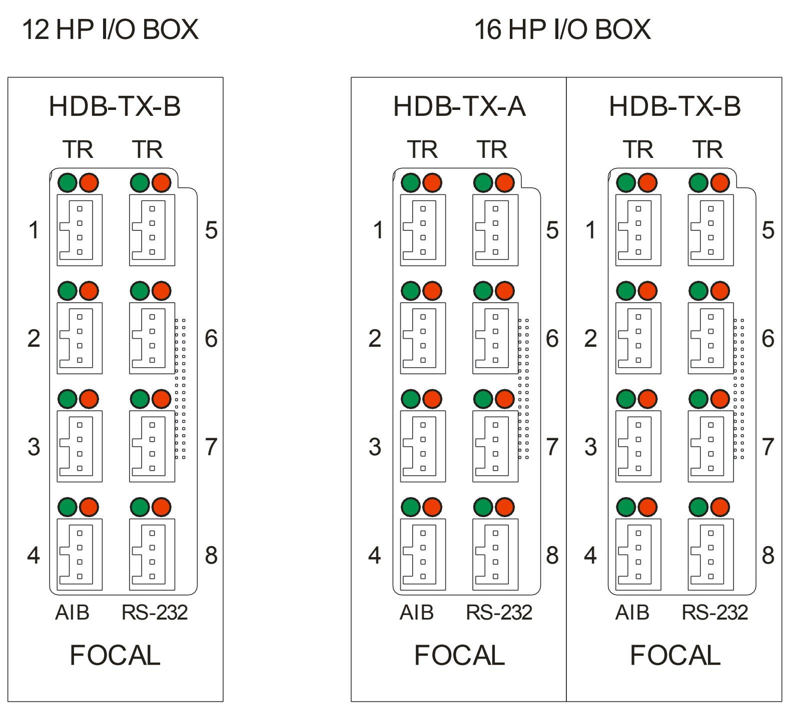
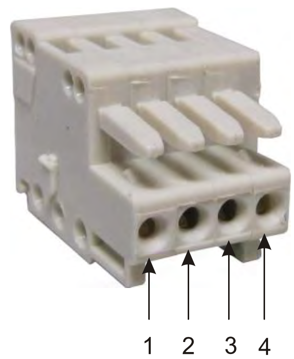


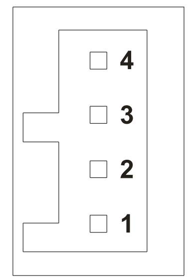
Figure 4-4: I/O Interface Box for 12 HP and 16 HP High Density Remote Systems

Installation Note:
Headers for the external connections are all four-pin, right-angled 733 series WAGO connectors. Mating WAGO connectors, P/N 733-104, are supplied with the system. Pin locations of the WAGO headers are shown in the figure below. Corresponding pins of the mating connector, shown at left, use clamps rather than screw terminals to hold wires in place. External wires should be 20-28 AWG stranded conductors with 0.22” - 0.24” stripped ends. The clamp for each pin can be opened up by inserting either the WAGO tool provided or a small screwdriver in the hole immediately above the wire hole.

4-Pin WAGO Connector
(733-104)



4-Pin WAGO Header



Pin assignments for the WAGO connectors used with the I/O-Box and AIB-4 cards are given in the table below for RS-232 and RS-485. The dedicated RS-232 channels on the I/O-Box include opto-isolated data lines and separate isolated power/ground per channel. Also, each AIB-232 or AIB-485 plug-in module includes opto-isolated data lines and separate isolated power/ground per channel. **Refer to appendix A for more information about the connector part numbers and pin assignments.**

Table 4-1: AIB Plug-In Modules and I/O-Box Connector Pin Assignments (Typ 4VID and 8VID Systems)

Board	Connector	Signal Type	Pin #	Designation
HDB-TX RS-232 (Dedicated RS-232 Channels)	4-pin WAGO on I/O-Box Only	RS-232 (DCE)	1 2 3 4	Ground (Isolated) Receive (RX) Transmit (TX) N/C
AIB-232 or I/O-BOX AIB Channel	4-pin WAGO on AIB-4 card or I/O-Box	RS-232 (DCE)	1 2 3 4	Ground (Isolated) Receive (RX) Transmit (TX) N/C or Chassis*
AIB-485 or I/O-Box AIB Channel	4-pin WAGO on AIB-4 card or I/O-Box	RS-485	1 2 3 4	+ TX/RX - TX/RX N/C N/C (or ISOGND)

* Chassis connections, for shielding purposes only, are available through the multiplexer's AIB WAGO headers for AIB-4 and HDB-TX cards. In general, chassis pins on headers should be left open (no connection on mating external WAGO). If chassis connections are required, consult the factory.
Note: RX refers to inputs into the card in question. TX refers to outputs from the card in question.

4.2 Video Cards

4.2.1 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 video interface board is configured with four SMB video jacks on the front panel, per Figure 4-5. 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).

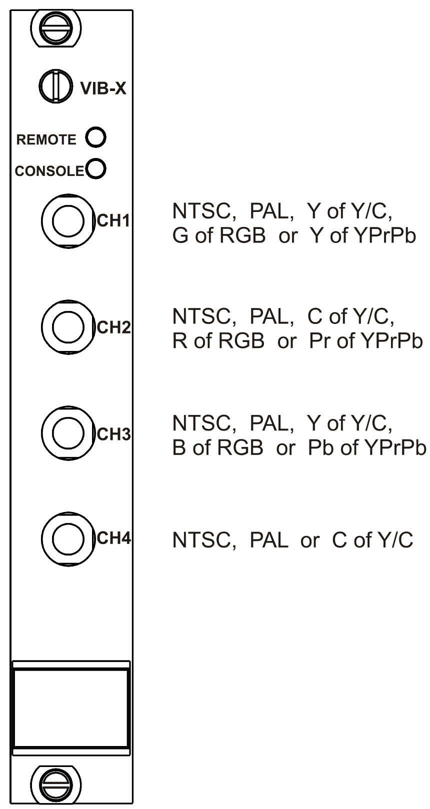


Figure 4-5: VIB-X Front Panel

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 (see Figure 4-6). 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.

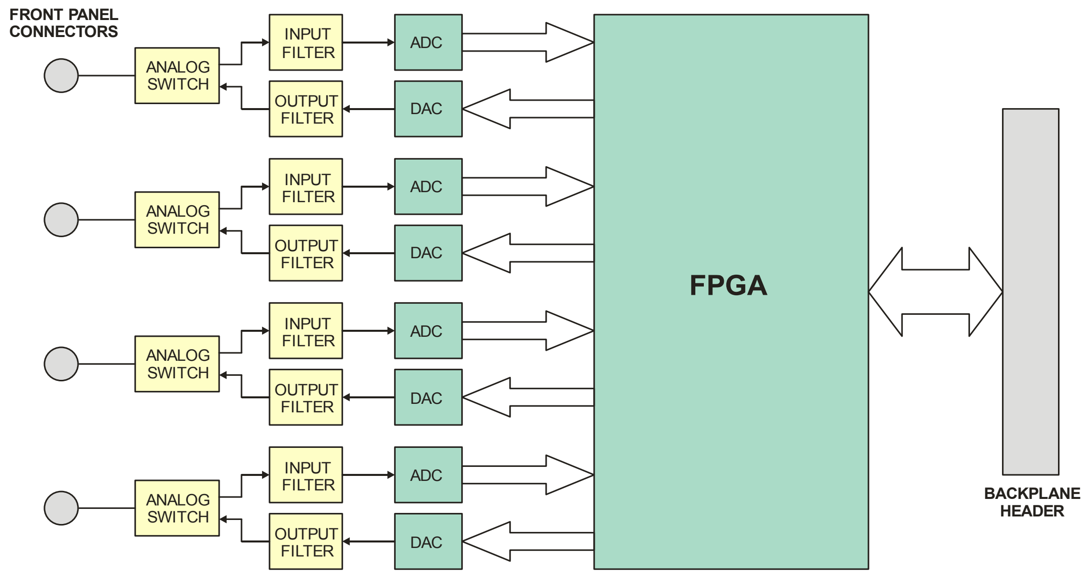


Figure 4-6: Block Diagram of VIB-X Card

Note: VIB-X cards shipped before August 2011 (cards with SN < 10018473) only support LED diagnostics but do not support enhanced diagnostics, which provides card serial number information and a video test pattern generator.

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.

4.2.1.1 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.

4.2.1.2 Configuration Settings

The VIB-X is configured as a remote (video input) or console (video output) using switch SW3, as shown in Figure 4-7 and Table 4-2. 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 4-2: 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 4-3. 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**. Switch configurations for video format on the remote and console video cards must match.

Table 4-3: 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)** **(Default configuration for typical 4VID and 8VID systems)**
ON	OFF	OFF	OFF	Single S-Video[1] (Channels 1/2 = Y/C, Channels 3, 4 = Composite)
OFF	ON	OFF	OFF	Dual S-Video[1] (Channels 1/2 = Y/C, Channels 3/4 = Y/C)
ON	ON	OFF	OFF	RGB Mode[2] (Channels 1/2/3 = G/R/B, Channel 4 = Composite)
OFF	OFF	ON	OFF	YPrPb Mode[2] (Channels 1/2/3 = Y/Pr/Pb, Channel 4 = Composite)

Notes:

1. 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.
2. 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.

All VIB-X cards supplied in typical 4VID and 8VID systems are factory configured as console cards and tested with 10-bit composite format on all four channels.

Although the VIB-X can be configured for several video formats, it can only be used with composite signals (NTSC/PAL) when paired with the HDB-TX cards, as with typical 903 high density 4VID and 8VID systems.

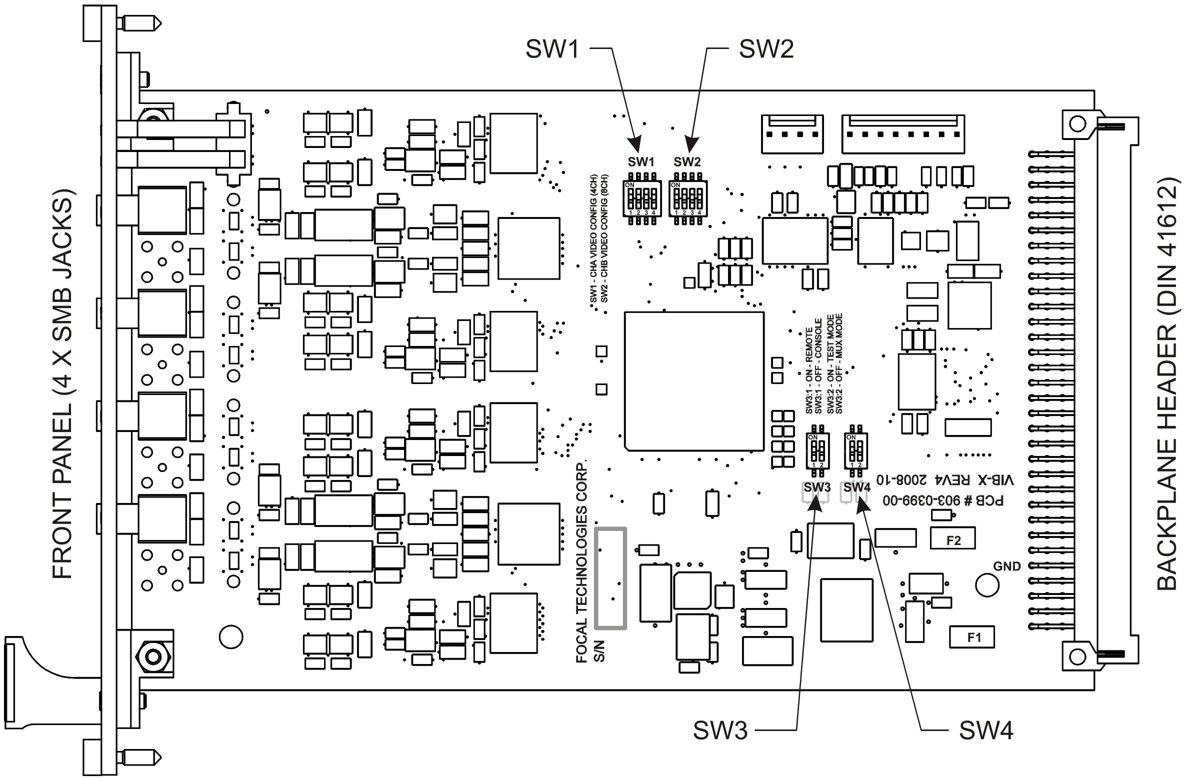


Figure 4-7: VIB-X Plan View

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 4-7. 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 the factory for assessment.

The sync status of each video channel is represented by the sync LEDs on the front panel of the corresponding FMB-X-2.5 module. 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 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 the factory for any non-standard video signals or switched video configurations.

4.3 Data Cards

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

4.3.1 AIB-4 - Adaptable Interface Board

Card P/N 903-5003-00 (Motherboard)

The Adaptable 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, CAN Bus and Tritech sonar ARCNET. The figure 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 = 0) and off when the line is in a “mark” state (TTL = high = 1). Idle lines are typically in the “mark” state. If an AIB socket is not populated, the red LED 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.

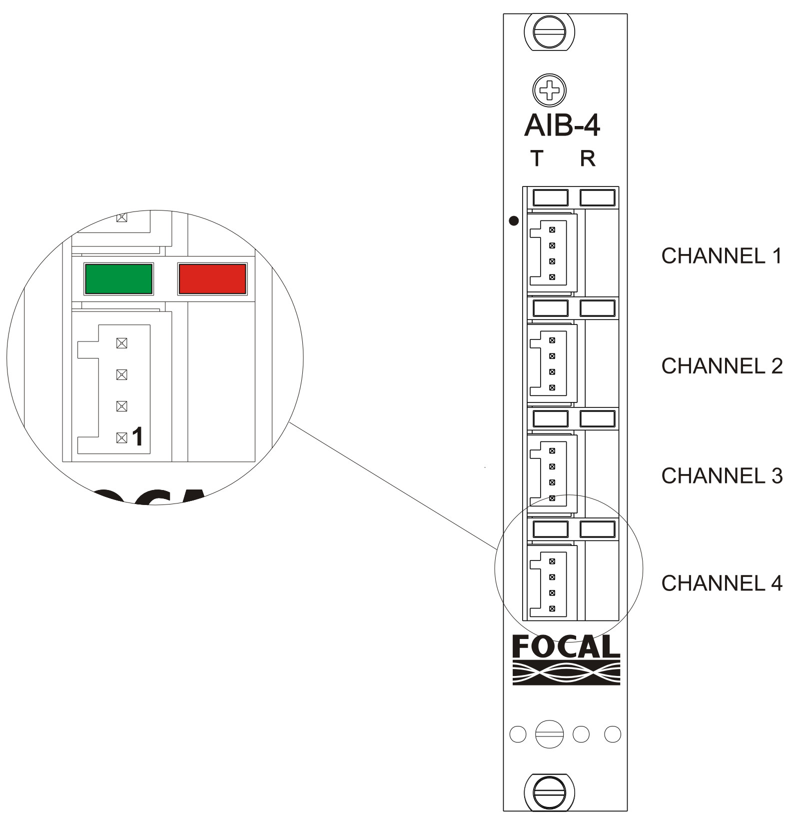


Figure 4-8: Adaptable Interface Board (AIB-4) Front Panel

The following figure shows the AIB motherboard.

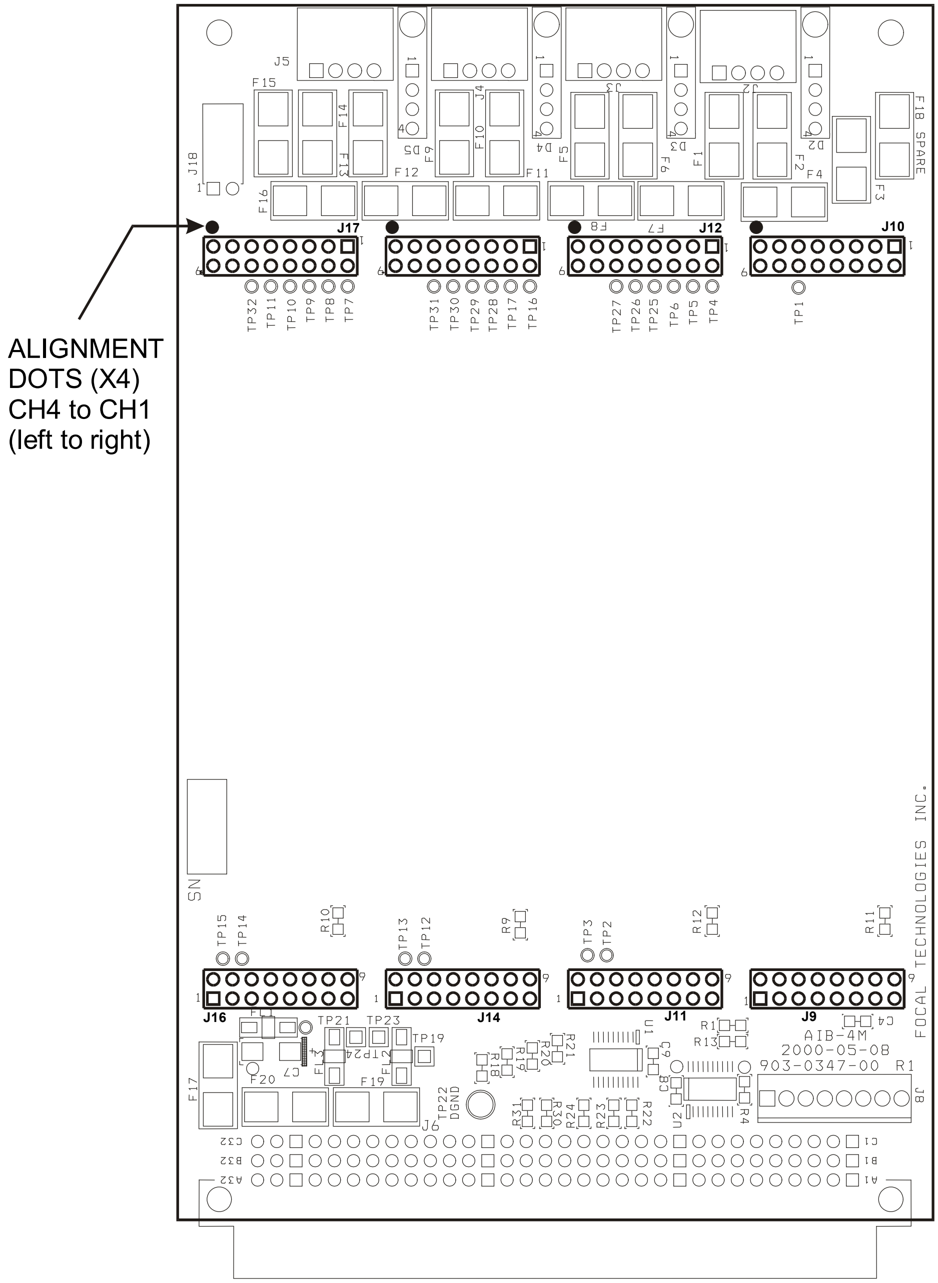


Figure 4-9: Adaptable Interface Board (AIB-4) PCB

The following figure shows the block diagram for the AIB motherboard.

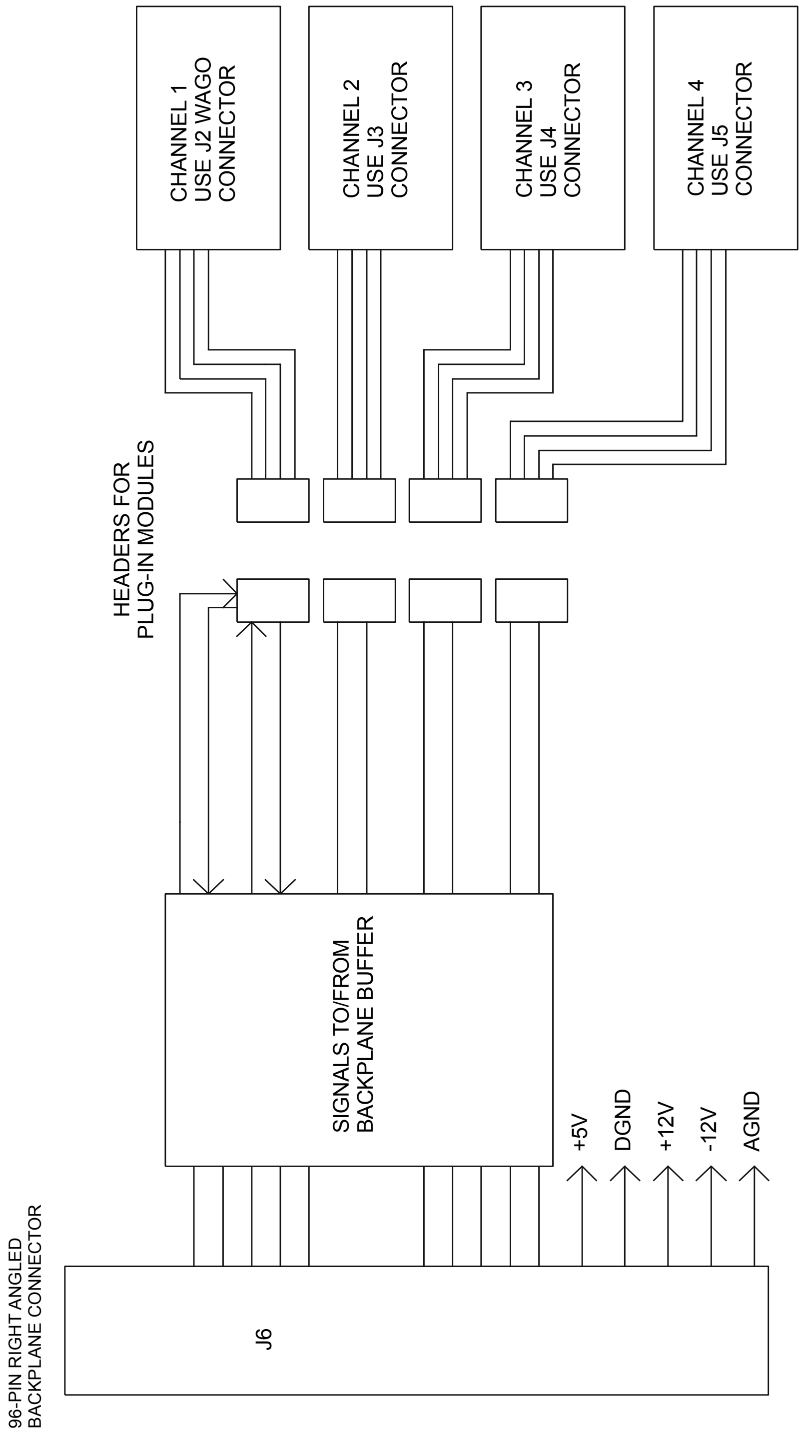


Figure 4-10: Block Diagram of Adaptable Interface Board (AIB-4)

4.3.2 Plug-In Modules

A variety of plug in modules are 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 4-4: AIB Plug-in Modules

Card ID	Card Description	Card P/N
AIB-232	RS-232 Plug-In	903-0251-00
AIB-TRIG	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

AIB-plugins may be changed for different signal types as required when reconfiguring the multiplexer. Contact the factory prior to any system reconfiguration or upgrades.

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

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

The AIB-232 plug-in module, which supports RS-232, is shown below in the figure below. No jumper or switch settings are required since the board is used solely for RS-232 data at rates up to 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-isolators.

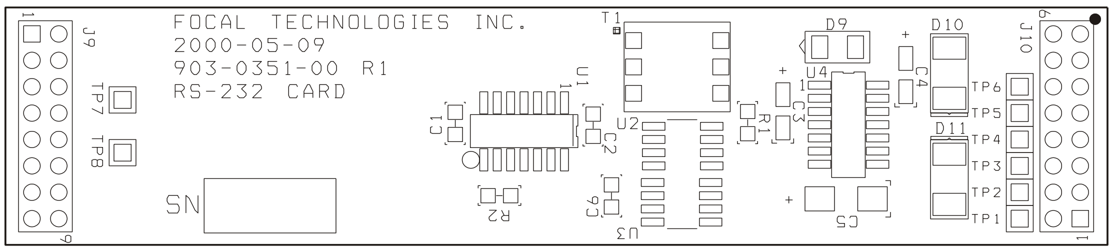


Figure 4-11: AIB RS-232/TRIGGER Plug-In Module

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. LEDs on the motherboard or adapter cards can be used to identify the presence and direction of serial data.

Table 4-5: AIB-232 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.

The AIB-TRIG plug-in module is a modified version of the AIB-232 that supports trigger signals for responders and sonars that require trigger voltages between +5 and +25 V. For triggers that require 5 V or less, the AIB-485 card should be used with the TTL configuration.

The RS-232 receiver circuit is unmodified, allowing input signals from -25 V to +25 V but typically configured for positive trigger voltages from the triggering device of up to +25 V. The RS-232 transmit circuit is modified to prevent excessive negative voltage excursions, i.e. a diode clamp limits the voltage to no lower than -0.5 V for connection to the subsea responder. When the trigger input voltage is above +1.5 V at the surface AIB-TRIG, the RS-232 driver output is held high at the subsea AIB-TRIG, typically +8 V with a 3 kΩ load (+5V min.).

Please consult the factory on recommended interfaces for specific responder triggers.

4.3.4 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 4-12. 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-isolators.

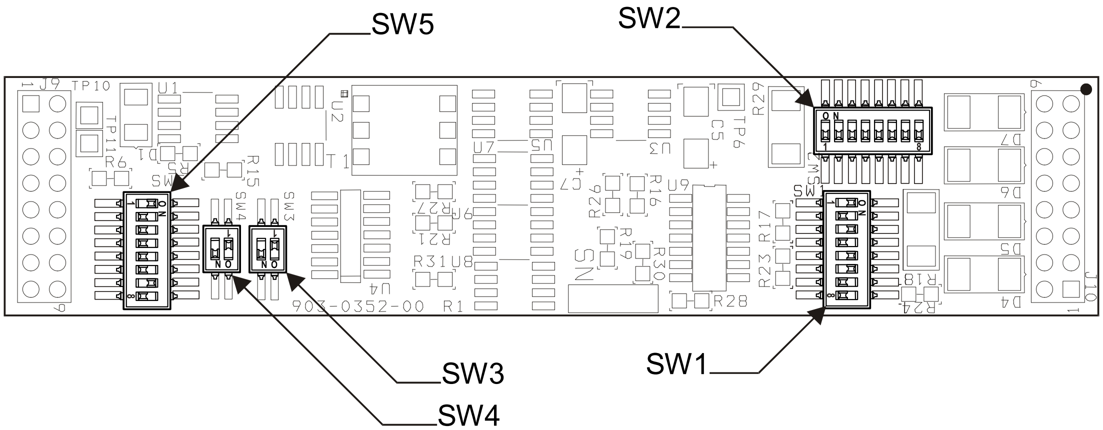


Figure 4-12: AIB RS-485 Plug-In Module

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 4-13, 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.

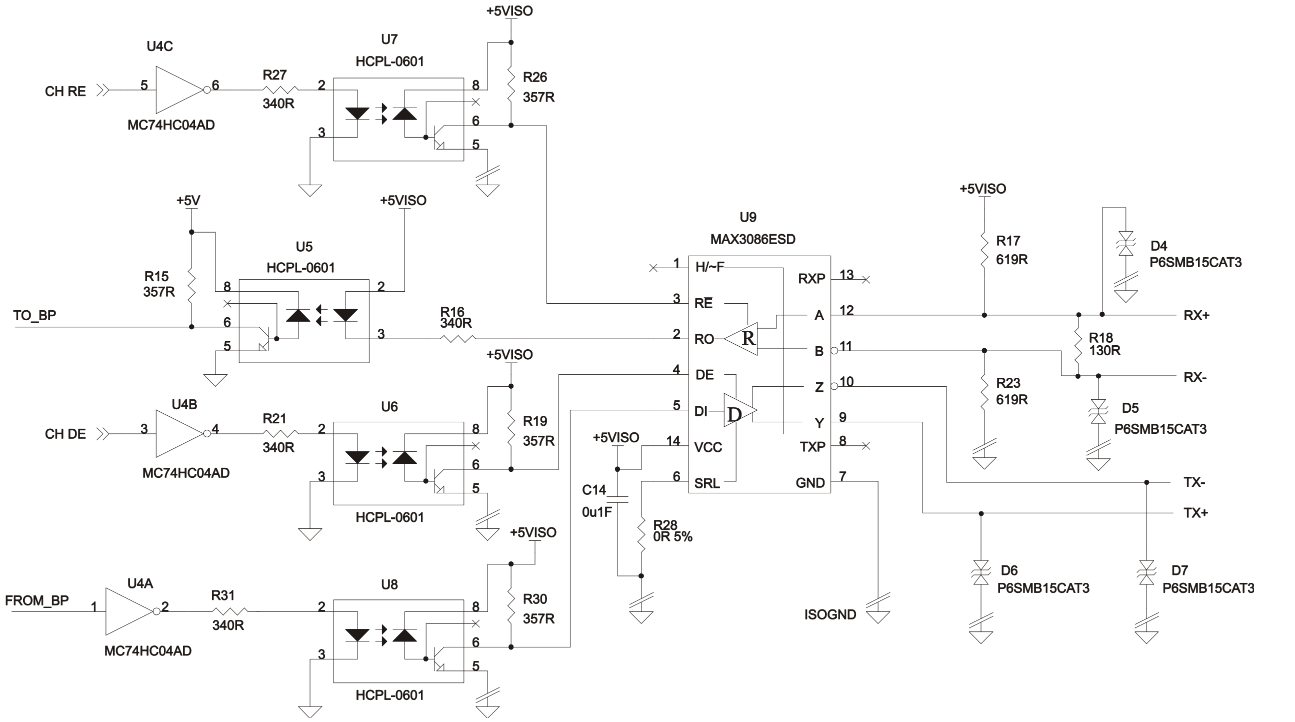


Figure 4-13: AIB RS-422 Interface Schematic

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 WAGO connectors are given in the table below with default configuration shaded.

Table 4-6: 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 (or ISOGND)	TX-	ISOGND

Switch settings for the various configurations are given in Table 4-7. 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.

As shown in Table 4-6 and Table 4-7, ISOGND for RS-485 configuration can be made available on pin 4 of the Wago connector by setting switch SW2 circuit #6 to “ON” (=1). This can be used as a ground reference for external equipment. (The default setting for pin 4 is N/C.)

Table 4-7: 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
**Set to ‘1’ to make ISOGND for RS-485 available on Wago pin 4.

4.3.5 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 sonars manufactured by Tritech International Ltd., is shown in the figure below. 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.

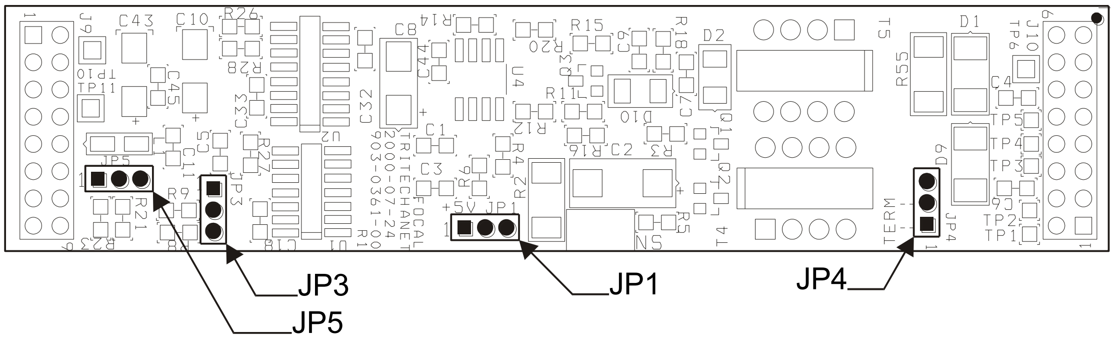


Figure 4-14: AIB Tritech ARCNET Plug-In Module

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 the table below. The +12 V drive 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 4-8: 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 left open (short pin 2 to pin 3, which is open, to store the shunt).

In most applications, the 68 ohm terminators on the AIB cards should be enabled. One exception is when the sonar head has a 39 ohm terminator installed with a “short” cable connection to the multiplexer. In this case, the 68 ohm terminator on the AIB card should be disabled. (But the preferred configuration is with no terminator on the sonar head and the 68 ohm terminator on the AIB card.)

The default settings illustrated in the shaded rows of Table 4-8 are typically used for systems with *short* cables, i.e. a few meters, 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 or 270 ohm 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	270 ohm 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 > 100 m 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.

Note that the AC coupling of the ARCNET interface circuits and pulse nature of the signal makes it impossible to verify termination resistance or signal level with a standard multimeter. To measure signals, a suitable oscilloscope and probe should be used with input set for 1 MΩ and AC coupling.

Pin designations for the AIB-ARCNET plug-in modules are given in the table below. Corresponding connections to Tritech sonar heads and surface equipment should be to the LAN A and LAN B pins indicated by Tritech documentation. Note that the correct polarity of the wiring must be used at both ends of the multiplexer. Crossing the wires at either end, or both ends, will cause the ARCNET link to fail. Furthermore, lack of terminators on any of the connections can also cause the link to fail.

Table 4-9: AIB-ARCNET Pin Designations

Pin	Designation
1	Chassis* (optional)
2	LAN A
3	LAN B
4	N/C

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

Data indicator LEDs on the front panel of the AIB-4 may be used for troubleshooting. Red LEDs indicate a signal coming into the multiplexer and green LEDs indicate a signal being transmitted from the multiplexer to the external sonar device. Only the presence of green LEDs verifies that signals are being carried through the multiplexer. Lack of a red LED at either end indicates no external signal is coming from the local sonar equipment, implying an error with wiring or other fault condition external to the multiplexer.

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

Card P/N 903-0244-00 (AIB-HYDRO, surface)
Card P/N 903-0244-02 (AIB-HYDRO, subsea)

The AIB-HYDRO hydrophone plug-in module, shown in the figure below, 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 4-10.

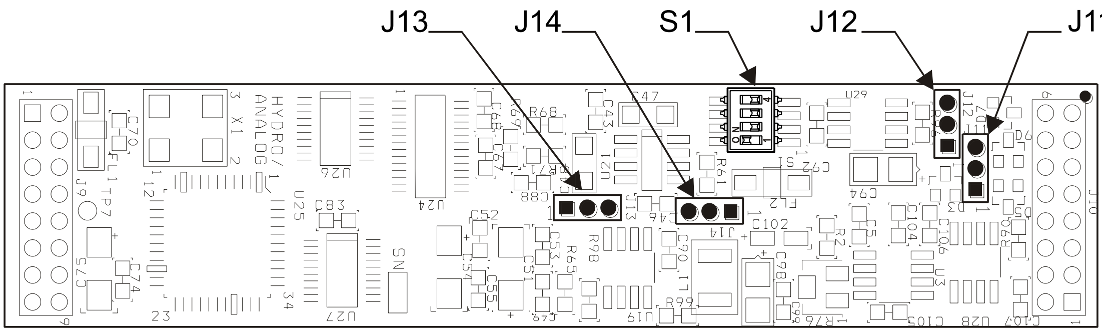


Figure 4-15: AIB Hydrophone Plug-In Module

Table 4-10: 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 ultra-fast fuses on the AIB motherboard. The table below shows the switch S1 gain settings and corresponding maximum input voltage.

Table 4-11: 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 plugin 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.

Pin designations for the AIB-HYDRO plug-in modules are given in the table below.

Table 4-12: AIB-HYDRO Pin Designations

Pin	Designation
1	Chassis* (optional)
2	N/C (+12 VDC optional)
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 cutoff 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.

AIB-HYDRO cards may be modified for compatibility with different input voltage levels, such as IRIG-B or outputs from pre-amps. For large input signals (> 45 mVpp) the on-board pre-amp is typically bypassed. Modified AIB-HYDRO cards will have different variants in the part numbers (-XX). For example, AIB-HYDRO with P/N 903-0244-02 is modified to provide +12 VDC supply at the Wago connector on pin 2, and the input pre-amp is bypassed. (The 903-0244-02 is only used at the subsea for connection to the hydrophone; the standard 903-0244-00 should be used at the surface.)

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

Card P/N 903-0250-00 (AIB-MS900)
Card P/N 903-0250-01 (AIB-MS900L modified for low frequency (LF))

The MS900 Analog Sonar Interface AIB plug-in (AIB-MS900) is compatible with the analog telemetry used by the Mesotech MS900 sonar system. The AIB uses only one configuration jumper, J11, shown in the figure below. Pin 1 of J11 is the square pin, which is also marked with a silk-screened "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.

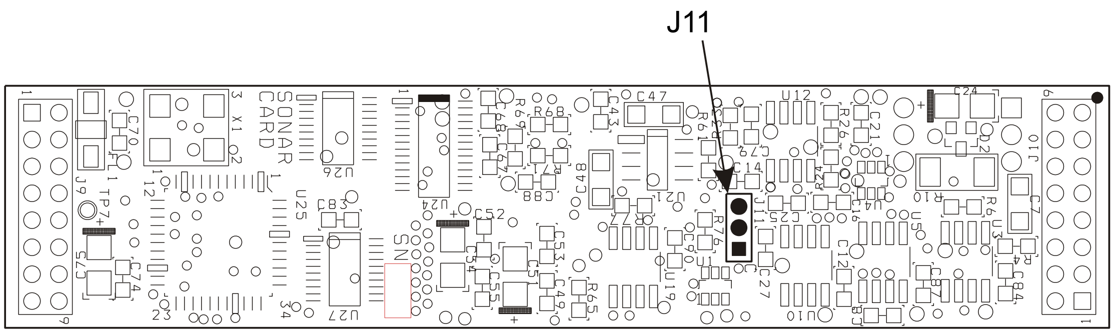


Figure 4-16: MS-900 Plug-In Module (Top View)

The MS900 interface must be installed on a motherboard or adapter card supporting AIB plug-ins, such as the AIB-4 or the HDB-TX.

Because of the high-speed sampling required, the MS900 plug-in cannot be used in the medium-speed data slots on the Model 903. The MS900 plug-in can be used with the GLINK-based Model 903 high speed data slot (typically adjacent the FMB). The 2.5G Model 903 systems (with FMB-X-2.5) support the MS900 module in any data slot.

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 4-13: 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.

The standard AIB-MS900 plug-in is designed for compatibility with the high frequency (HF) telemetry system used by the MS900 system. The card may be modified to the AIB-MS900L version for compatibility with the less common low frequency (LF) analog telemetry system, used mainly for commercial fishing applications.

Sonars with digital telemetry, such as the MS900D and MS1000, should be used with a digital serial interface AIB plug-in, such as the AIB-485 or AIB-232.

4.3.8 CANBUS Plug-In (AIB-CANBUS)

Card P/N 903-0297-00

The CAN bus interface AIB plug-in (AIB-CANBUS), as shown in the figure below, provides transparent extension of CAN 2.0A and 2.0B over the fiber optic multiplexer system. Each AIB card acts as a node on the local CAN bus, handling media access and packet 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 bridge are regenerated as CAN format packets at the other end and placed on the local bus.

This CAN bus bridge 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.

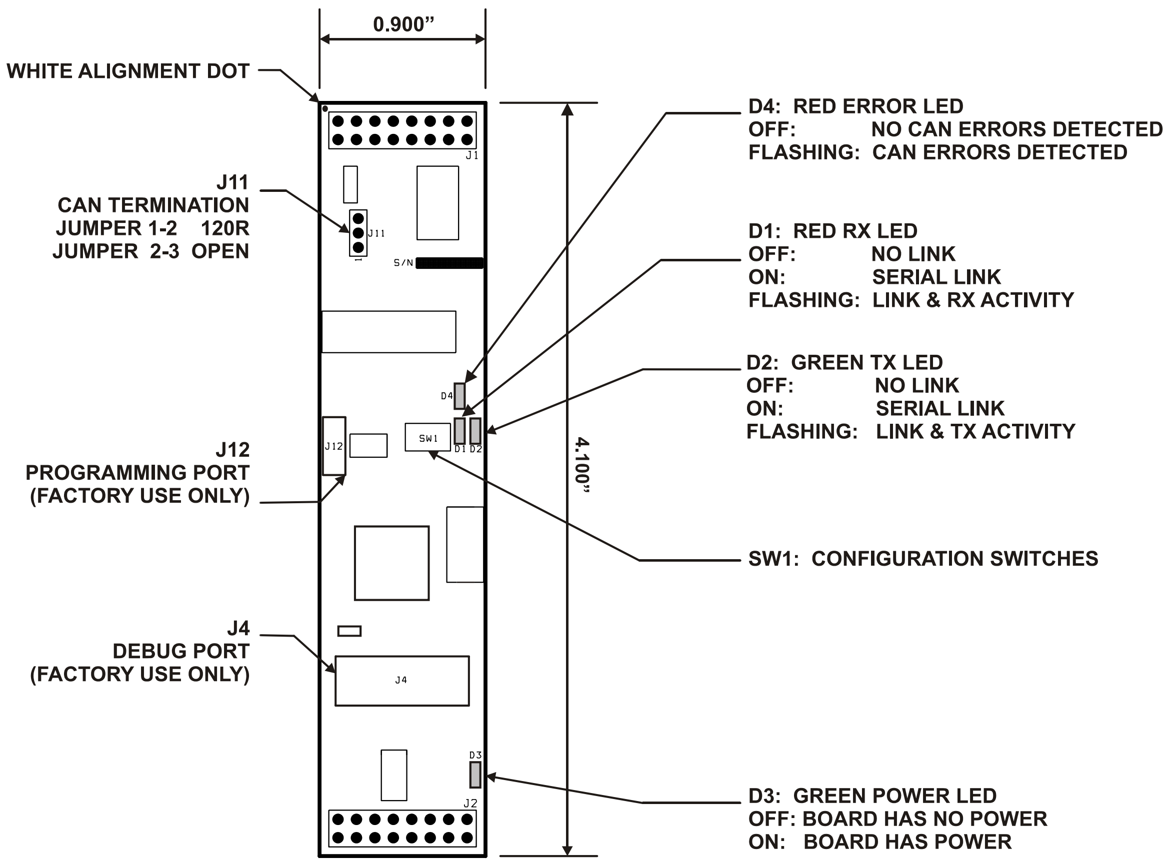


Figure 4-17: AIB-CANBUS Plug-In Module (Top View)

The optical bridge maintains the full 1 Mbps maximum data rate of CAN when used with the Model 914, Model 907, or in the high speed data slot of a GLINK-based Model 903 system. In a low speed data slot on a GLINK-based Model 903 system, the optical link supports up to 250 kbps CAN traffic. The 2.5G Model 903 systems (with FMB-X-2.5) support the full 1 Mbps rate of the AIB-CANBUS in any data slot.

Maximum sustained CAN throughput is typically limited by the bus master, not the AIB-CANBUS cards. Messages 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 link. The maximum unidirectional throughput is 75% at 1 Mbps and 100% at all other speeds.

For real-time control systems, average bus loads above 30% are not recommended due to the non-linear increase in latency inherent with contention based protocols. For non-critical applications, average bus loads should be kept below 50% to maintain good performance.

LEDs on the AIB-CANBUS card may be used for diagnostics during bench testing. Diode D3 is on when power is applied to the card. Link LEDs D1 and D2 are both on when the optical link is established and off if the optical link is not working. Link LEDs also indicate traffic on the local CAN bus: the green TX LED (D2) flashes when there are frames going out to the local CAN bus; the red RX LED (D1) flashes when there are frames being received from the local CAN bus. Error LED D4 is on for roughly half a second when a local CAN frame error is detected and flashes when multiple errors are detected. LEDs D1, D2, and D4 are only active in bridge mode. Note that the LEDs flash five times on power up to indicate the card is ready for operation.

When the cards are configured in “Bridge Mode”, optical frames received with errors are dropped at the receiving AIB and flagged by the error LED. Excessive optical link errors force the CAN port into reset until a good optical link is re-established. On firmware revision A, a local CAN error or packet collisions forces a five second reset of the CAN ports at both ends; firmware version B does not force a CAN reset, so other methods must be used to convey detection of remote errors.

An on-board 120 ohm CAN terminator shown Figure 4-17 is for bench testing only (shunt across J11 pins 1-2) and is normally left open (shunt across J11 pins 2-3). In typical industrial CAN networks operating with 12 or 24 VDC power, an external terminator should be used with sufficient power rating to handle a short to these voltage rails and ground under worst-case conditions. (A 5W, 120-ohm terminating resistor is needed for 24 VDC systems.) Regardless, each CAN bus end node should be terminated with 120 ohms to ensure a net bus load of 60 ohms.

Switch SW1 on the AIB-CANBUS card may be used to set the optical link bit rate of the cards, indicated in the table below. Remote and console cards must have the same settings.

Table 4-14: 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
*Requires high speed data slot in Model 903 with medium or high speed backplane.

A slow (62.5 kbps) repeater mode is available in which the bridge mode is disabled and the optical link simply maintains a direct “virtual wired connection” between the paired AIB-CANBUS CAN ports. This provides extremely low latency, typically less than 4 us, but can only be used with short fiber links and is not recommended for ROV configurations. LEDs D1, D2, and D4 are disabled in this mode.

Pin connections for the WAGO connector used with the plug-in are shown in the table below. Typically shielded, impedance controlled (120 ohm) twisted pair cabling is required to maintain signal quality.

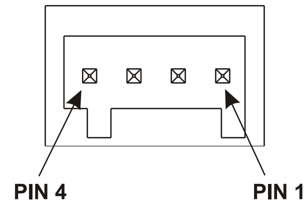


Figure 4-18: WAGO 4-Pin Header

Table 4-15: 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.

Refer to drawing 903-2020-00 for additional configuration details on the AIB-CANBUS card.

5.0 Fiber Optics

5.1 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.

5.2 System Design

The Model 903 fiber optic transmission system contains all the necessary transmitters, receivers, and couplers, including WDMs and splitters, to provide a redundant fiber optic interface to a user's cable or umbilical. **The system is designed to work with up to two fiber optic rotary joints and up to 10,000 meters of SMF-28 singlemode fiber.**

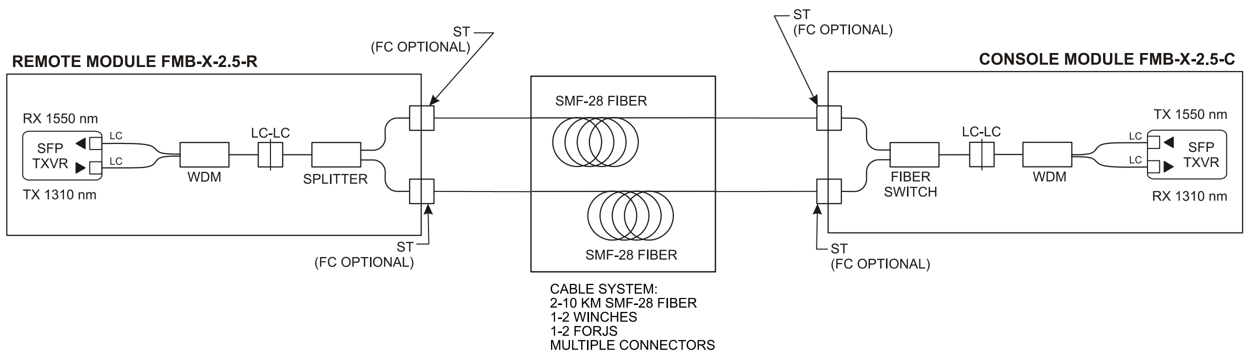


Figure 5-1: Block Diagram of Model 903 Fiber Optic Transmission System

System design consists largely of preparing a power budget as provided in the example on the following page. 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 cables, an additional 1-2 dB should be allowed for dispersion.

The standard Model 903 with FMB-X-2.5 cards 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 shorter cables. This budget is applicable between the front panel connectors on the remote and console modules. Internal WDMs, switches, splitters, and connectors are already accounted for and the full 20 dB budget is available between the two front panel connectors when used with up to 10 km of singlemode fiber.

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 power 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 fault conditions, measurements at 1310 nm may be fine while losses at 1550 nm are excessive.

4VID and 8VID systems use external ST/PC connectors and are acceptance tested with an uplink and downlink power budget of 20 dB plus 10 km of singlemode fiber to provide a dispersion penalty. Note that the front panel transmit power and receive sensitivities for these systems typically provide a nominal 22 dB budged on short fiber links with attenuators. **Refer to the 903-8xxx-xx installation drawing for actual power budget specifications of your system.**

Table 5-1: Typical ROV System Power 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	-24.0	dBm
Available Margin	9.6	10.6	dB

5.3 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.

Momentary violations of bend radius or excessive lateral pressure may significantly reduce the long term reliability of fiber, even if it appears undamaged. When in doubt, do not use the fiber.

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 5-2 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 5-3 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 5-2: LC connector

Figure 5-3: 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 means 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 5-4.

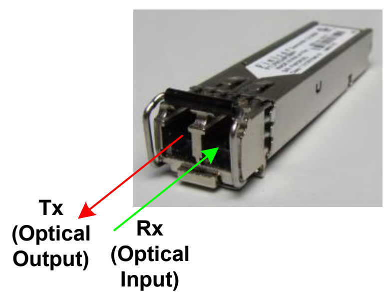


Figure 5-4: SFP Transceiver

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.

6.0 Installation and Operation

6.1 Mounting

The console module is intended to be rack-mounted with the side flanges. Extender pieces are available for mounting to a standard 19” equipment rack. Alternatively, the side flanges may be removed to allow use of the four mounting holes with installed PEM nuts on each side plate. The figure below shows the side view of a typical Model 903 console card rack. If PEM nuts are used, ensure the length of mating screws do not extend into the internal cards. **Refer to installation drawings 903-8xxx-xx in Appendix C for spacing and dimensions of your system**.

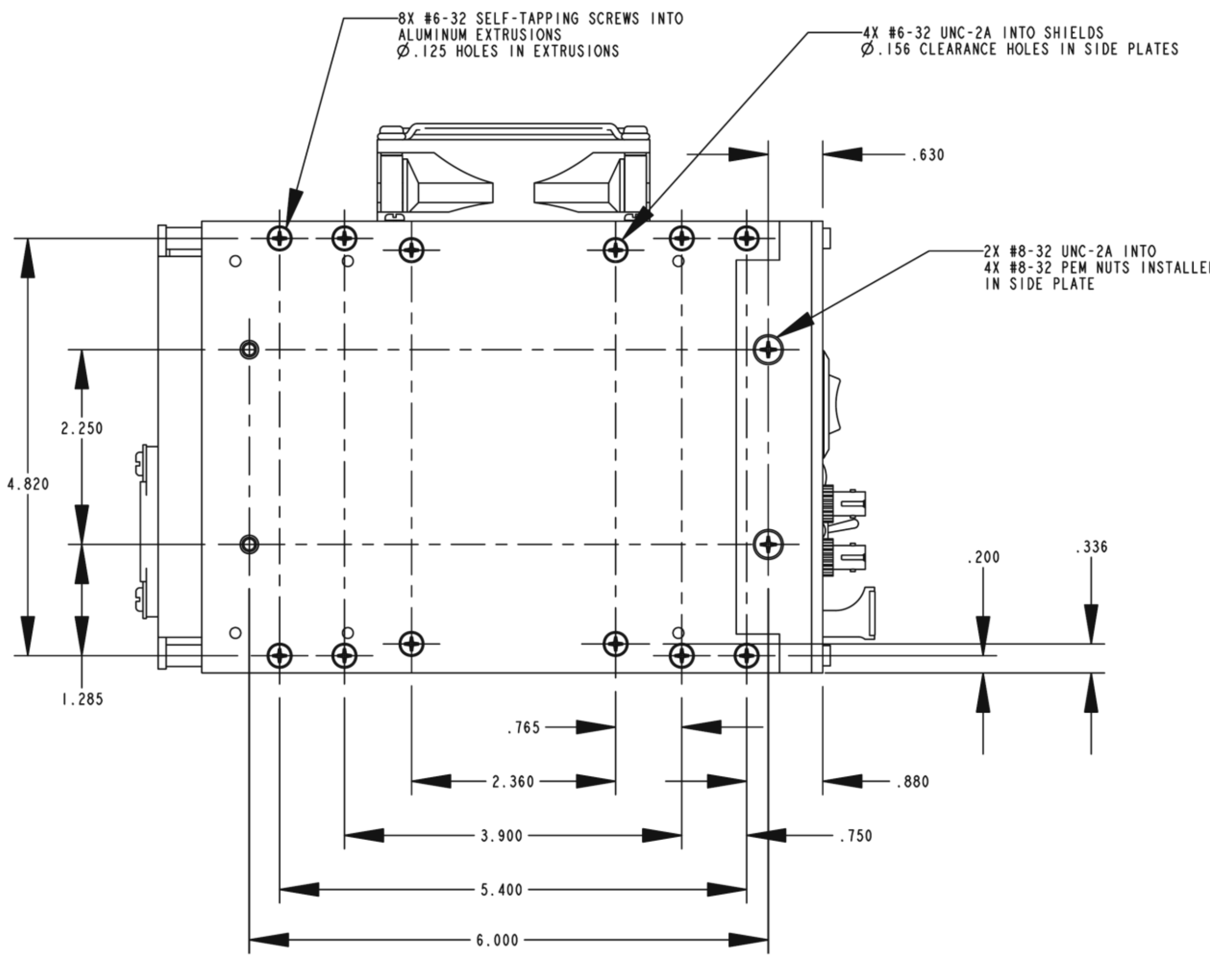


Figure 6-1: Side View of Typical Model 903 Console Card Cage.

(Refer to Appendix C for as-built drawings.)

The figure below shows an exploded view of a 4VID console module.

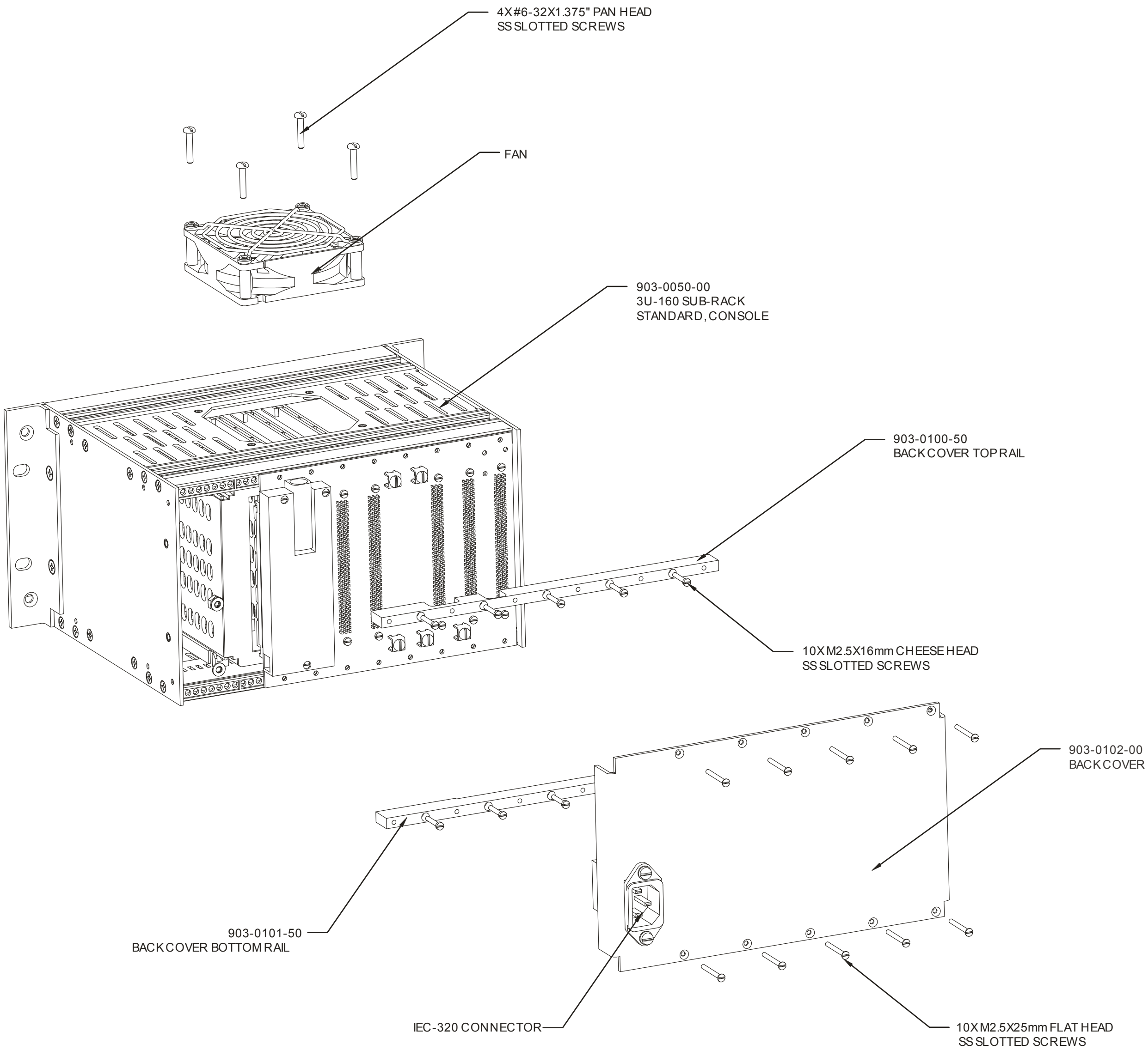


Figure 6-2: Exploded View of a Model 903 4VID Console Card Cage

The high density remote modules are intended to be mounted in a user-supplied rack installed in the ROV electronics pressure case. The boards and backplane adhere dimensionally to the Eurocard standard and should be installed in compatible rack of this type. The remote high density 4VID module uses a 12 HP rack and the remote high density 8VID module uses a 16 HP rack. The figure below shows the side view of a typical 16 HP Model 903 high density remote card rack. If PEM nuts are used, ensure the length of mating screws do not extend into the internal cards. **Refer to installation drawings 903-8xxx-xx in Appendix C for spacing and dimensions of your system**.

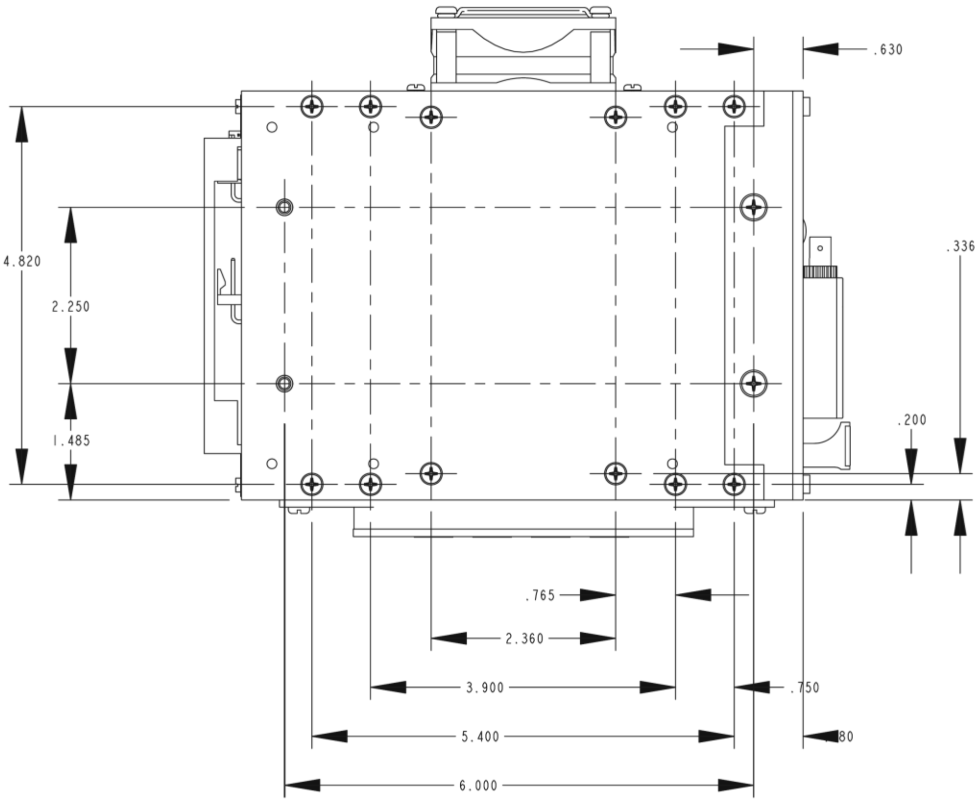


Figure 6-3: Side View of Typical 16 HP Model 903-HD Remote Card Cage.

(Refer to Appendix C for as-built drawings.)

The figure below shows an exploded view of a Model 903 high density 4VID remote module.

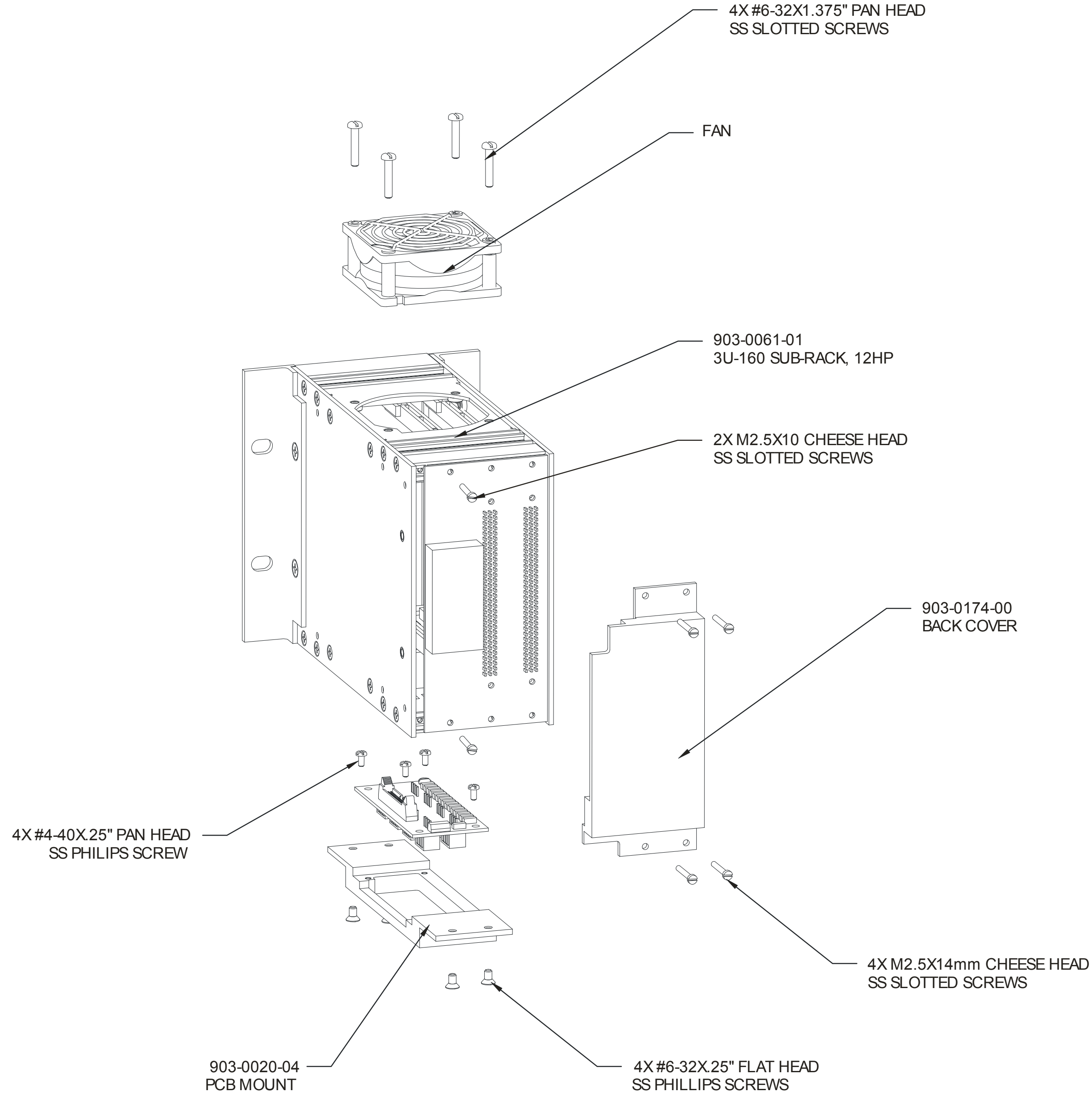


Figure 6-4: Exploded View of a Model 903 High Density 4VID Remote Card Cage

6.2 Cooling

Forced air cooling, or equivalent conductive 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 boards. Fans may be removed as long as other devices are present to provide the same circulation and forced air cooling.

6.3 Diagnostics

Model 903 system diagnostics are available via the 10/100 Mbps Ethernet port (RJ-45) or RS-232 serial port (3.5 mm stereo jack) on the front panel of the FMB-X-2.5 cards.

Ethernet diagnostics are available as Modbus TCP/IP or through an embedded web server. Diagnostic packets are handled as low priority and must be polled by an external computer. When accessed, diagnostic packets use up less than 0.1 % of the Ethernet channel capacity.

Serial diagnostics are automatically transmitted from the serial port in a format compatible with older multiplexer VDM software, e.g. 903-0406-00. A command line interface (CLI) is also available through the serial port to allow more advanced product configuration and diagnostics.

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.

Additionally, 903 systems based on FMB-X-2.5 and backplane –X boards include the following diagnostic information:

- Backplane –X serial number
- Backplane type (12 HP or 16 HP)
- High density board (HDB-TX):
    - Video status information
    - On-board DIP switch setting status
    - Video test pattern generator
    - FPGA version

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.

6.4 Bench Test for Model 903 Systems

BASIC LINK OPERATION (FMBs)

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 10 dB attenuator supplied between a bushing on the remote FMB-X-2.5 turret and a bushing (F1 or F2) on the console FMB-X-2.5. The fiber switch 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 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.

OPTICAL POWER BUDGET TEST

1. To verify the uplink (remote to console) power budget, measure the 1310 nm transmit power (P1) 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.

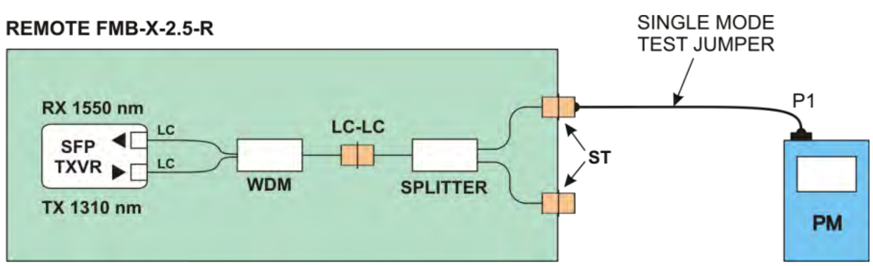


Figure 6-5: Power Budget Test Setup – Transmit Optical Power Measurement

2. With the test jumper included, install a singlemode variable optical attenuator (VOAT) between the remote and console FMBs plus a 10 dB attenuator. 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.

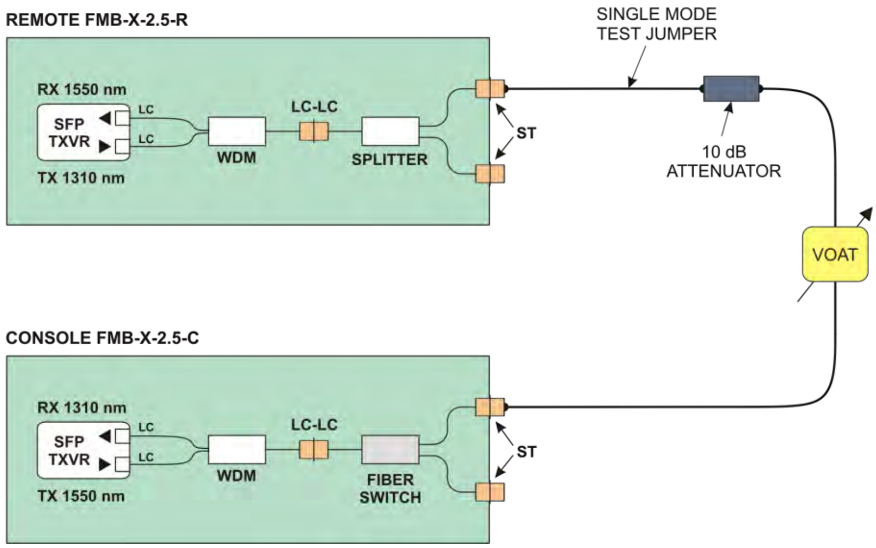


Figure 6-6: Power Budget Test Setup – Link Threshold Measurement

3. Disconnect the end of the VOAT that is connected to the console FMB-X-2.5 and measure the optical power (P2) received (received sensitivity) by connecting that end of the VOAT to the optical power meter. The difference between the transmit power (P1) and the receive power (P2) is an estimate of optical power budget (P1-P2). (Add a spool of SMF-28 fiber with the VOAT to simulate dispersion over long cables if necessary.)

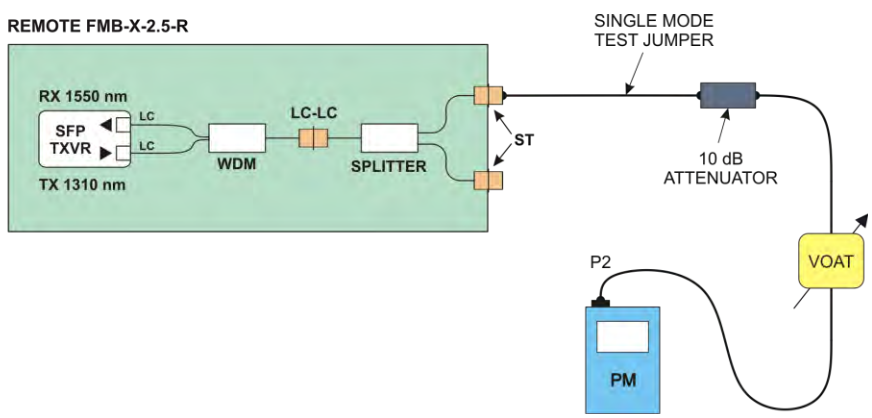


Figure 6-7: Power Budget Test Setup – Received Sensitivity Measurement

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. Often, 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 power budget is required, use external WDMs to isolate the 1310 nm and 1550 nm links on separate fibers.

   Example Power Budget Calculation:

1310 nm Uplink Power Budget (measured)	**1550 nm Downlink Power Budget (measured)**
Rem_Tx_Pwr = -4.0 dBm (P1)	Con_Tx_Pwr = +1.0 dBm (P1)
Con_Rx_Pwr = -29 dBm (P2)	Rem_Rx_Pwr = -25 dBm (P2)
Power Budget = -4.0 dBm - (-29 dBm) = **25 dB**	**Power Budget =** +1.0 - (-25 dBm) = **26 dB**

The Model 903 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 power 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.

6.5 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 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.

Fiber connectors should be inspected prior to installation with an optical fiber scope to ensure there is no contamination or damage to the ferrule or fiber. Contaminated connectors account for the vast majority of optical link problems, hence it's critical to ensure they are clean prior to mating them. Refer to section 5.3 of this document for more information about fiber handling.

<u>NEVER</u> 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.

6.6 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 (ESD).

BOARD REMOVAL AND INSTALLATION

Ensure the system is powered down when removing or installing cards, as the system is not "hot swappable".

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. The backplane connectors have a strong mating force to ensure cards are held in place with significant vibration present.

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 the card from popping out abruptly once the backplane connector disengages. 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. **For HDB-TX cards, only remove the card far enough to reach and disconnect the ribbon cable connector before fully extracting the card**. 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, insert the board in both the top and bottom card guides, then slowly push the card in to mate it with the backplane connector. Tighten the top and bottom panel screws to hold the card in the chassis. **Connect the ribbon cable on an HDB-TX card before fully inserting the card**.

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 Cards

The Model 903 fiber multiplexer boards (FMBs) 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 radius 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 5.3 of this document.

7.0 Troubleshooting

7.1 System Verification

7.1.1 Initial Checks

- Ensure cards installed and configured as per installation drawing.
- Ensure correct input power is supplied and verify the primary fuse is not open.
- Fuses: each module and card have fuse protection. Ensure there are no input power supply issues or incorrect connector wiring before replacing fuses. Several spare kits are available for fuses, e.g. 903-8022-18.
- Verify the proper fuse type and value and location per the appendices sections in this User's Guide.
- Ensure voltage rail levels are acceptable using either the diagnostics software or a voltmeter.
- Ensure external fibers and bushings are clean and have low optical loss. (May be verified with diagnostic software or an optical power meter.)
- Ensure optical output power levels are sufficient at the FMB front panels with an optical power meter:
  - Console FMB 1550 nm downlink output power should be -2 dBm or better and
  - Remote FMB 1310 nm uplink output power should be -6 dBm or better.
- Ensure receiver power at the FMB front panel is acceptable, between -4 dBm and -24 dBm at remote and between -7 dBm and -28 dBm at console. Excessive receive power will cause errors or possibly even damage the receiver and low receive power will cause errors or link faults. In general, bench testing should be conducted with a 10 dB optical attenuator.

7.1.2 Review Settings

- Cards are shipped from the factory in the default configuration for the specific system. Shunt terminals are 2-pin or 3-pin; pin 1 is typically designated with a square pad or silk-screened '1'.
- DIP switches are set either on (1) or off (0). Circuit 1 is the leftmost switch when reading the text on the switch.
- Mode settings should generally match on remote and console cards, except AIB-MS900, AIB-ARCNET, and AIB-HYDRO.
- FMB DIP switch settings should not normally be changed. When troubleshooting an older card with a DIP switch, switch the DIP switch back and forth a few times to ensure there is a good, stable contact.

7.1.3 Using Diagnostic Software

- Check for acceptable voltage levels (screen LEDs).
- Check acceptable temperature, remote and console (both should be less than +70C).
- Check for uplink/downlink errors (<= 1 error per hour typical).
- Verify expected optical levels (transmitted and received) with fiber optic power meter.
- Verify power budget with VOAT (Variable Optical Attenuator), refer to section 6.4 of this document for a bench test example.
- Observe strip chart for unusual power fluctuations in the optical link.
- Verify losses of video sync.
- Log diagnostics files for long term monitoring.
- When new FMBs are installed, the software may need to be recalibrated for optical readings. (OK if within 2 dB).

7.2 Most Common Problems

7.2.1 Most Common Video Problems

- Improper impedance matching (75 ohms) or missing ground connection.
- Video signal “too hot”, i.e. >> 1 Vpp nominal. (Camera outputs may be set to drive long copper cables.)
- RG-179 OK but attenuates at higher frequencies, so limit to a few meters or use RG-59 for long runs.
- Isolation required, e.g. Deerfield Labs transformer P/N: 262-1, BNC-BNC (grounding problems between camera, mux, monitor).
- Wrong switch configuration settings on video card for composite versus S-video (Y/C) and RGB (see video card section of this user’s guide, Table 4-3).
- Anti-piracy protection on VCR tapes or DVDs during testing (e.g. Macrovision)

7.2.2 Most Common Data Problems

- Improper RS-485 auto sense settings (see RS-485 section of this user’s guide, Table 4-7)
- AIB plug-ins not installed in proper orientation or socket, or different card types used in remote and console end.
- Incorrect RS-485 polarity: AIB-485 card’s standard is negative pin is inverting and RS-485 biased with 619 ohm pull up/down resistors plus optional 120 ohm terminator. When the two-wire polarity is correct, the red receive LED is typically on less often then when the wires are reversed.
- No or poor terminations: terminators and impedance controlled cable is needed at high data rates (> 500 kbps).
- Poor cabling or grounding: Use twisted pairs for differential serial links. Verify proper grounding and shielding.
- AIB switch settings: Incorrect or default settings need to be changed.
- RS-422 Cross-over: Pins 1, 2 (Mux Rx) and 3, 4 (Mux Tx) are the same at both ends. Hence RS-422 coming into the mux on pins 1/2 at one end will exit the mux at the other end on pins 3/4 for the corresponding channel.
- MS900 AIB settings: Jumper on AIB must be set one way for the remote and the opposite way for the console.
- ARCNET AIB settings: Mux and sonar settings must match, per manual.

7.2.3 Most Common Optical Problems

- Bad or contaminated connections (excessive loss and/or back reflection) cause 80% of all link problems.
- Excessive fiber bends or damaged cables cause excessive optical loss, particularly at 1550 nm.
- Insufficient fiber bandwidth, particularly in multi-mode fiber, can cause intermittent problems on long cables.
- Optical overload (not enough attenuation) during bench tests can cause link faults or errors.
- Dust contamination from bushings or connectors not being covered (especially turrets) can cause link faults.
- Mixed multimode/singlemode fiber jumpers (orange/gray vs yellow jackets) cause optical faults.
- Refer to section 5.3 of this document for Fiber Handling Guidelines.

7.3 Possible problems, symptoms, and solutions

The following is a table outlining possible problems, symptoms, and solutions for Model 903:

SYMPTOM	POSSIBLE PROBLEM	POTENTIAL SOLUTION
No link lights	Non-functioning optical cable/damaged or dirty connector	Change optical cable Clean optical connections
	Optical loss is too high	Reduce optical loss
	Unit(s) not powered	Apply power to modules
	One or both FMBs in wrong configuration/type	Use same type of FMBs (e.g. make sure that FMBs are FMB-X-2.5 and refer to FMB section of this manual for default dip switch configuration)
No RS-232 serial diagnostics	Cable not connected to serial port on FMB-X-2.5	Install RS-232 Cable (Focal P/N: 903-9059-00)
	Wrong PC's serial port settings	Serial port settings should be: 9600 Baud, 8 Data bits, 1 Stop bit, No Parity
No Ethernet diagnostics	Cable not connected to RJ-45 port on FMB-X-2.5	Use a standard Cat5e Ethernet cable
	Wrong PC's IP address or subnet mask	Default FMB-X-2.5 values are: IP: 192.168.0.100 (console) IP: 192.168.0.101 (remote) Subnet Mask: 255.255.255.0 (remote and console) Refer to diagnostics manual 903-0622-00 for more details.
No data and/or no data LEDs	Improper channel configuration (also see no link lights). Improper wiring of WAGO connector. (RED LED = Data into Mux; GREEN LED = Data out of Mux)	Reference appropriate manual section for data board configuration & wiring of WAGO connector
	Data I/O board not connected at the remote end (903-HD only)	Install ribbon cable at J5 of both HDB-TX and DATA IO boards
	Non-working data daughtercard	Replace daughtercard
No Video	Improper channel configuration (see also no link lights)	Reference appropriate manual section for video and high density board configuration
No video sync lights at console	No video source at remote end	Plug camera into appropriate remote video channel
Console module voltage reading low	Older FMB systems: PSU internal 110/220 VAC selector switch (bottom side of cassette) may be set incorrectly (default is 110 VAC)	Set switch to appropriate AC input voltage (110 or 220 VAC)
Noisy video	Partial LINK, observable in diagnostics	Inspect / clean / replace optical cable system. Ensure valid ground connection on video cables.
Very bright video	Video signal input is too large	Ensure video input is 1.0Vpp nominal

7.3.1 Diagnostic LEDs

- PSU LEDs are on solid if +5, +12, -12 VDC rails are valid.
- AIB-4 Data Direction LEDs: Red = Receive (into front panel); Green = Transmit (from front panel to external equipment). A lit red LED at one end of the system should have corresponding lit green LED at the other end of the system.
- Only on during the space state (TTL = 0) and off during the mark state (TTL = 1); data activity is indicated by the flashing or brightness of the LED. Idle signals are usually in the mark state (TTL = 1, LED = off)
- Ethernet LEDs (on with valid link and/or collision)
- Refer to Table 3-1 of this document for information about the FMB-X-2.5 front panel LEDs.

7.3.1.1 Card Diagnostic LEDs:

CARD	LED STATUS – NORMAL OPERATION CONDITION
Fiber Multiplexer Boards	Green LED on LINK, FO-RX and STAT on both remote and console modules.
Ethernet Cards (EIB-10/100)	Green RJ-45 port LED: ON = valid link, FLASHING = data activity Yellow RJ-45 port LED: ON = full duplex link, FLASHING = data collisions Green Panel LED (“T”): ON = data received from backplane (10 Mbps EIB only) Red Panel LED (“R”): ON = data sent to backplane (10 Mbps EIB only)
AIB-4, DIB-232, DIB-485 Cards	Two LEDs for each channel indicate the presence of a signal transmitted or received: Green LED (“T”): ON = data being transmitted out of card front panel to external equipment. Red LED (“R”): ON = data being received into card front panel from external equipment. Non-digital i/o cards (e.g. AIB-MS900) or blank sockets force both LEDs on.
Remote Module Data I/O (903-High Density Only)	Two LEDs for each channel indicate the presence of a signal transmitted or received: Green LED ("T”): ON = data being transmitted out of i/o box to external equipment. Red LED (“R”): ON = data being received into i/o box from external equipment.
Power Supply	Green LEDs on PSU front panel indicate corresponding output voltage levels are OK. Flickering or dim LEDs indicates power problems on the rails.

7.3.1.2 FMB-X-2.5 Link LEDs (FMB Front Panel):

LED STATUS	CONDITION	POTENTIAL SOLUTION
Both LEDs On Green	Normal operating condition (Valid uplink/downlink established)	OK
LED Flickering Green/Red	Insufficient power budget	Verify optical power budget with VOAT.
One LED On Green & One LED On Red	Insufficient optical power in one direction	Verify attenuation, optical cable and connections. Re-establish synchronization (unplug/plug the fiber optic cable). Replace FMB that has the red LED if received optical power is OK. Check FMB DIP switch settings per Manual.
Both LEDs Red	Problem with optics between remote and console modules	Bad connector: clean all optical connections. Bad fiber: bypass fiber sections with jumpers.

7.4 General Handling and Failure Reporting Guidelines

- Verify the problem on other cards or channels, if possible.
- Use a spare card and see if that fixes the problem.
- Note card part number and serial number, as well as PO number, if possible.
- Confirm whether the problem appeared during installation or well after successful installation, i.e. did the problem occur with no changes to a previously working system?
- Log a diagnostics file, if relevant, and email it to the factory. Diagnostics files include all optical measurements, temperature, voltage levels, video syncs, and errors detected. Ensure the log file is configured properly per the software user’s manual. (The various log fields may be enabled/disabled and the logging frequency may be changed from the one second default.)

7.4.1 Focal Service and Support

It is recommended that damaged cards or cards/systems that the fault cannot be found in using the above guide be returned to Focal or local supplier.

- Request a RMA # from Focal (Tel: 1-902-468-2263) and complete a return product form.
- Provide key information, such as a description of the problem, the part number of the board, how long the board has been in service, any attempted fixes, and the urgency for repair.
- Ensure packaging is secure and ESD safe.

<This page intentionally left blank>

APPENDICES

<This page intentionally left blank>

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
HDB-TX	Video Input Connectors	Johnson	131-1701-376 [SMB Jack, RA]	131-1403-116 [SMB Plug Connector (RA)]
	I/O Box (Data I/O Connectors)	Wago	733-364 [4-pin RA Header]	733-104 [4-pin Connector]
VIB-X	Video Input / Output Connectors	Johnson	131-1701-376 [SMB Jack, RA]	131-1403-116 [SMB Plug Connector (RA)]
AIB-4	Data Connectors	Wago	733-364 [4-pin RA Header]	733-104 [4-pin Connector]
Console Backplane -X	Backplane Power Terminals	Keystone	8191	Standard #6 Ring Lug
Remote HD Backplane -X	+24 VDC Power Connector	Molex	09-75-2024 [2-pin, RA Header]	26-03-4020 [housing], 08-52-0113 [crimp terminals]

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/Ring) 3 (Base/Sleeve)	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				
HDB-TX	SMB	Video	Core Shield	Video Signal Ground
	4-Pin WAGO I/O Box	RS-232	1 2 3 4	Ground (Isolated) Receive (RX) Transmit (TX) N/C or Chassis*
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 A LAN B 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

Board	Connector	Signal Type	Pin #	Designation
AIB-CANBUS	4-pin WAGO	CAN Bus	1 2 3 4	CAN H CAN L GND Shield
BACKPLANES (BP)				
HD –X Backplane	2-pin Molex	Fan Connection	1 2	+VDC DGND
Std. –X Backplane (console)	3-pin Molex	Fan Connection	1 2 3	+12 VDC TACH +12 VDC Return
HD –X Backplane **(Remote 8VID and 4VID Systems)**	2-pin Molex	+24 VDC Power Input	1 2	-VDC (Isolated) +VDC

Notes:

1. Chassis connections, for shielding purposes only, are available through the multiplexer's AIB WAGO headers for AIB-4 and HDB-TX cards. In general, chassis pins on headers should be left open (no connection on mating external WAGO).
2. 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	24 VDC High Density	0454005	5 A	Time Delay	Littelfuse	SMT fuse F3 is located on remote HD backplane. This fuse protects the primary DC voltage input.
1	24 VDC Fan	miniSMDC050F-2	0.5 A	Resettable	Raychem	SMT fuse on back-plane underneath back cover plate. Used by fan.

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.
1	12 VDC Fan	miniSMDC050F-2	0.5 A	Resettable	Raychem	SMT fuse on back-plane underneath back cover plate. Used by fan.

CARDS

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)
Video & Data	HDB-TX	2	0452.500	0.5A	SMT fuse to protect on-board +12VDC (F2) and -12VDC (F3)
		1	0452003	3.0A	SMT fuse to protect on-board +5VDC (F1)
Data	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).

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. 0451 and 0452 type fuses are manufactured by Littelfuse.
4. 0452 type SMT fuses are time delay fuses.
5. 0451 type SMT fuses are fast acting fuses.
6. The parts listed in this appendix might become obsolete in the future. Please contact the factory for advice on replacement parts.

APPENDIX C – INSTALLATION DRAWINGS

DIGITAL COPY OF MANUAL DOES NOT INCLUDE CURRENT INSTALLATION DRAWINGS, WHICH ARE AVAILABLE SEPARATELY.

CURRENT INSTALLATION DRAWINGS SHOULD BE INSERTED HERE FOR HARD COPIES OF THE MANUAL.

<This page intentionally left blank>

APPENDIX D – ISOLATION, PROTECTION, AND GROUNDING

MODEL 903-HD HIGH DENSITY MULTIPLEXER - PROTECTION AND ISOLATION CHART

BOARD	PROTECTION			ISOLATION		
	TVS Clamp	Fuse	Other	Ground/ Power	Signals	Full Isolation
HDB-TX: Video Input	Yes	No	Capacitor coupled	None	None	No
HDB-TX: RS-232 (via I/O-Box)	Yes	No	1K resistors (on inputs)	Transformer (1 per 4 i/o)	Opto-isolator	Yes
HDB-TX: AIB slots (via I/O Box)	Per plug-in	No	Per plug-in	Per plug-in	Per plug-in	Per plug-in
HDB-TX: +5 V rail	No	3 A soldered	EMI filter	n/a	n/a	n/a
HDB-TX: ±12V rails	No	0.5 A soldered	EMI filter	n/a	n/a	n/a
VIB-X: Video Output	Yes	No		None	None	No
Plug-In: AIB-232	Yes	Yes		Transformer	Opto-isolator	Yes
Plug-In: AIB-485	Yes	Yes		Transformer	Opto-isolator	Yes
FMB-X-2.5: +5V rail	No	3 A soldered	EMI filter	n/a	n/a	n/a
FMB-X-2.5: ±12V rails	No	0.5 A soldered	EMI filter	n/a	n/a	n/a
FMB-X-2.5: RS232 Port	Yes	No		Yes	Yes	Yes
FMB-X-2.5: RJ-45 Port	Yes	No		n/a	Transformer	Yes
Backplane: +VDC In (HD Remote)	No	5 A socketed	Reverse polarity	Yes	n/a	Yes
Backplane: Fan (HD Remote)	No	0.5 A resettable		None	None	No
Backplane: AC Input (Console)	No	1 A	EMI filter on AC input	Yes	n/a	Yes
Backplane: Fan (Console)	No	0.5 A resettable		None	None	No

APPENDIX E – BACKPLANE PIN CONFIGURATIONS

MODEL 903 HIGH DENSITY (HD) BACKPLANE PIN CONFIGURATIONS (FMB-X-2.5 SYSTEMS)

REMOTE MODULE

FMB-X-2.5 SLOT BACKPLANE PINS

Pin	Row A	Row B	Row C
1	DATA	DATA	DATA
2	DATA	DATA	DATA
3	DATA	DATA	DATA
4	DATA	DATA	DATA
5	DATA	DATA	DATA
6	DATA	DATA	DATA
7	DATA	DATA	DATA
8	DATA	DATA	DATA
9	DATA	DATA	DATA
10	DATA	DATA	DATA
11	DATA	DATA	DATA
12	DATA	DATA	DATA
13	DATA	DATA	DATA
14	DATA	DATA	DATA
15	DATA	DATA	DATA
16	DATA	DATA	DATA
17	DATA	DATA	DATA
18	DATA	DATA	DATA
19	DATA	DATA	DATA
20	DATA	DATA	DATA
21	DATA	DATA	DATA
22	DATA	DATA	DATA
23	DATA	DATA	DATA
24	DGND	DATA	DGND
25	V2-FCLK	DATA	V1-FCLK
26	DGND	DATA	DGND
27	V2-SCLK	DATA	V1-SCLK
28	DGND	DATA	DGND
29	DATA	DATA	DATA
30	DATA	DGND	DATA
31	+12VDC	+5VDC	-12VDC
32	+5VDC	+5VDC	+5VDC

HDB-TX SLOT BACKPLANE PINS

Pin	Row A	Row B	Row C
1	DATA	DATA	DATA
2	DGND	DATA	DATA
3	DATA	DATA	DATA
4	DGND	DATA	DGND
5	DATA	DATA	DGND
6	DGND	DATA	DGND
7	DATA	DATA	DATA
8	DGND	DGND	DGND
9	DATA	DATA	DATA
10	DGND	DATA	DGND
11	DATA	DATA	DGND
12	DGND	DATA	DATA
13	DATA	DGND	DGND
14	DGND	FCLK	DATA
15	DATA	DGND	DGND
16	DGND	DGND	DATA
17	DGND	DGND	DGND
18	DGND	SCLK	DATA
19	DGND	DGND	DGND
20	DGND	DATA	DATA
21	DGND	DATA	DGND
22	DGND	DATA	DATA
23	DGND	DATA	DGND
24	DGND	DGND	DATA
25	DGND	DATA	DGND
26	DGND	DATA	DATA
27	DGND	DATA	DGND
28	DGND	DATA	DGND
29	DGND	DGND	DGND
30	AGND	AGND	AGND
31	+12VDC	+5VDC	-12VDC
32	+5VDC	+5VDC	+5VDC

V1 = Video/HDB 1 (Slot A)

V2 = Video/HDB 2 (Slot B)

FCLK = 62.5 MHz, TTL

SCLK = 15.625 MHz, TTL

DGND = Digital Ground

AGND = Analog Ground

DATA = Data Line, TTL

FMB = Fiber Multiplexer Board

HDB = High Density Board

VIB = Video Interface Board

Function of each data line depends on the types of data and video cards used in each slot.

FMBs have 2 additional shield rows (D, E) with all pins connected to DGND.

High speed probes and oscilloscopes are required for viewing the clock signals.

CONSOLE MODULE

FMB-X-2.5 SLOT BACKPLANE PINS

Pin	Row A	Row B	Row C
1	DATA	DATA	DATA
2	DATA	DATA	DATA
3	DATA	DATA	DATA
4	DATA	DATA	DATA
5	DATA	DATA	DATA
6	DATA	DATA	DATA
7	DATA	DATA	DATA
8	DATA	DATA	DATA
9	DATA	DATA	DATA
10	DATA	DATA	DATA
11	DATA	DATA	DATA
12	DATA	DATA	DATA
13	DATA	DATA	DATA
14	DATA	DATA	DATA
15	DATA	DATA	DATA
16	DATA	DATA	DATA
17	DATA	DATA	DATA
18	DATA	DATA	DATA
19	DATA	DATA	DATA
20	DATA	DATA	DATA
21	DATA	DATA	DATA
22	DATA	DATA	DATA
23	DATA	DATA	DATA
24	DGND	DATA	DGND
25	V2-FCLK	DATA	V1-FCLK
26	DGND	DATA	DGND
27	V2-SCLK	DATA	V1-SCLK
28	DGND	DATA	DGND
29	DATA	DATA	DATA
30	DATA	DGND	DATA
31	+12VDC	+5VDC	-12VDC
32	+5VDC	+5VDC	+5VDC

VIB-X VIDEO SLOT BACKPLANE PINS

Pin	Row A	Row B	Row C
1	DGND	DATA	DATA
2	DGND	DATA	DATA
3	DGND	DATA	DGND
4	DGND	DATA	DGND
5	DGND	DATA	DGND
6	DGND	DATA	DGND
7	DGND	DATA	DGND
8	DGND	DGND	DGND
9	DGND	DATA	DGND
10	DGND	DATA	DGND
11	DGND	DATA	DGND
12	DGND	DATA	DGND
13	DGND	DGND	DGND
14	DGND	FCLK	DGND
15	DGND	DGND	DGND
16	DGND	DGND	DGND
17	DGND	DGND	DGND
18	DGND	SCLK	DGND
19	DGND	DGND	DGND
20	DGND	DATA	DGND
21	DGND	DATA	DGND
22	DGND	DATA	DGND
23	DGND	DATA	DGND
24	DGND	DGND	DGND
25	DGND	DATA	DGND
26	DGND	DATA	DGND
27	DGND	DATA	DGND
28	DGND	DATA	DGND
29	DGND	DGND	DGND
30	AGND	AGND	AGND
31	OPEN	+5VDC	-12VDC
32	+5VDC	+5VDC	+5VDC

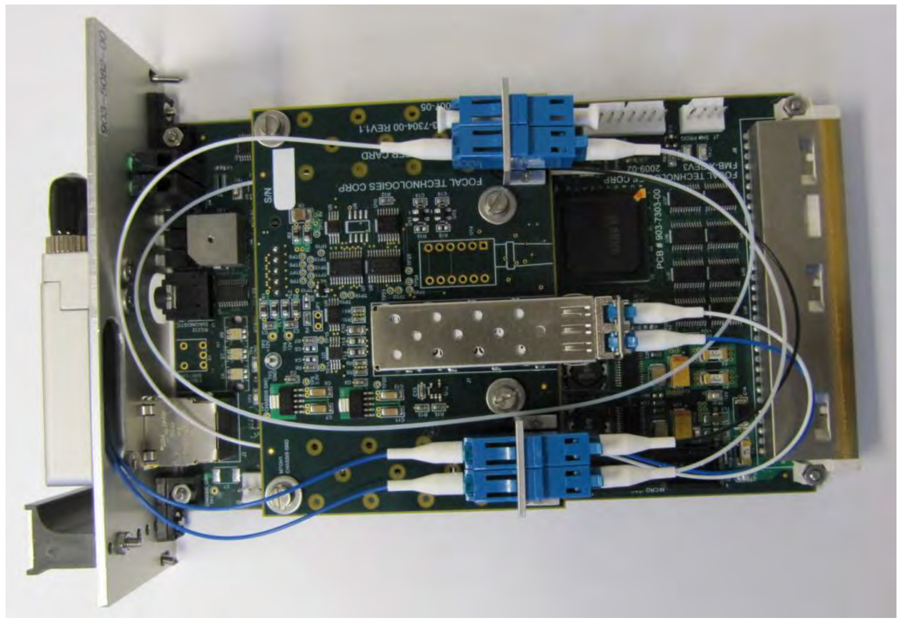
DATA SLOT BACKPLANE PINS

Pin	Row A	Row B	Row C
1	DGND	DGND	DGND
2	DGND	DATA	DGND
3	DGND	DGND	DGND
4	DGND	DATA	DGND
5	DGND	DGND	DGND
6	DGND	DATA	DGND
7	DGND	DGND	DGND
8	DGND	DATA	DGND
9	DGND	DGND	DGND
10	DGND	DATA	DGND
11	DGND	DGND	DGND
12	DGND	DATA	DGND
13	DGND	DGND	DGND
14	DGND	DATA	DGND
15	DGND	DGND	DGND
16	DGND	DATA	DGND
17	DGND	DGND	DGND
18	DGND	DATA	DGND
19	DGND	DGND	DGND
20	DGND	DATA	DGND
21	DGND	DGND	DGND
22	DGND	DATA	DGND
23	DGND	DGND	DGND
24	DGND	DATA	DGND
25	DGND	DGND	DGND
26	DGND	DGND	DGND
27	DGND	DGND	DGND
28	DGND	DGND	DGND
29	DGND	DGND	DGND
30	OPEN	AGND	OPEN
31	+12VDC	+5VDC	-12VDC
32	+5VDC	+5VDC	+5VDC

APPENDIX F – CARD & SYSTEM PHOTOS

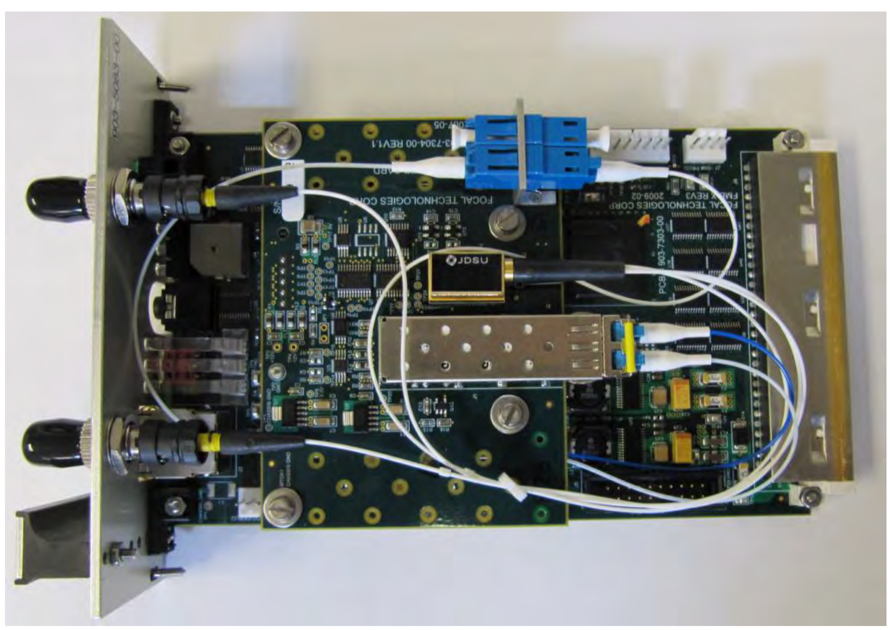
FMB-X-2.5 REMOTE AND CONSOLE

FMB-X-2.5 Remote Front Panel View



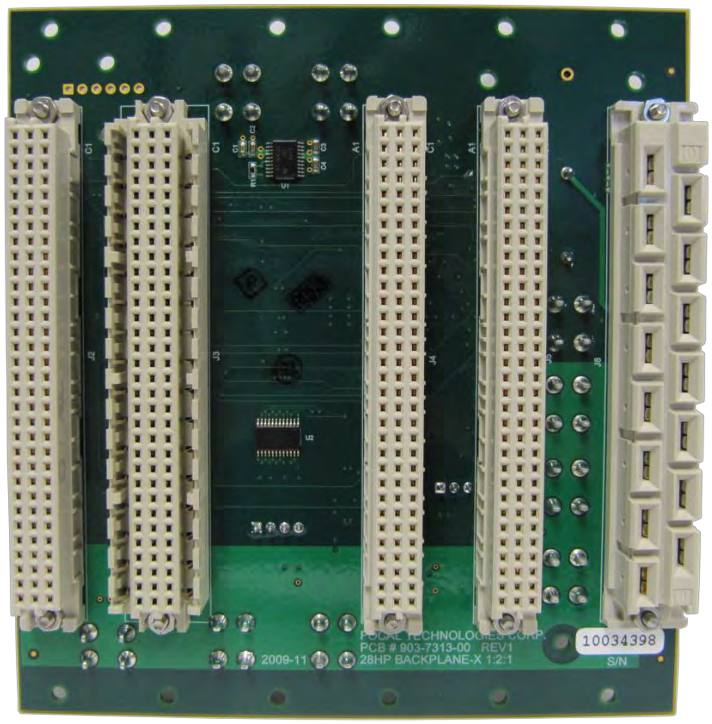
FMB-X-2.5 Remote – Top View

FMB-X-2.5 Console Front Panel View

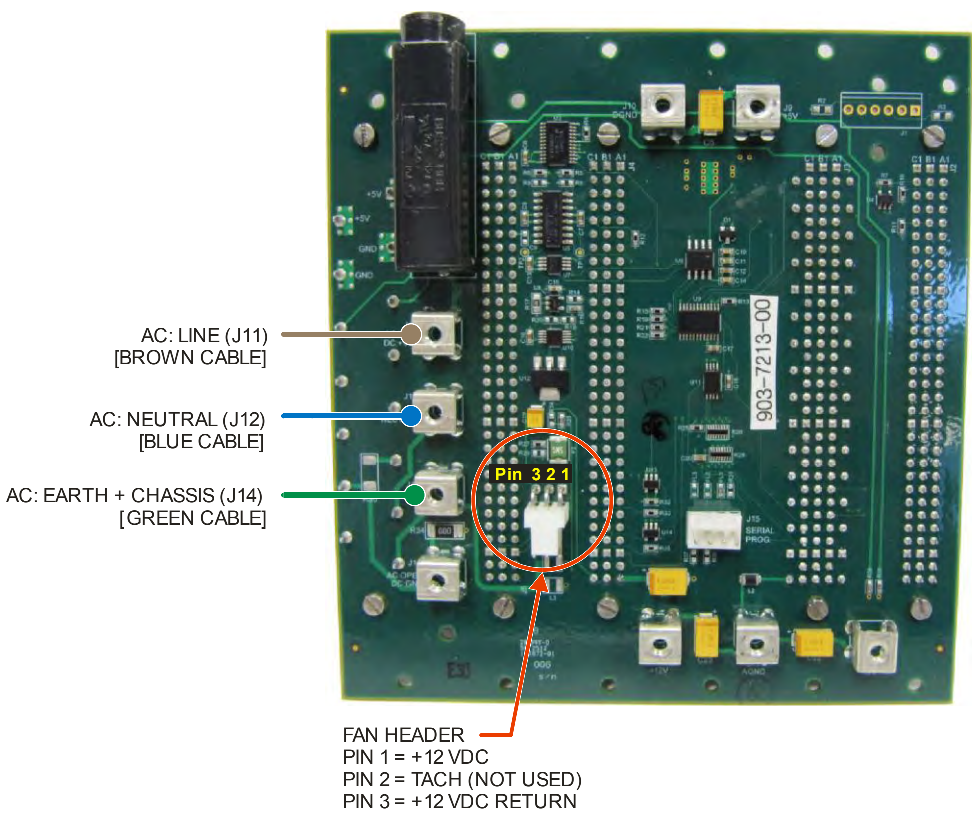


FMB-X-2.5 Console – Top View

28 HP –X BACKPLANE (Focal P/N: 903-7213-00)



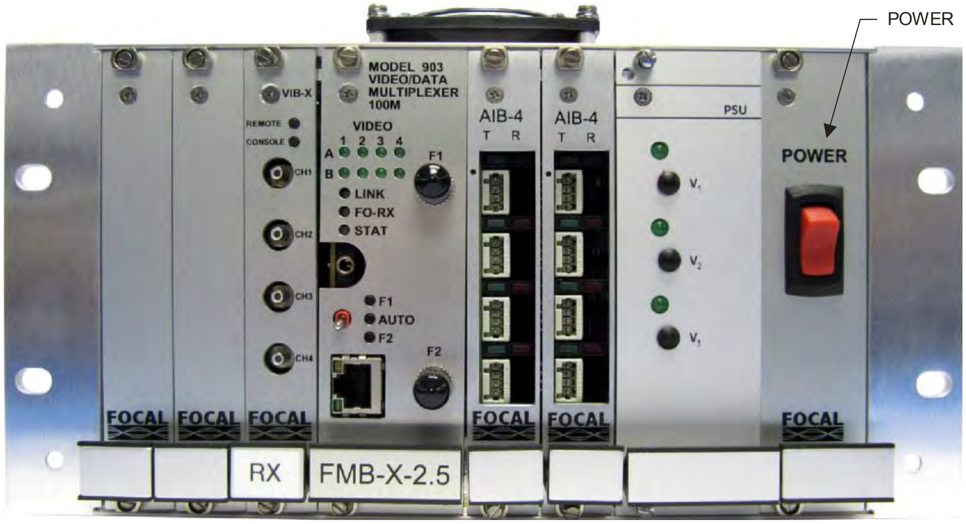
(Front View)



(Back View)

MODEL 903 4VID CONSOLE MODULE

Front View



Back & Top View

MODEL 903 HIGH DENSITY 4VID REMOTE MODULE

Front View

Back View

Bottom View with I/O Box Shown

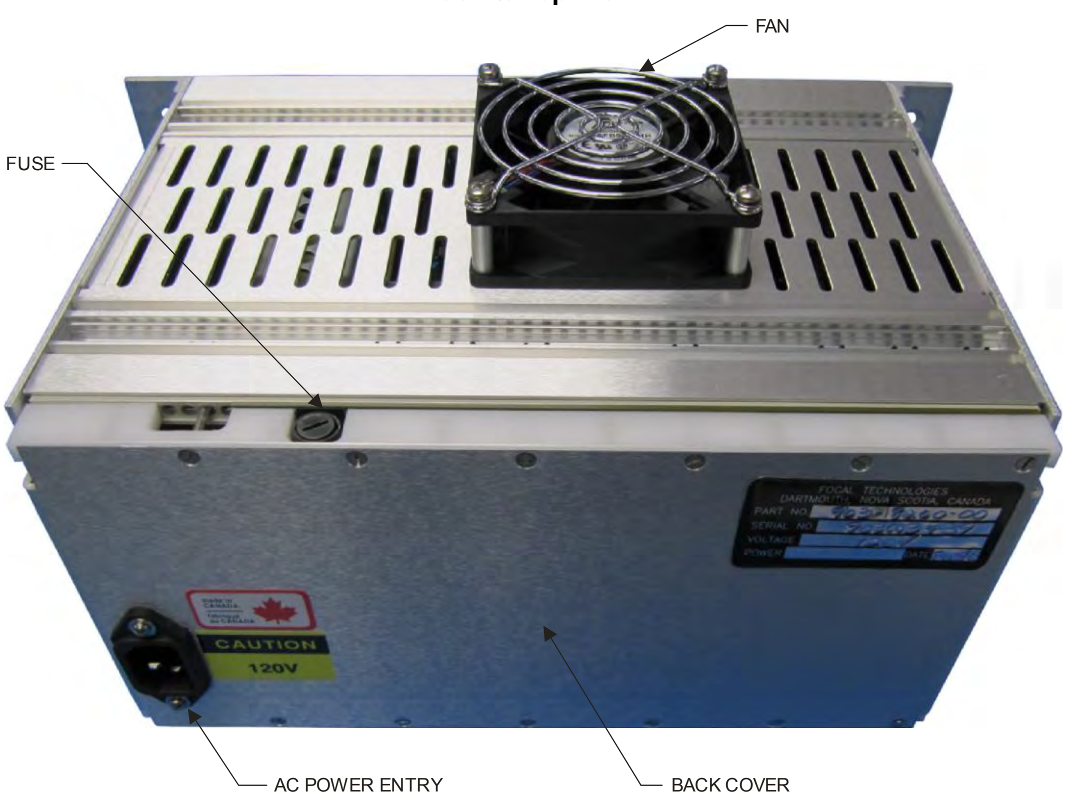
(FRONT)

(BACK)

MODEL 903 8VID CONSOLE MODULE

Front View

Back & Top View



MODEL 903 HIGH DENSITY 8VID REMOTE MODULE

Front View

Back View

Bottom View with I/O Box Shown

(FRONT)

(BACK)