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Model 903
Fiber Optic
Video/Data Multiplexer
User's Guide

Part No. 903-0602-00 B
March 28, 2005

REVISION HISTORY

Revision	A	2003-02-14	IBM
	B	2005-03-28	IBM

Revision	Revision Notes
A	Preliminary Issue, based on 903-0601-00 F
B	Corrected minor typos and formatting errors.
	Updated EIB-10/100 section 4.9 to include electrical mode. Updated figure 4.9-3 to rev 2 PCBA image. Added section 4.9.3 on flow control. Updated EIB-10/100 optical section, 4.9.4.
	Updated AIB-ARCNET section 4.6.4 with recommended settings for long coaxial cables.
	Added notes on 1550 nm cable losses to section 5.0.
	Added tables for WAGO pin designations in section 4.6. Tables in section 4.6 are renumbered.
	Default ARCNET terminators changed in Table 4.6-4
	Default AIB-485 configuration changed to RS-485 (was RS-422 in 4.6.3 and Table 4.6-3)
	Updated Appendix E fuse list with reference designators

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ACRONYMS AND ABBREVIATIONS

AIB	Adaptable Interface Board
APD	Avalanche Photodiode
CWDM	Coarse Wavelength Division Multiplexer
CIB	Control Interface Board (TOR)
DIB	Data Interface Board
ECL	Emitter Coupled Logic
EIA	Electronic Industries Association
EIB	Ethernet Interface Board
ESD	Electrostatic Discharge
FORJ	Fiber Optic Rotary Joint
FMB	Fiber (Optic) Multiplexer Board
LED	Light Emitting Diode
NTSC	National Television System Committee (Composite Video Format)
PAL	Phase Alternation Line (Composite Video Format)
PECL	Positive Emitter Coupled Logic
PCBA	Printed Circuit Board Assembly (Populated PCB)
PLD	Programmable Logic Device
ROV	Remotely Operated Vehicle
SMT	Surface Mount Technology
TDM	Time Division Multiplexing
TTL	Transistor-Transistor Logic
VIB-RX	Video Interface Board (console module)
VIB-TX	Video Interface Board (remote module)
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 2 additional bidirectional optical channels for high-speed sonar, digital video, or 100 Mbps Ethernet links.

The Model 903 fiber optic transmission system contains all the necessary transmitters, receivers, and wavelength division multiplexers needed to provide a single fiber optic interface to a user's cable or umbilical. The system's optical budget will support transmission through an optical system with up to 10 km of singlemode or 2-4 km of multimode fiber optic cable, 1-2 fiber optic rotary joints (FORJs), and a number of optical connectors.

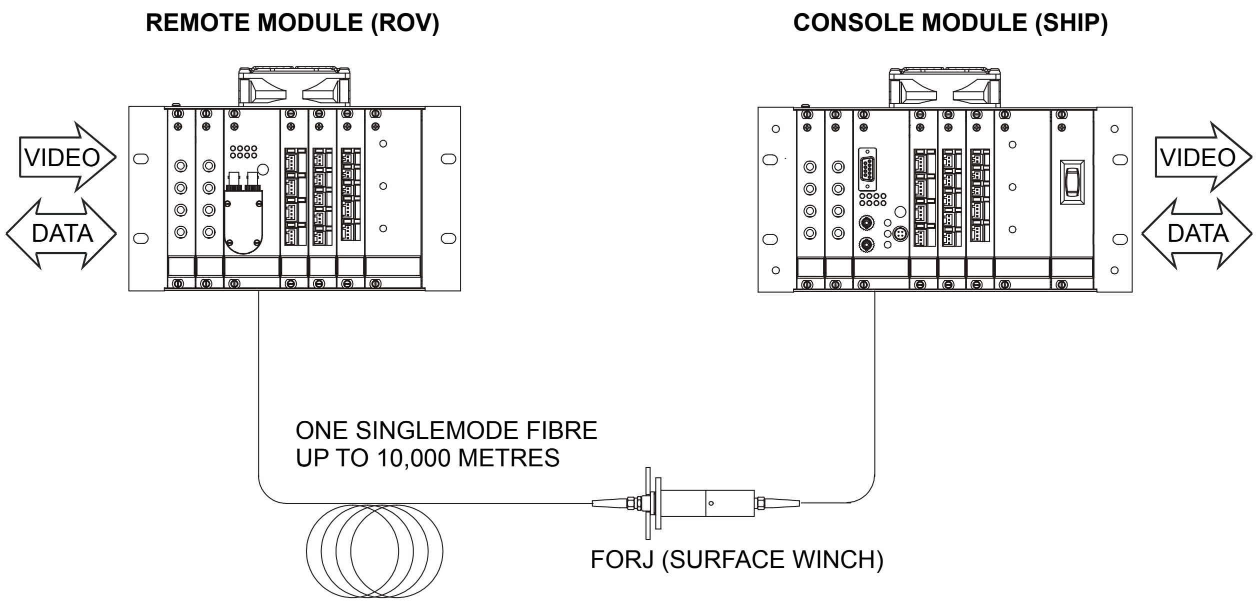


Figure 1-1: Model 903 Multiplexer, Typical ROV Application

This User Guide provides complete information on the design, configuration, installation and operation of the Model 903 multiplexer. This manual should be reviewed prior to installation or reconfiguration of the multiplexer. Some sections of the manual apply to optional cards or features that are not included with the delivered system but may be added later.

Appendices include the following information:

Appendix A - A copy of all related data sheets
Appendix B - Installation drawings and other related "as-built" documents
Appendix C - A copy of the manual for the diagnostics software provided
Appendix D - A list of connectors and pin configurations
Appendix E - A list of all fuses used in the system

Details on any new or custom cards not covered in the main body of the manual are included as configuration drawings in Appendix B.

2.0 System Overview

Each Model 903 multiplexer system consists of a 3U Eurocard remote module (vehicle or ROV end) and a 3U Eurocard console module (surface or shipboard end), often mounted inside a standard 19” rack. Each module is provided completely packaged with an integrated power supply unit (PSU) and all necessary optical components. Eurocard PCB dimensions are 100 x 160 mm.

There are two main types of Model 903 systems: high-speed (HS) and medium speed (MS). High-speed systems support 8 simultaneous video channels whereas medium speed systems support 4 simultaneous video channels, though video switching cards can allow for more than 4 camera connections. The aggregate data uplink rate, including formatting bits, is 1.375 Gbps for the high-speed uplink and 687 Mbps for the medium speed uplink. The downlink data rate is always 172 Mbps, regardless of the uplink rate, since no video is transmitted in that direction.

High-speed uplink systems require a backplane and fiber multiplexer board (FMB) that support high-speed uplinks. Medium speed uplink systems require a backplane and FMB that support medium speed uplinks. Singlemode FMBs are available in both high-speed and medium speed versions (8 or 4 video channels). Multimode FMBs are available only in medium speed versions (4 video channels). All FMBs support the same uplink and downlink data capacity, which is up to 64 data channels, depending on the size of the backplane.

Video and data cards can be used in high-speed and medium speed systems, as well as with both singlemode and multimode FMBs. Video cards are not interchangeable between the remote and console module, since the signals are unidirectional: the remote cards have video inputs, the console video cards have video outputs. Data cards generally have bidirectional data channels and hence the cards are usually interchangeable between the remote and console modules.

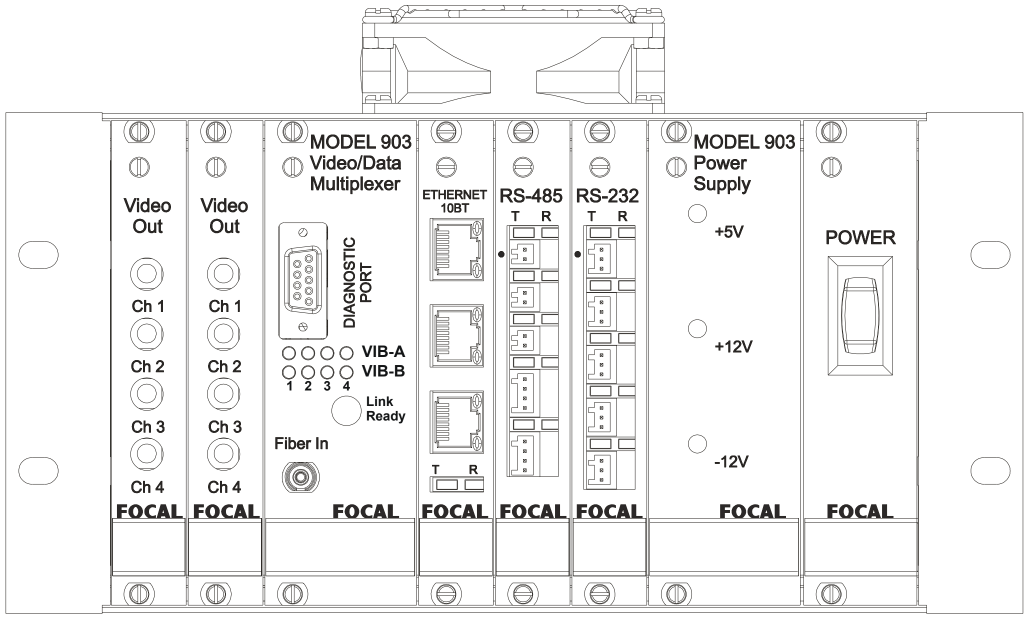
2.1 Rack Configuration

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

Slots in each rack are referenced by letter, per the installation drawings. Slots A and B are 4 HP video slots, slot C is the 8 HP slot for the FMB, slot D is a high-speed data interface slot, and slots E, F, G, if present, are typically data slots. The last slot is usually the power supply module on the remote module or the power switch on the console module. Figure 2.1-1 shows front panel views of a high-speed remote and console module with typical card configuration. Figure 2.1-2 shows the same panel views for a typical medium speed system.

Refer to Appendix B for the actual as-built rack configuration.

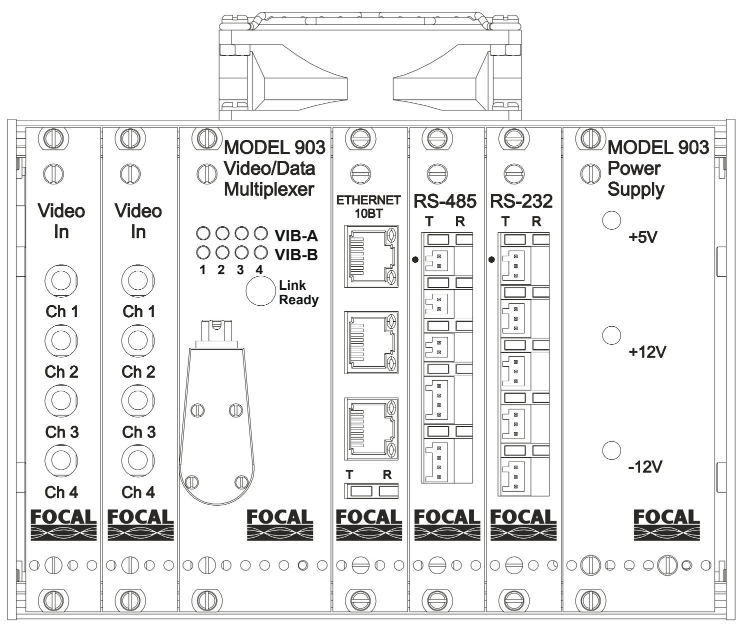
CONSOLE (SURFACE) MODULE



SLOT A B C D E F G H

SLOTS A, B = VIDEO BOARDS
SLOT C = FIBER MULTIPLEXER BOARD
SLOT D, E, F = DATA BOARDS
SLOT G = POWER SUPPLY UNIT (PSU)
SLOT H = POWER SWITCH (CONSOLE ONLY)

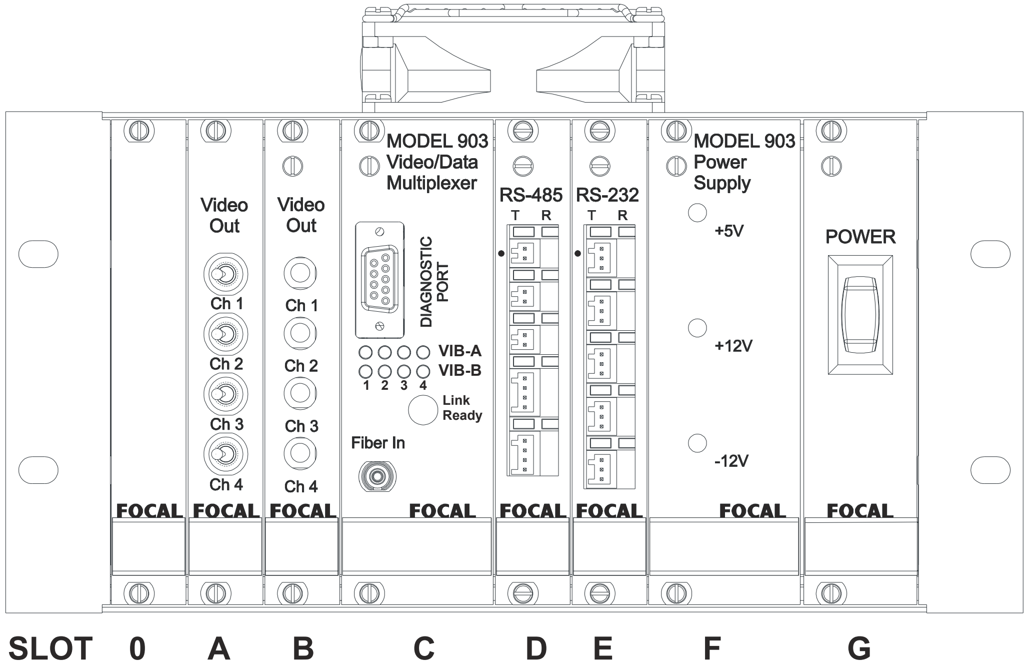
REMOTE (ROV) MODULE



SLOT A B C D E F G

Figure 2.1-1: Model 903 Front Panel View (Typical High-speed System)

CONSOLE (SURFACE) MODULE



SLOT A = VIDEO SWITCHES (CONSOLE ONLY)
SLOT B = VIDEO BOARD
SLOT C = FIBER MULTIPLEXER BOARD
SLOTS D, E = DATA BOARDS
SLOT F = POWER SUPPLY UNIT (PSU)
SLOT G = POWER SWITCH (CONSOLE ONLY)

REMOTE (ROV) MODULE

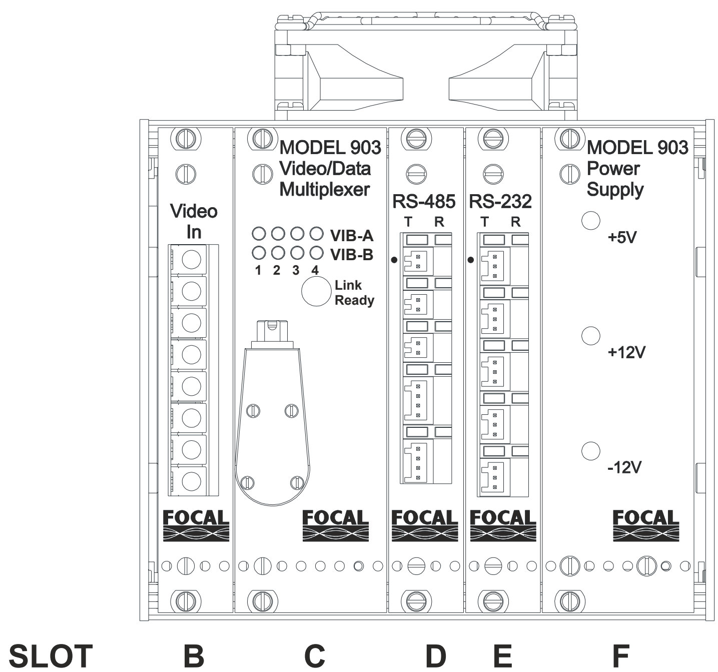


Figure 2.1-2: Model 903 Front Panel View (Typical Medium Speed System)

High-speed data slot D supports high-speed-only cards, such as the EIB-10BT, or allows certain types of data cards to take advantage of the higher sampling rate. For example, the high density RS-232 card, DIB-232-16, allows a maximum RS-232 data rate of 115 kbaud when used in slot D and 56 kbaud in the other data slots. Use of the AIB-4 card in slot D increases the maximum data rate from 625 kbps NRZ to 2.5 Mbps NRZ on RS-422/485 channels.

2.2 Optical Configuration

Model 903 systems can be provided in a variety of optical configurations with singlemode or multimode fiber, and with a single or dual fiber connection. Typical systems use 1310 nm as the uplink wavelength and 1550 nm as the downlink wavelength, which are combined with a wavelength division multiplexer (WDM) on the FMB. Dual fiber configurations increase reliability by providing fiber redundancy with an integrated splitter at the remote FMB and an automatic fiber switch at the console FMB, as shown in Figure 2.2-1 below.

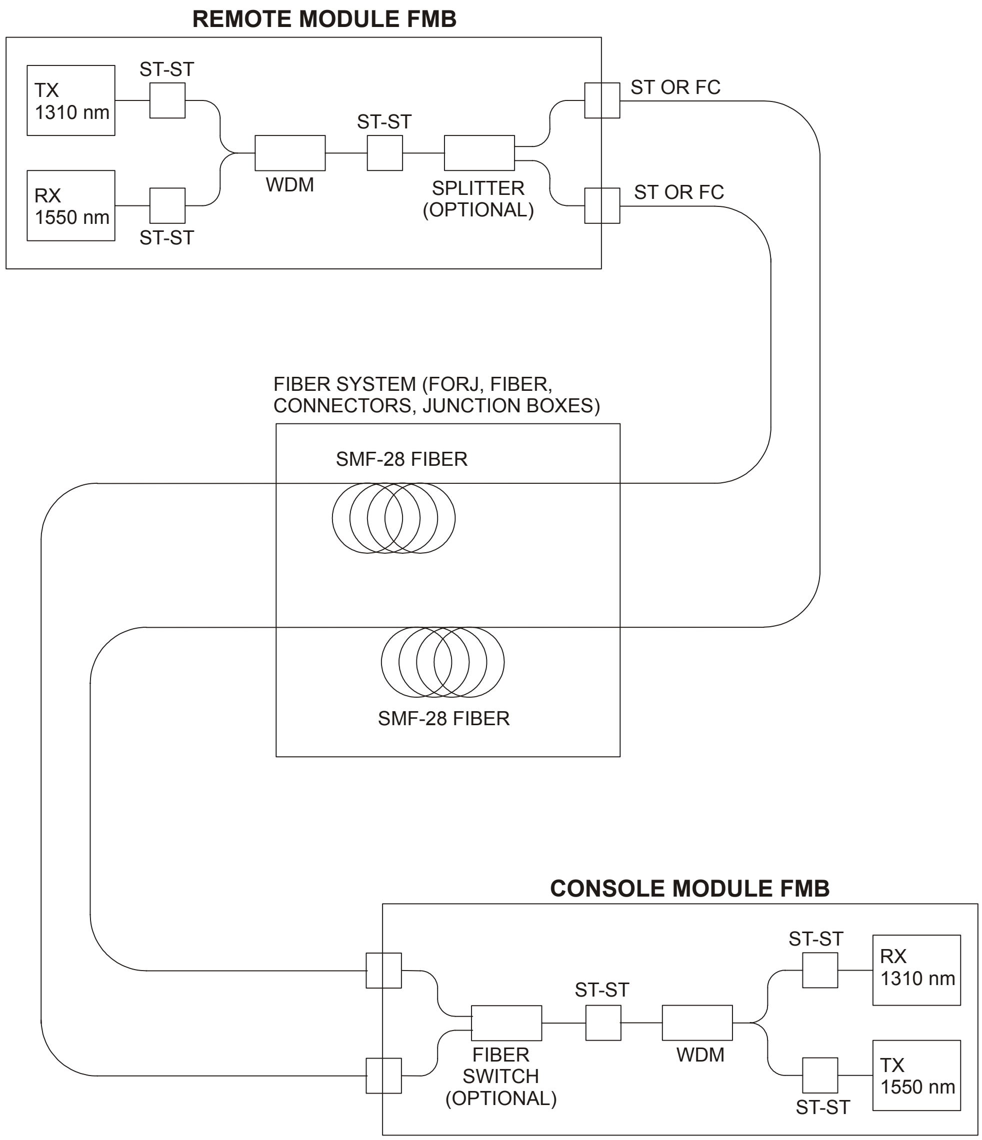


Figure 2.2-1: Model 903 Fiber Optic Transmission System

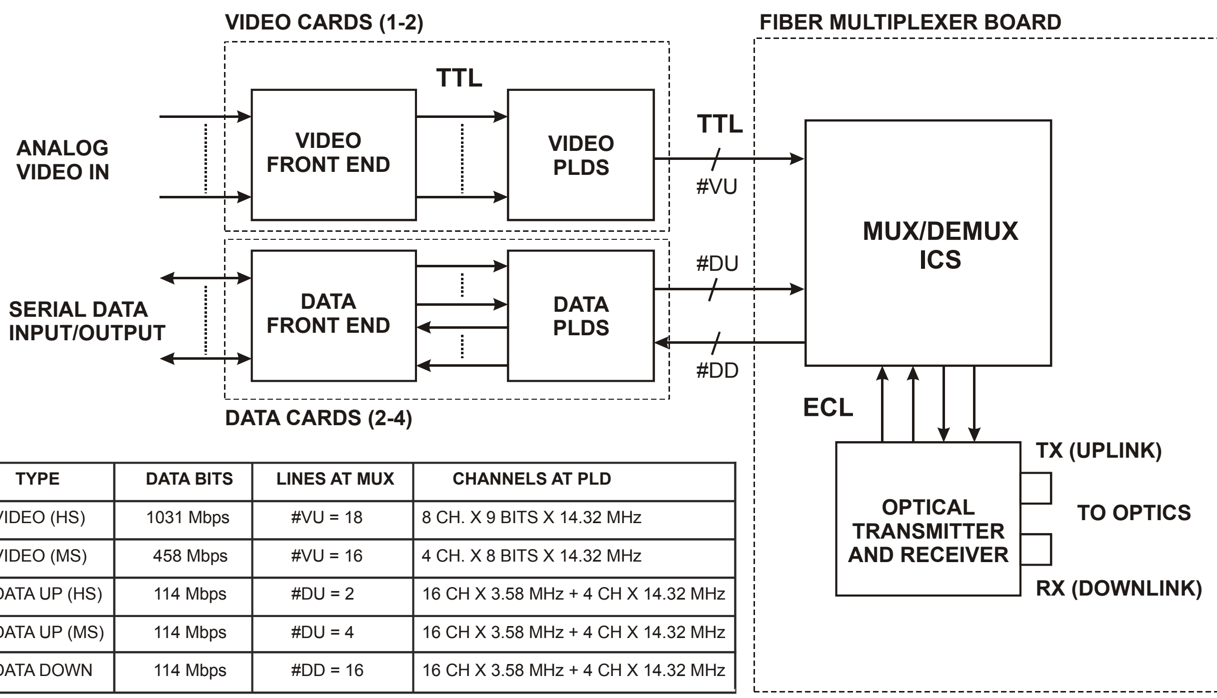
Standard FMB cards use lasers with loosely controlled wavelengths that can vary significantly from unit to unit and over temperature. Since 1310 nm and 1550 nm are widely separated on the optical spectrum, there is no problem with crosstalk or interference even when the exact wavelengths are variable.

FMB cards are also available with more carefully controlled wavelengths for use in multi-channel systems based on CWDM (Coarse Wavelength Division Multiplexing) and DWDM (Dense Wavelength Division Multiplexing). CWDM systems support 8 wavelengths; DWDM systems support 16 or more wavelengths. Both CWDM and DWDM enable the combination of two or more FMBs, plus other optical interface cards, on a single optical fiber, allowing considerable expansion of the Model 903 video and data channel capacity.

CWDM wavelengths may be used to expand an existing Model 903 system by adding separate optical uplinks, typically for high-speed sonar, 100 Mbps Ethernet, or digital video. Daisy-chaining the new optical card into the existing 1310/1550 nm optical link allows the upgraded system to continue operating on a single fiber. CWDM optical cards may be installed in any data slot.

2.3 Electrical Configuration

Figure 2.3-1 shows the electrical multiplexing configuration of each remote module. (The console module performs the reverse functions.) Each video card "pre-multiplexes" four video channels on #VU = 10 video lines to the FMB. There are 18 total lines available at the FMB multiplexer for video in a high-speed system, which is default configured with 9 lines per video card, effectively resulting in 9-bit digitization for each video channel. The FMB may optionally be switch configured for 10-bit video on slot A and 8-bit video on slot B. Medium speed FMBs default to using 8 lines for each pair of video channels, effectively resulting in 8-bit digitization. Medium speed backplanes may be switch configured to alternatively support 9-bit video by giving up the high-speed data lines.



TYPE	DATA BITS	LINES AT MUX	CHANNELS AT PLD
VIDEO (HS)	1031 Mbps	#VU = 18	8 CH. X 9 BITS X 14.32 MHz
VIDEO (MS)	458 Mbps	#VU = 16	4 CH. X 8 BITS X 14.32 MHz
DATA UP (HS)	114 Mbps	#DU = 2	16 CH X 3.58 MHz + 4 CH X 14.32 MHz
DATA UP (MS)	114 Mbps	#DU = 4	16 CH X 3.58 MHz + 4 CH X 14.32 MHz
DATA DOWN	114 Mbps	#DD = 16	16 CH X 3.58 MHz + 4 CH X 14.32 MHz

Figure 2.3-1: Block Diagram of Model 903 Electrical Multiplexing

Each data card slot has 4 or 5 lines on the backplane to and from the FMB. In total, #DU = number of data uplink lines = 20, including one line reserved for diagnostics on the FMB. The downlink uses a different sampling scheme but maintains the same per channel sampling with #DD = number of data downlink lines = 20, also including one line for diagnostics. Some data cards, such as the AIB-4, map a single data input to a single data line to the FMB. Other data cards, such as the CIB-10 and DIB-232-16, map several data channels to a single line to the FMB.

Programmable Logic Devices (PLDs) are used to perform the various pre-multiplexing and multiplexing tasks to structure the multiple video and data channel inputs to match the 20 lines available on the final multiplexing IC, which combines the lines into a single, high-speed ECL output to the optical transceiver.

3.0 Fiber Multiplexers And Backplanes

3.1 FMB-VTX - Remote Fiber Multiplexer Board

The remote Model 903 Fiber Multiplexer Board (FMB-VTX) employs time division multiplexing (TDM) to combine the various data and video signals originating at the ROV into a single 1310 nm uplink signal — 1.375 Gbaud for high-speed uplinks, 687 Mbaud for medium speed uplinks. Both high-speed and medium speed remote FMBs demultiplex data signals originating at the console end as a lower speed (172 Mbaud) downlink signal at 1550 nm. A wavelength division multiplexer (WDM) inside the FMB combines the optical signals, allowing a bidirectional optical link on a single fiber. Remote FMBs may be supplied with a dual fiber option (-DF suffix) for redundant operation over two fibers.

Front panels are shown in Figure 3.1-1 for a single fiber FMB (FMB-VTX-00/-01, FMB-VTX-50, FMB-VTX-20/-21) and an FMB with the dual fiber option (FMB-VTX-01-DF, FMB-VTX-21-DF, FMB-VTX-50). A green LED labeled "Link" or "Link Ready" turns on when the optical data downlink (1550 nm) has been established. Two banks of four green LEDs, marked VIB-A and VIB-B, indicate the presence of sync on the video channels, where VIB-B corresponds to the video card or HDB-TX card in slot B. Each LED is lit only if a sync pulse is detected on the corresponding video channel. Standard PAL or NTSC signals will turn on the sync LEDs, whereas chroma and other component video signals (R, B of RGB) without sync pulses will not.

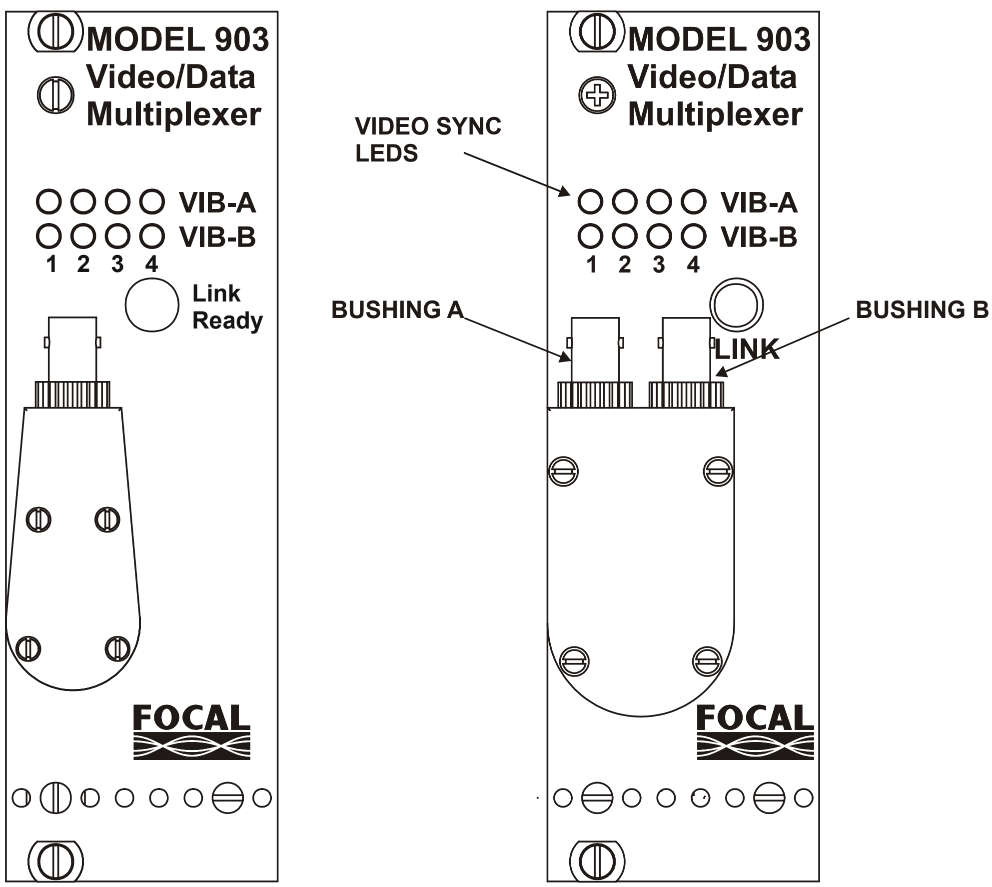


Figure 3.1-1: Remote Module FMB Front Panels (-DF version on right)

Single fiber FMBs have one input/output bushing on the right-angled turret. Internal WDM and opto-electronics connections are shown in the Figure 3.1-2 block diagram for the FMB-VTX-00/01 configuration. (Other single fiber configurations are similar.)

Dual fiber FMBs have two input/output bushings connected internally to a 50/50 optical splitter, a WDM, and internal opto-electronics. The block diagram for the FMB-VTX-01-DF is shown in Figure 3.1-3. (Other dual fiber configurations are similar.) The splitter divides the uplink power evenly between the two bushings, which are typically connected to two separate fibers in the umbilical cable for redundancy. (Since bushings A and B each carry the same uplink optical signals, they are functionally identical and do not normally require marking.) While the uplink is transmitted on both fibers simultaneously, a fiber-switching console FMB, if used, ensures the downlink is present on only one fiber. Dual fiber FMB-VTX remote cards may be used without a fiber switching FMB in the console module as long as an external fiber switch or manual connection of fibers at the console ensures the downlink exists on only one fiber at a time.

High-speed, singlemode remote FMBs are available with either standard power (FMB-VTX-00) or high power (FMB-VTX-01) uplink lasers. Standard power FMBs provide a 20 dB uplink flux budget; high power FMBs provide a 26 dB uplink flux budget. Dual fiber versions of the FMB are designated by the -DF suffix and are typically provided with the high power option, i.e., FMB-VTX-01-DF. The dual fiber option reduces overall flux budget by 5 dB: output of the FMB-VTX is reduced by 4 dB and sensitivity at the FMB-VRX is reduced by 1 dB. Higher power dual fiber systems are available on request.

Medium speed, singlemode remote FMBs are also available with standard (FMB-VTX-20) or high power (FMB-VTX-21) laser as well as dual fiber versions (FMB-VTX-21-DF). Multimode FMBs are inherently medium speed and are available in a single fiber (FMB-VTX-50) or dual fiber (FMB-VTX-50-DF) configuration.

Video bit resolution and uplink data rate are configured on the fiber multiplexer board with switch SW1. Settings for both FMB-VTX and FMB-VRX are shown in Table 3.1-1 and normally do not require changes. Single or dual fiber versions use the same settings.

Table 3.1-1: FMB Switch SW1 Settings

High-speed FMBs (FMB-VTX-00, FMB-VTX-01, FMB-VRX-00)		**Medium Speed FMBs (FMB-VTX-20, FMB-VTX-50, FMB-VTX-21, FMB-VRX-20, FMB-VRX-50)**	
A	Closed (On)	A	Open
B	Open	B	Closed
C	Closed	C	Open
D	Open	D	Closed
E	Open	E	Open
F	Closed	F	Closed
G	Open	G	Closed
H	Closed	H	Open

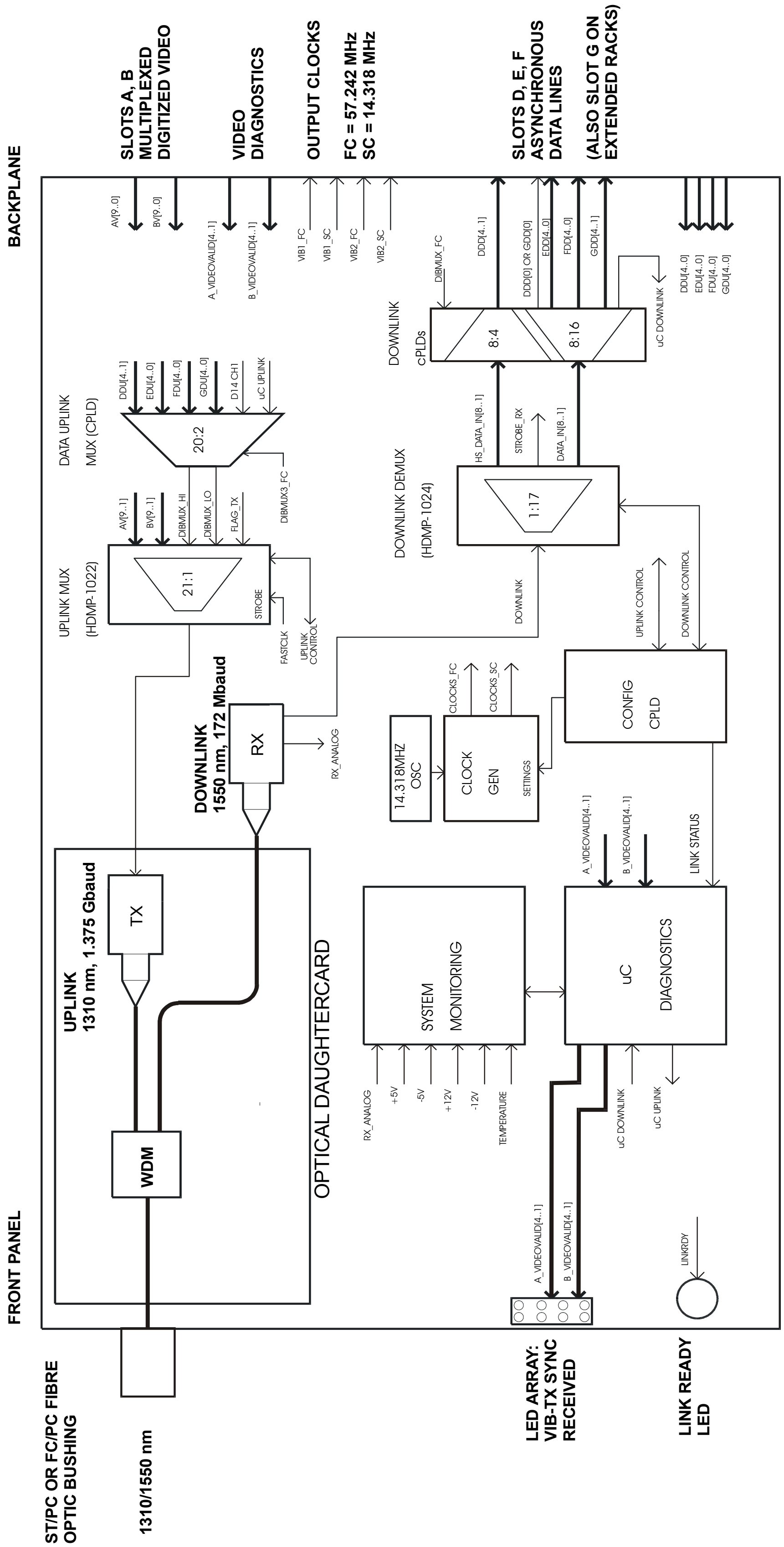


Figure 3.1-2: FMB-VTX-00/01 Block Diagram (Remote FMB with Single Fiber)

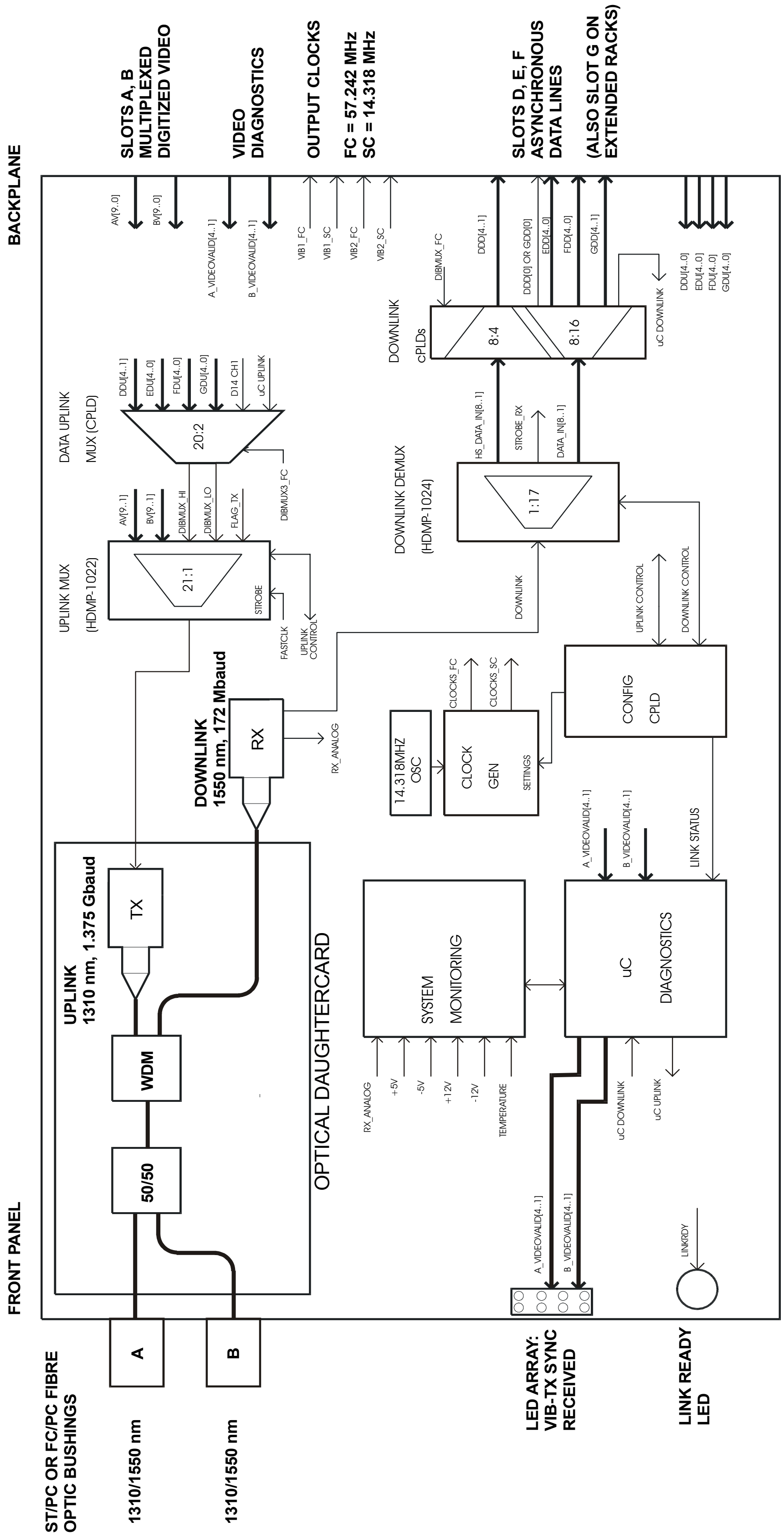


Figure 3.1-3: FMB-VTX-01-DF Block Diagram (Remote FMB with Dual Fiber Option)

3.2 FMB-VRX - Console Fiber Multiplexer Board

The console version of the fiber multiplexer board (FMB-VRX) performs the complementary functions to the remote version: the 1.375 Gbaud or 687 Mbaud uplink is demultiplexed into video and data channels while data inputs at the console are multiplexed on the 172 Mbaud downlink. As with the remote FMB, the WDM and opto-electronic components are mounted internally on the board, thus requiring only one fiber connection to be made at each end of the system.

Front panels are shown in Figure 3.2-1 for a single fiber FMB (FMB-VRX-00, FMB-VRX-20, FMB-VRX-50) and an FMB with the dual fiber option (FMB-VRX-00-DF, FMB-VRX-20-DF). A green LED labeled "Link" or "Link Ready" turns on when the optical data uplink (1310 nm) has been established. Two banks of four green LEDs, marked VIB-A and VIB-B, indicate the presence of sync on the video channels, where VIB-B corresponds to the video card nearest the FMB. Each LED is lit only if a sync pulse is detected on the corresponding video channel. Standard PAL or NTSC signals will turn on the sync LEDs, whereas chroma and other component video signals (R, B of RGB) without sync pulses will not.

Each console FMB includes an isolated serial interface to transmit data to the diagnostics software via a DB-9F connector on the front panel. A straight-through-wired serial cable is provided to connect the FMB to the PC. Details on the software are located in Appendix C. Figure 3.2-2 shows the diagnostics serial port schematic.

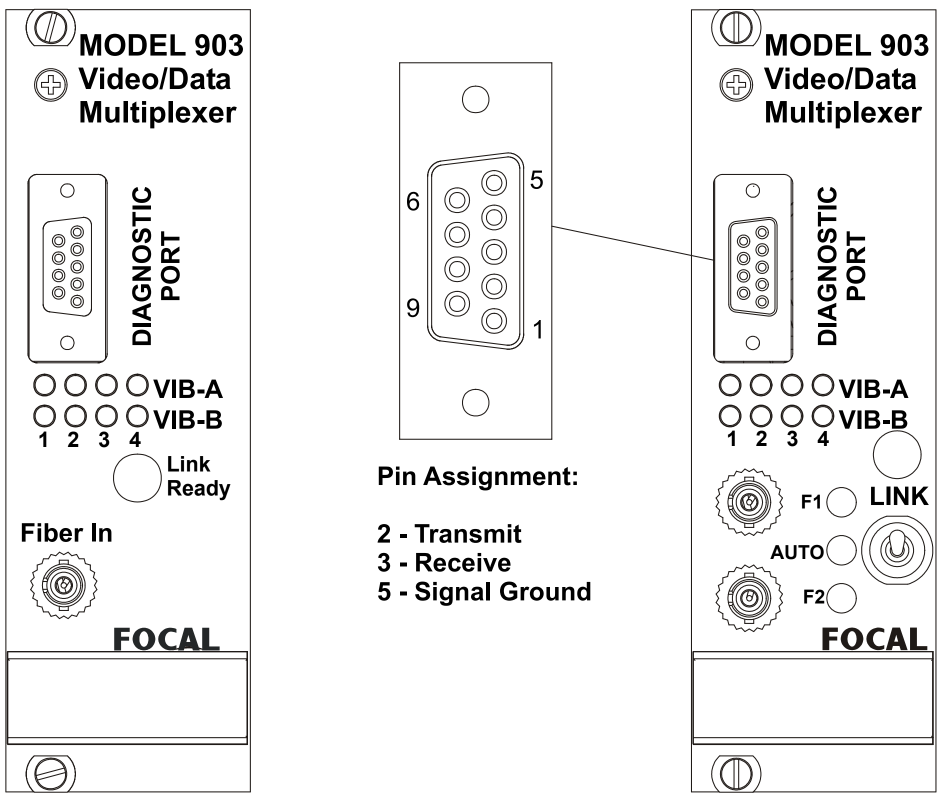


Figure 3.2-1: Console Module FMB Front Panels (-DF version on right)

Units provided with automatic fiber switching (FMB-VRX-00-DF, FMB-VRX-20-DF) allow operation over dual fibers for redundancy. As shown in Figure 3.2-1, the FMB-VRX-00-DF front panel has two bushings for the fibers plus a manual over-ride toggle switch and status LEDs (F1, AUTO, F2).

The fiber toggle switch allows manual switching to either fiber F1 or fiber F2 by flipping the switch up or down to the corresponding fiber. When the switch is set to the center position, the fiber switch will automatically select one of the fibers, as indicated by the F1 or F2 LED. The AUTO LED is lit only when the system is in automatic switching mode. The F1 or F2 LED is lit when that specific fiber is active, whether in automatic or manual mode. (The F1 fiber is the top bushing.)

When the FMB-VRX is initially powered up in automatic switching mode, the system tests the received 1310 nm power on F1 and F2 and chooses the fiber with the higher value. The system will stay locked on the chosen fiber until 3 consecutive frame errors are received. When this error condition occurs, the system will automatically switch to the other fiber. Other types of conditions may be programmed into the microcontroller per consultation with Focal. When in automatic switching mode, the switch may also be controlled from the diagnostics software, as discussed in Appendix C.

Block diagrams of the FMB-VRX-00 and FMB-VRX-00-DF are shown in Figures 3.2-3 and 3.2-4 respectively. Configurations for the FMB-VRX-20, FMB-VRX-20-DF, and FMB-VRX-50 are similar.

When high power FMB-VTX cards are used in the remote module, such as FMB-VTX-01 and FMB-VTX-21, a minimum optical attenuation is required between the remote and console modules to ensure the high sensitivity uplink receiver is not overloaded or damaged. Maximum mean optical power into the FMB-VRX bushing should never exceed -8 dBm. A 10 dB attenuator, supplied with the system, should be used during bench testing.

Settings for FMB video configuration and uplink data rate are given in Section 3.1. Newer revision FMB-VRX cards (revision 4 or later) include switch and resistor settings to allow conversion between high-speed uplink and medium speed uplink systems. Settings are shown in Table 3.2-1 below. These settings should normally be changed at the factory.

Table 3.2-1: Configuration Settings for FMB-VRX Uplink Data Rate

FMB-VRX SET UP	SWITCH AND RESISTOR CONFIGURATION					
	SW2:A	SW2:B	SW3:A	SW3:B	R2	R5
High-speed Uplink	CLOSED	OPEN	CLOSED	OPEN	0 R	OPEN
Medium Speed Uplink	OPEN	CLOSED	OPEN	CLOSED	OPEN	0 R

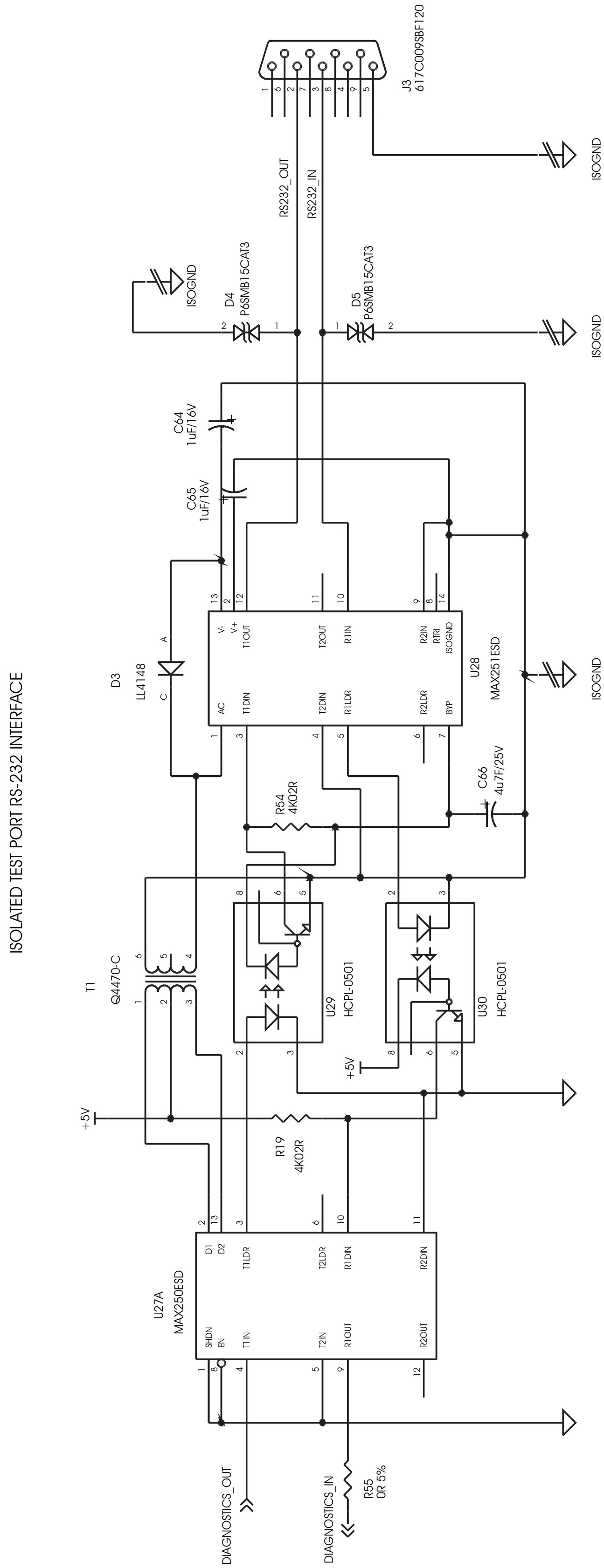


Figure 3.2-2: Diagnostics Port Interface Circuit

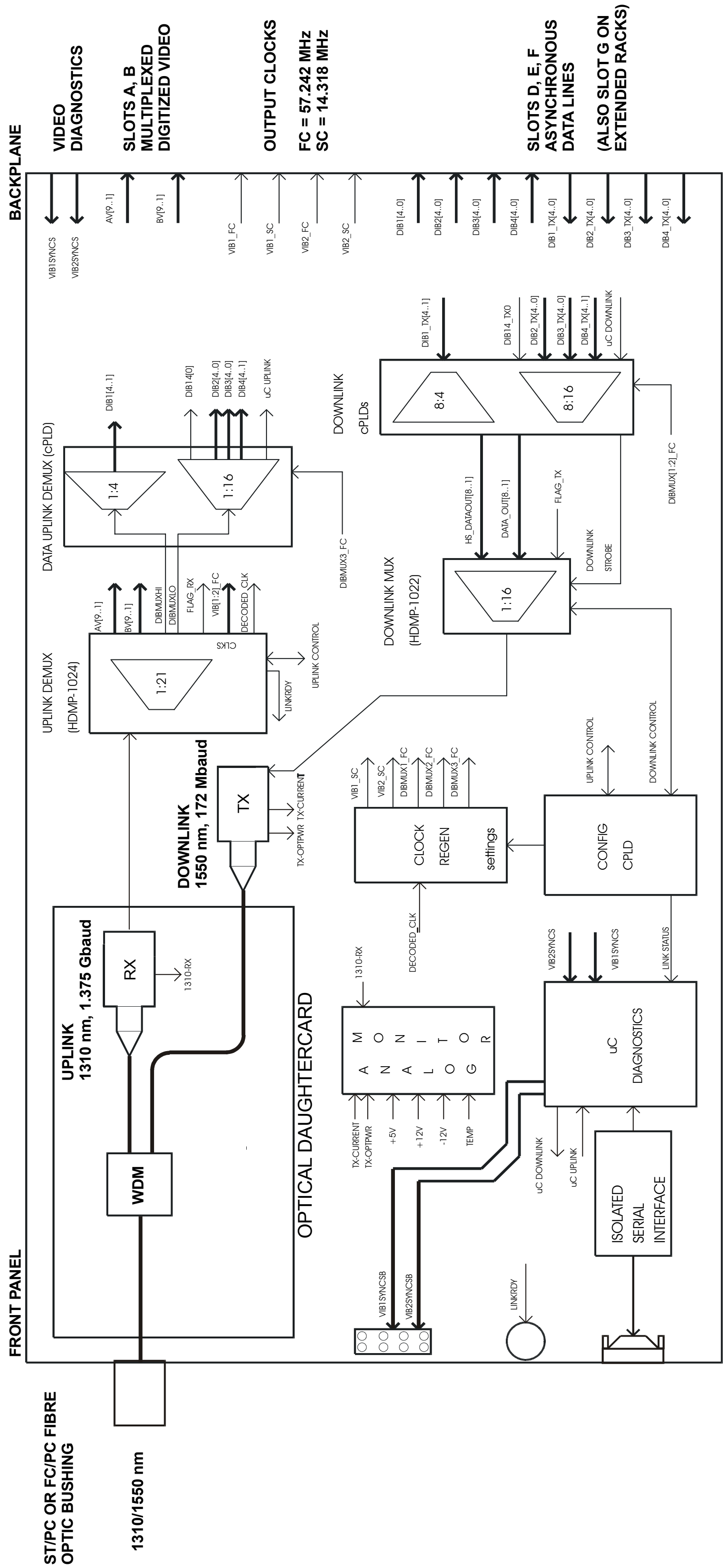


Figure 3.2-3: FMB-VRX-00 Block Diagram (Console FMB with Single Fiber)

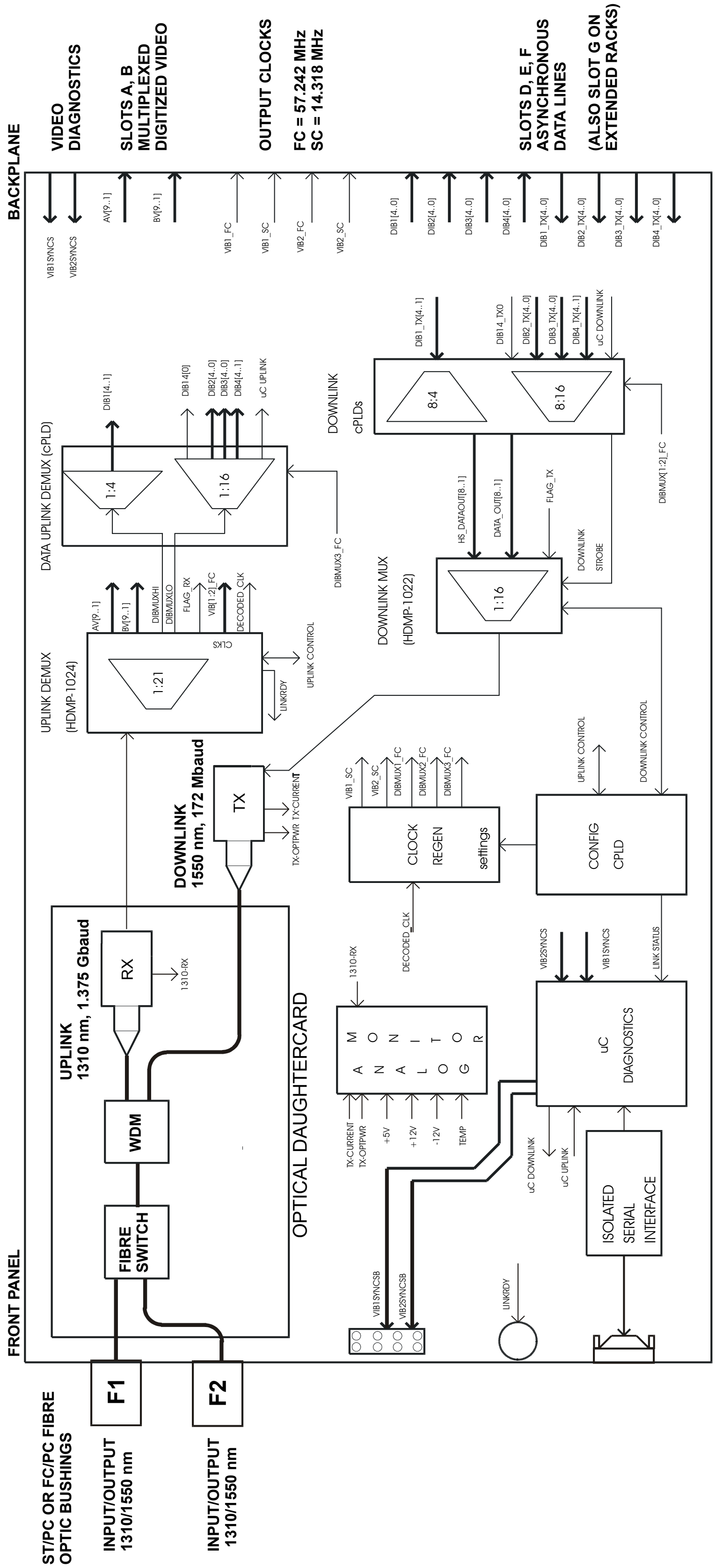


Figure 3.2-4: FMB-VRX-00-DF Block Diagram (Console FMB with Fiber Switching)

3.3 Backplanes

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

Standard rack descriptions are given in Table 3.3-1 below. The three digits following the CBP- designator represent the number of video, data, and PSU slots respectively. An "H" in the suffix indicates a high-speed backplane whereas an "M" in the suffix indicates a medium speed backplane. High-speed backplanes require high-speed FMBs and generally support 8 simultaneous video channels. Medium speed backplanes require medium speed FMBs and generally support 4 simultaneous or 8 switched video channels. An "R" in the suffix indicates the remote rack and a "C" in the suffix indicates the console rack, which is generally 6 HP wider to accommodate a front panel power switch. Custom rack sizes are also available. Remote racks that do not have a PSU slot have a DC-DC converter mounted on the back cover plate.

Table 3.3-1: Standard Racks and Backplanes

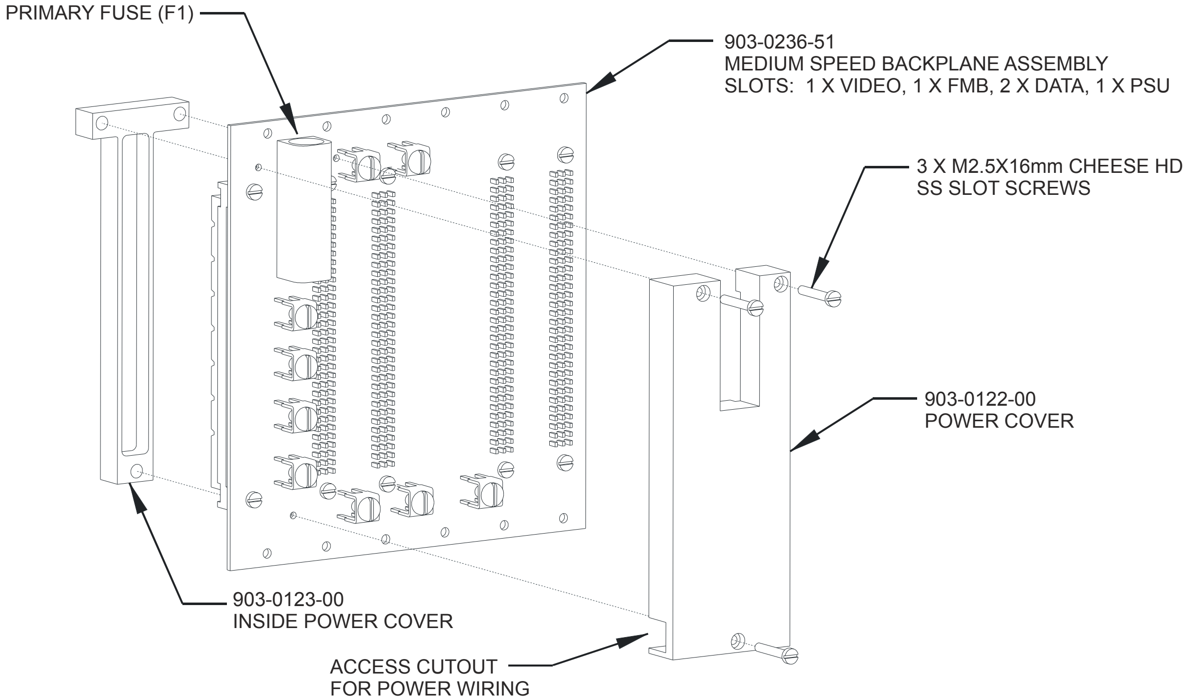
Rack Type	FMB Speed	Video Slots	Data Slots	PSU Slot	Remote Rack Width	Console Rack Width
CBP-241-HR/HC Extended	High	2	4	1	44 HP	50 HP
CBP-231-HR/HC Standard	High	2	3	1	36 HP	42 HP
CBP-230-HR	High	2	3	0	28 HP	42 HP
CBP-141-MR/MC	Medium	1	4	1	36 HP	42 HP
CBP-131-MR/MC	Medium	1	3	1	36 HP	42 HP
CBP-130-MR	Medium	1	3	0	28 HP	42 HP
CBP-121-MR/MC	Medium	1	2	1	26 HP	42 HP

Assembly views of the backplane PCBs for typical medium speed (CBP-121) and high-speed (CBP-241) consoles are given in Figures 3.3-1 and 3.3-2 respectively. The top 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). J20 is a programming port for the backplane PLD (medium speed backplane only); J19 is a port for the video switching harness (medium speed backplane only); J18 is a connector to the chassis fan. Rail voltages and grounds are directly accessible via screw terminals J8, J9, J10, J13, and J14 for +12 V, -12 V, +5 V, AGND (analog ground), and DGND (digital ground) respectively.

Primary power inputs are wired into screw terminals:

- J11 is not connected for AC sources and acts as ground for DC sources
- J15 is neutral for AC sources and is not connected for DC sources
- J16 is line for AC sources and +V input for DC sources
- J17 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. Nylon covers are used over the primary terminals as a safety precaution.



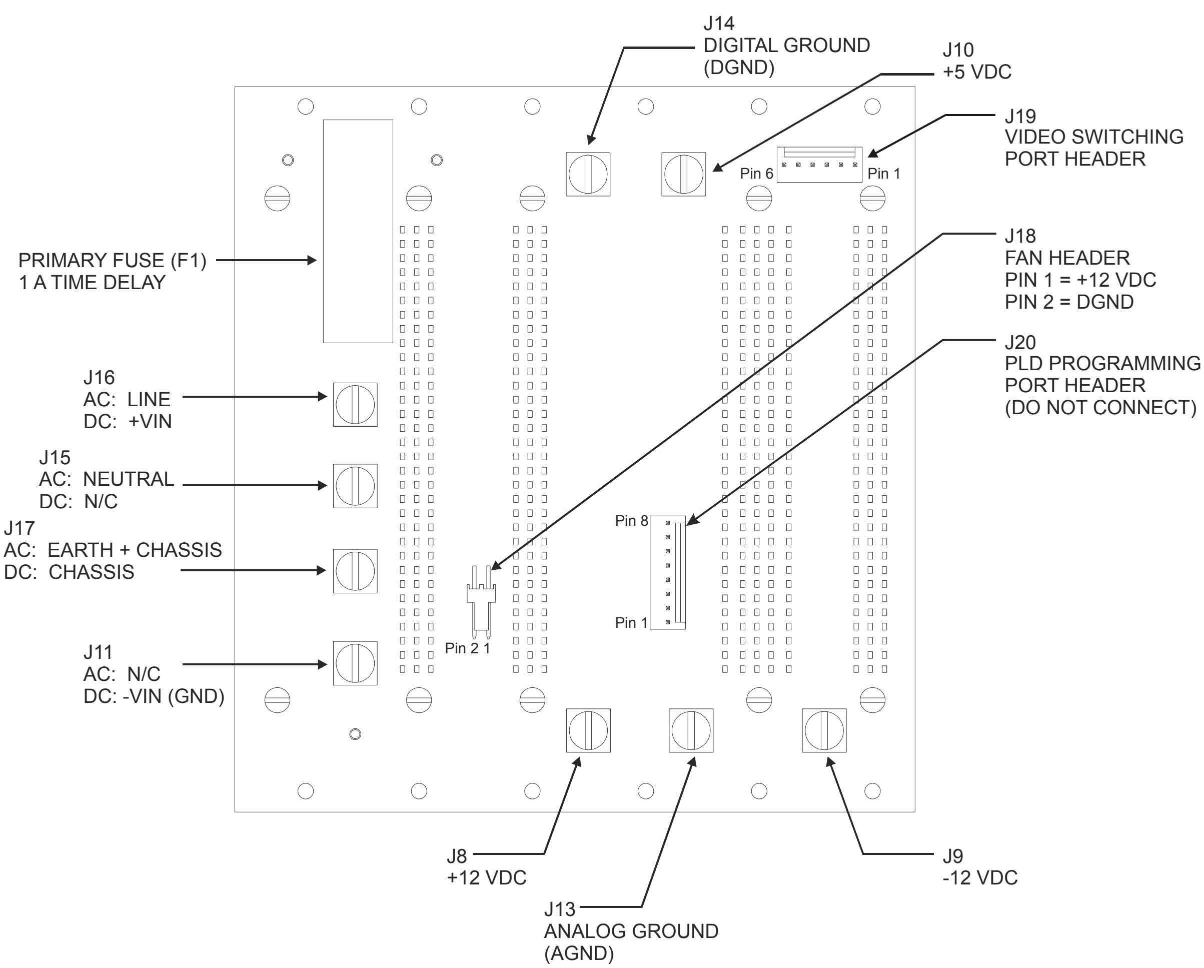


Figure 3.3-1: Medium Speed Backplane (CBP-121-MR/MC)

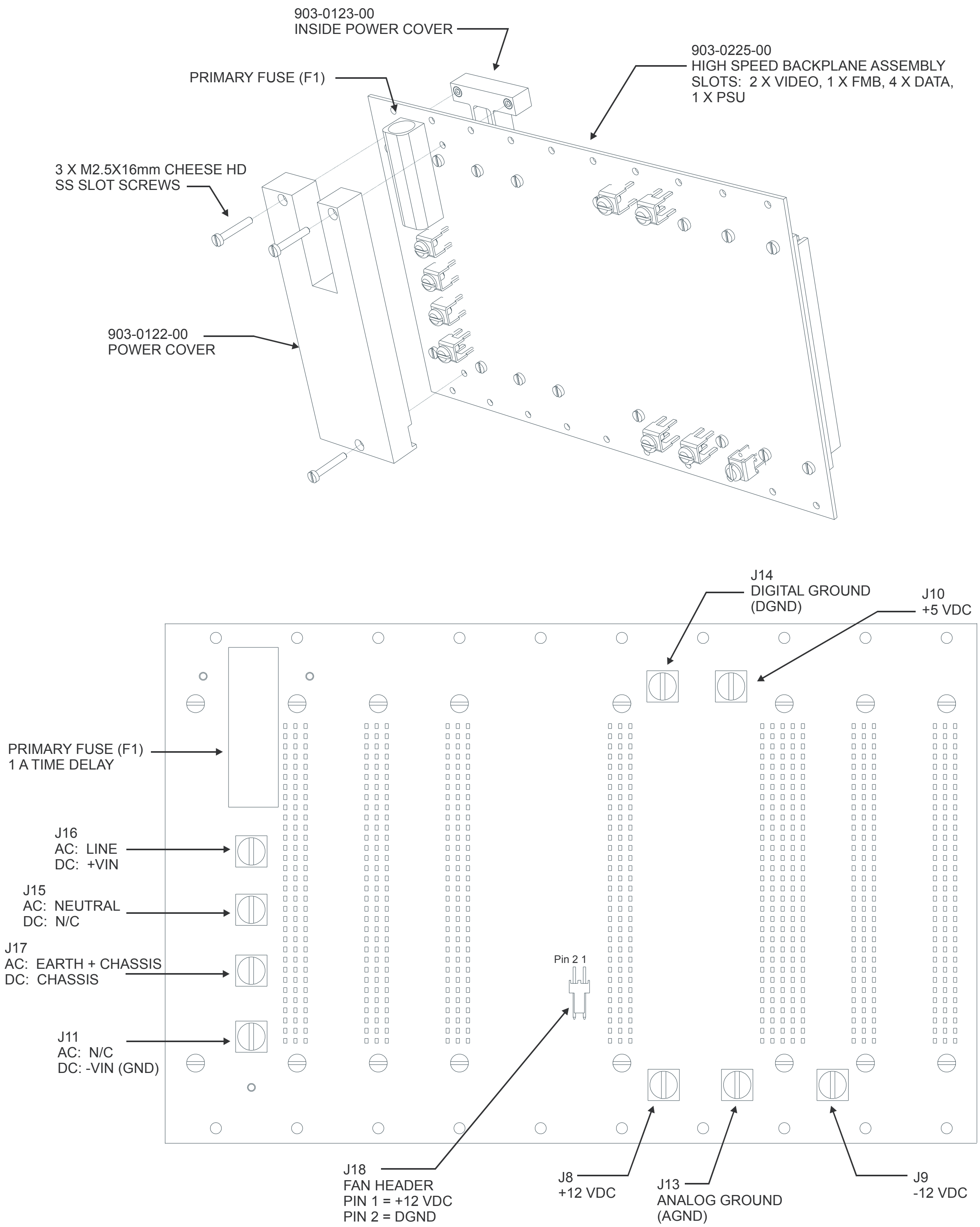


Figure 3.3-2: High-speed Backplane (CBP-241-HR/HC)

All medium speed backplanes have a switch to alter the bandwidth allocation of the FMB. As shown in Figure 3.3-3 below, switch SW1 is located on the inside of the backplane. (Location near the FMB slot is common to all medium speed backplanes.) The backplane may be set to either support 8-bit video and a high-speed data slot (required for EIB-10BT Ethernet card and others) or support 9-bit video with all standard speed data slots, per the silkscreen chart on the PCB. The 8-bit video configuration is the usual default unless a high-speed data card, such as Ethernet, is required. Switch configurations must match on the remote and console backplanes.

Medium speed backplanes include additional switches S2, S3, S4, and S5, which must all be configured per the silkscreen chart in Figure 3.3-3 to support switched video (SW VIDEO) — using the fourth data slot channels — or standard video (ST VIDEO). These switches are located between the FMB and VIB slot on the inside of the CBP-131 and CBP-141 backplanes. The CBP-121 backplane uses fixed resistors rather than switches, where R8, R11, R12, and R14 must be set to 0R with R9, R10, R13, and R15 left open for switched video operation; standard video operation uses reverse settings (R8 = open, R9 = 0R, etc.). These resistors are located on the outside of the backplane between FMB and VIB slots.

On medium speed console backplanes, header J19 provides access to the video switching lines. Usually J19 is connected via a harness to a front panel with four A-B toggle switches or connected with an external harness for remote switching control. Pin out is pin 1 = channel 1 A/B, pin 2 = channel 2 A/B, pin 3 = +5V, pin 4 = ground, pin 5 = channel 3 A/B, pin 6 = channel 4 A/B. Shorting a given channel select pin to the ground pin selects signal input B, and shorting the channel select pin to the +5V pin selects signal input A. Since the video switching information is transmitted to the remote module on data lines, the CBP-141 backplane's fourth data slot can only be used with optical interface cards (ECL-01, ECL-02, EIB-10/100) when video switching is used.

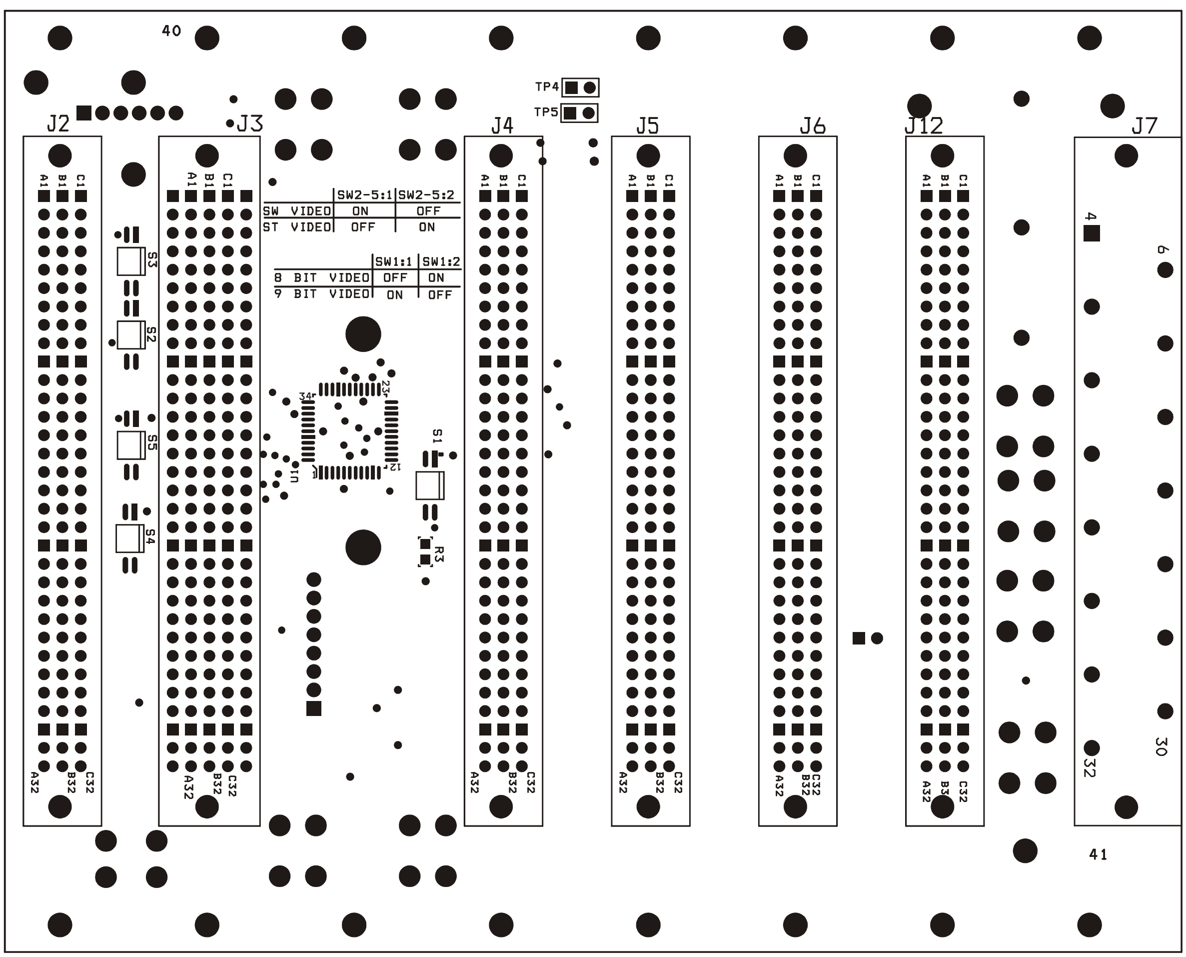


Figure 3.3-3: Medium Speed Backplane Bandwidth Allocation Switches

3.4 Power Supply

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

AC Module:	120 VAC, 50/60 Hz (standard for North America)
	230 VAC, 50/60 Hz (standard for Europe)
24 VDC Module:	Input range 18-36 VDC
48 VDC Module:	Input range 36-60 VDC

The AC power supply module has an internal switch to enable operation at either 230 VAC or 120 VAC. Standard DC power supply modules are available with 24 VDC or 48 VDC input. For other ranges, please contact Focal. Current draw from the primary 120 VAC for a typical high-speed console module is approximately 0.3 A. See Appendix E for fuse details.

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

All standard Eurocassette power supplies provide full transformer isolation between the primary input and the backplane rail outputs. If AC input power is used, the protective earth lead on the power cable is connected through the Eurocassette frame to the rack of the multiplexer, which is normally isolated from internal digital and analog ground. If DC input power is used, the console module frame is floating. It may be connected to a ground reference with a short strap between the Earth terminal (J17) and the desired reference.

Some remote modules use DC-DC converters mounted on the back cover of the rack to reduce the overall width of the rack. See Appendix B for details in the installation drawings.

4.0 Interface Cards

Interface cards consist of three basic types:

Video - Video signals are unidirectional. There are video input cards for the remote module and video output cards for the console module. The remote video cards are not interchangeable with the console video cards.

Data - Data cards are typically bidirectional, with some exceptions. Most data cards are interchangeable between the remote and console module. Some data cards can only be used in the high-speed data slot; others run at higher data rates when used in the high-speed data slot, but may also be installed in the standard speed data slots.

Optical - Optical 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, digital video, 100 Mbps Ethernet, and high-speed ECL/PECL data links. Optical interface cards can 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 VIB-TX Video Input Board (Remote)

Video signals are unidirectional and must originate at the remote module end. Video channel settings at the console end of the system must be jumper configured to match the remote module channels.

4.1.1 Input

Each VIB-TX video input card accepts four standard NTSC or PAL composite video signals (1Vpp nominal, 75 ohms) or other types of video signals brought in through the front panel SMB connectors shown in Figure 4.1-1 below. Channel 4 may be configured for non-video signals. An optional VIB-TX-8 card is also available which allows 8 video signals to be transmitted over 4 channels. Switches at the console end of the system select either camera A or B for each transmitted channel. VIB-TX-8 has very similar input circuits to the VIB-TX, except with an 8-to-4 video mux IC at the front end. Video sync status is unavailable at the remote module when the VIB-TX-8 card is used, but the sync status at the receiving VIB-RX is still available. Typically, the VIB-TX-8 card is used only with medium speed systems.

All video inputs are protected by 250 mA fuses and voltage suppression diodes per the input schematic, Figure 4.1-2. The digitizers take samples at a fixed frequency of 14.318 MHz with 10 bits of resolution to achieve video transmission quality exceeding EIA-250C end-to-end specifications. The FMB may be configured to transmit 8-10 bits, depending on bandwidth configuration. Default configuration is for 9-bit video transmission on both video slots.

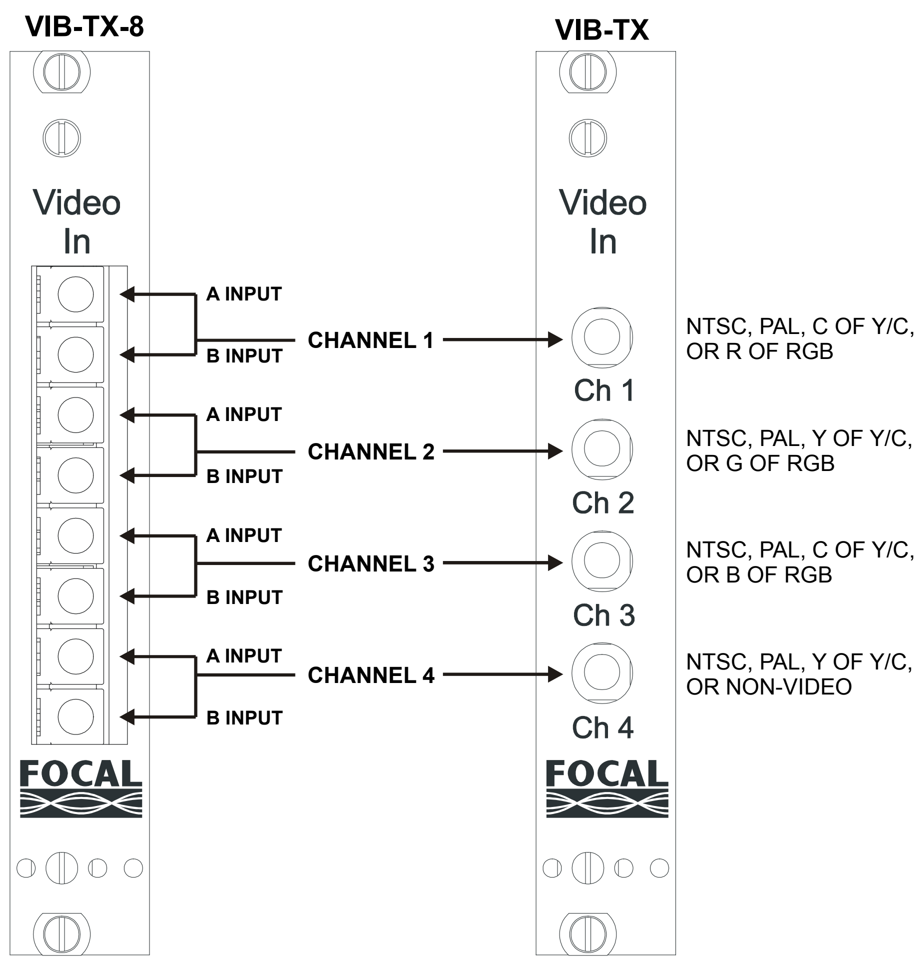


Figure 4.1-1: Remote Video Interface Board (VIB-TX) Front Panel

4.1.2 Configuration/Settings

The default configuration for all four video channels is composite video. There are several other possible configurations:

1. Channels 1 and 2 and/or 3 and 4 may be configured for Y/C video.
2. Channels 1, 2, and 3 may be configured for RGB video, with sync on G.
3. Channel 4 may be configured for generic non-video signals.

Table 4.1-1 describes locations of shorting terminals (shunts) for configuring the video input formats and input impedances of channels 1-3. Refer to the signal configuration drawing in Appendix B for as-built channel settings.

Table 4.1-1: Video Input Configuration Jumpers (Channels 1-3)

Channel 1 Input Format	JP1	JP13
Composite	2-3	2-3
C of Y/C (Channel 2 = Y)	1-2	1-2
R of RGB	1-2	2-3

Channel 1 Input Impedance	JP2
75 Ohm (default)	2-3
150 Ohm	1-2
High Impedance	Open

Channel 2 Input Format	
Composite	No jumper setting changes required
Y of Y/C (Channel 1 = C)	
G of RGB	

Channel 2 Input Impedance	JP3
75 Ohm (default)	2-3
150 Ohm	1-2
High Impedance	Open

Channel 3 Input Format	JP6	JP12
Composite	2-3	2-3
C of Y/C (Channel 4 = Y)	1-2	1-2
B of RGB	JP6:2-JP7:1	2-3

Channel 3 Input Impedance	JP4
75 Ohm (default)	2-3
150 Ohm	1-2
High Impedance	Open

Table 4.1-2 gives channel 4 jumper configurations, including non-video signals. Non-video signals can be high-speed TTL data, analog signals, and various types of sonar signals, such as the KSML SM2000 (use < 1.4 VAC setting). The full 6 MHz bandwidth of the video channel is available. Blank entries indicate the jumper setting does not matter for the selected format.

Table 4.1-2: Channel 4 Input Configuration Jumpers

Channel 4 Input Format	JP8	JP9	JP10	JP11	JP14	JP15	JP16	JP19
Composite	1-2	2-3						2-3
Y of Y/C (Channel 3 = C)	1-2	2-3						2-3
Non-Video: < 1.4 VAC	2-3	1-2	Open	Open	1-2	Open	Open	2-3
Non-Video: 0-5 VDC	2-3	1-2	1-2	1-2	2-3	1-2	Open	2-3
Non-Video: -2.5 to +2.5 VDC	2-3	1-2	1-2	1-2	2-3	Open	1-2	2-3

Table 4.1-3 shows input impedance settings for Channel 4. When channel 4 is used for non-video signals the input impedance must be set appropriately for the incoming non-video signal.

Note that JP17 is a spare shunt holder and is not connected to any circuit. JP20, JP21, and JP22 are also unconnected and may be used for storing spare or unused shunts.

Figure 4.1-3 is a PCB view of the VIB-TX card, with jumper locations shown; Figure 4.1-4 is a PCB view of the VIB-TX-8 card. Figure 4.1-5 is a block diagram of the VIB-TX board.

Table 4.1-3: Channel 4 Input Impedance Jumpers

Channel 4 Input Impedance	JP5
75 Ohm (default)	2-3
150 Ohm	1-2
High Impedance	Open

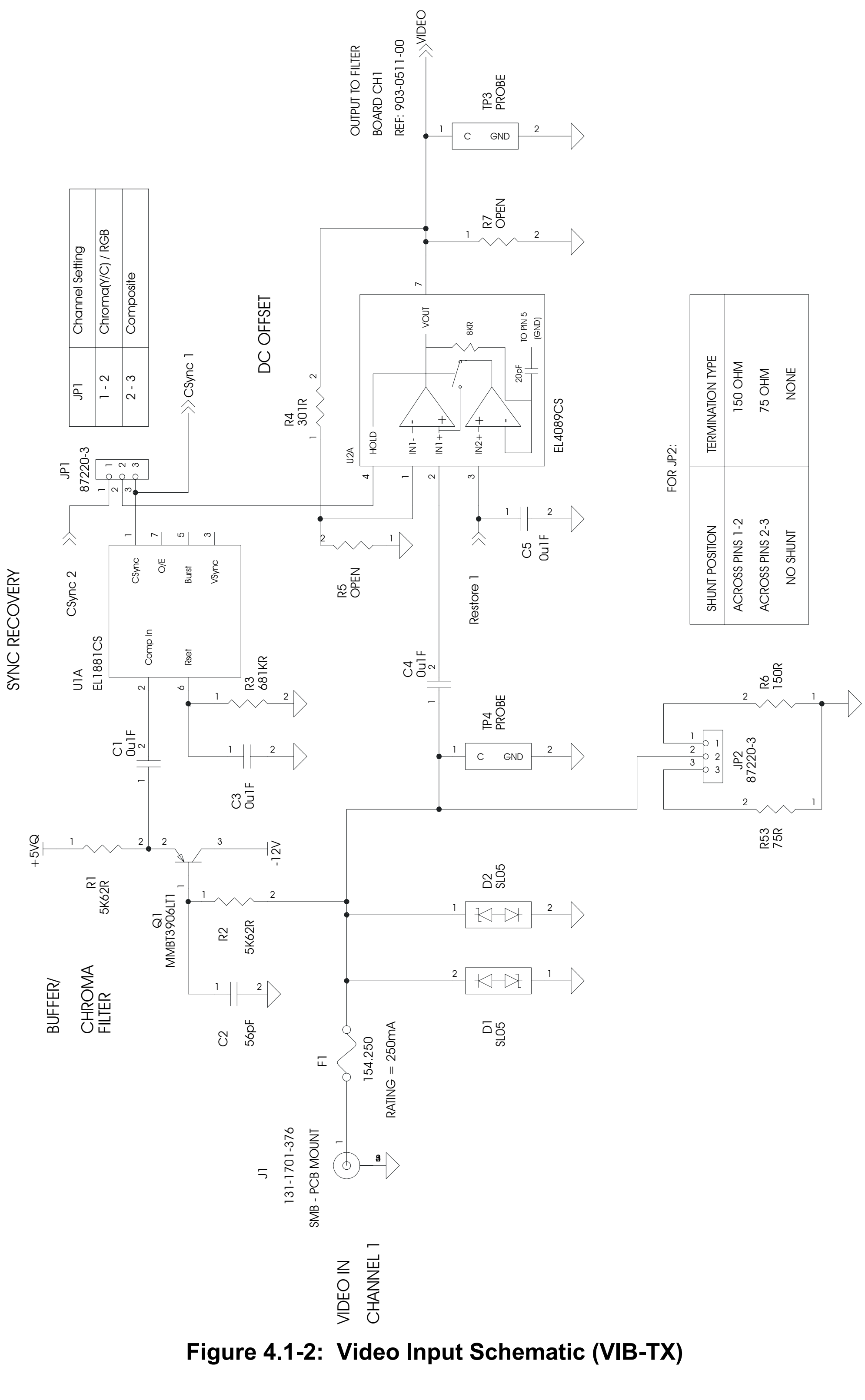


Figure 4.1-2: Video Input Schematic (VIB-TX)

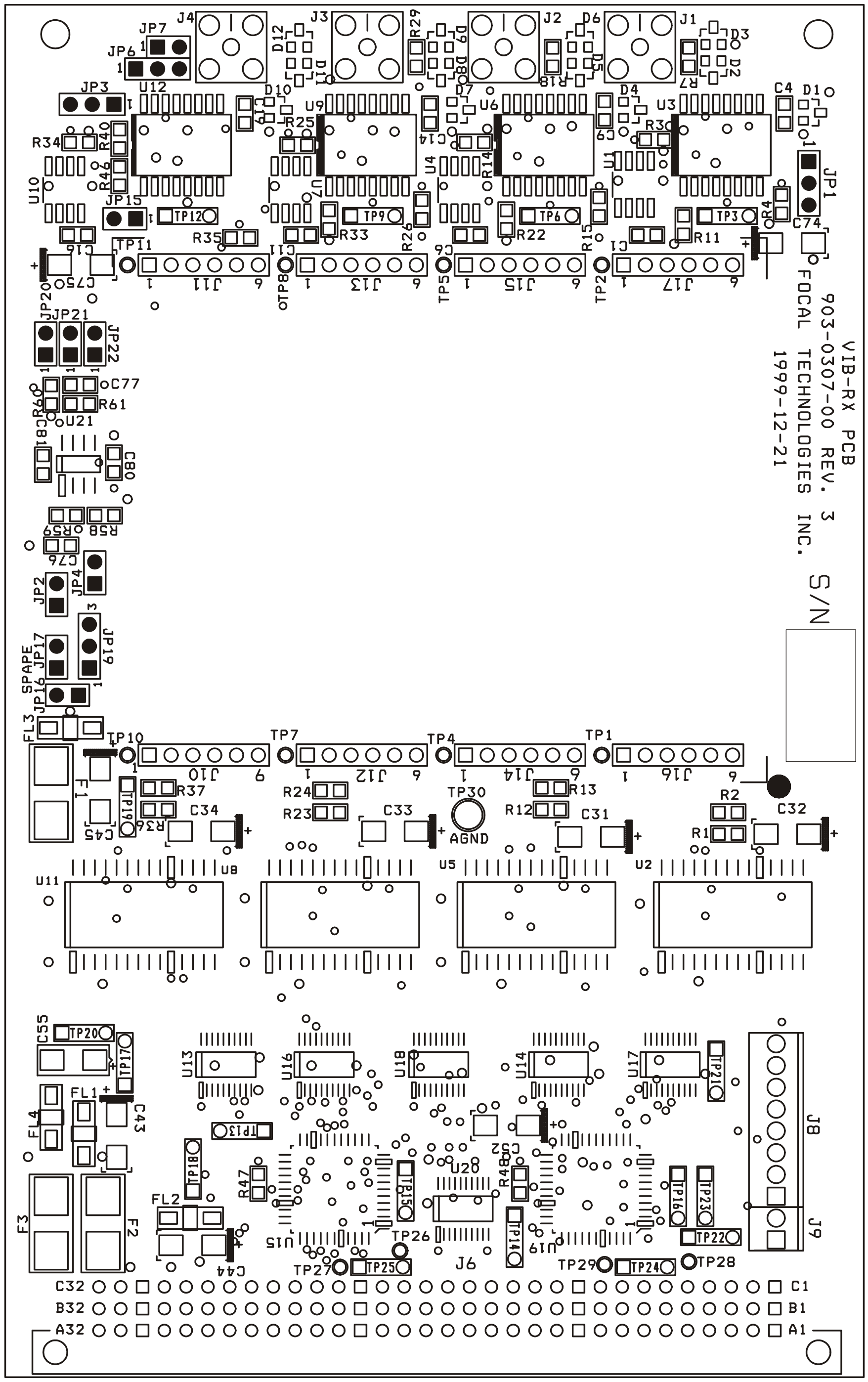


Figure 4.1-3: VIB-TX PCBA

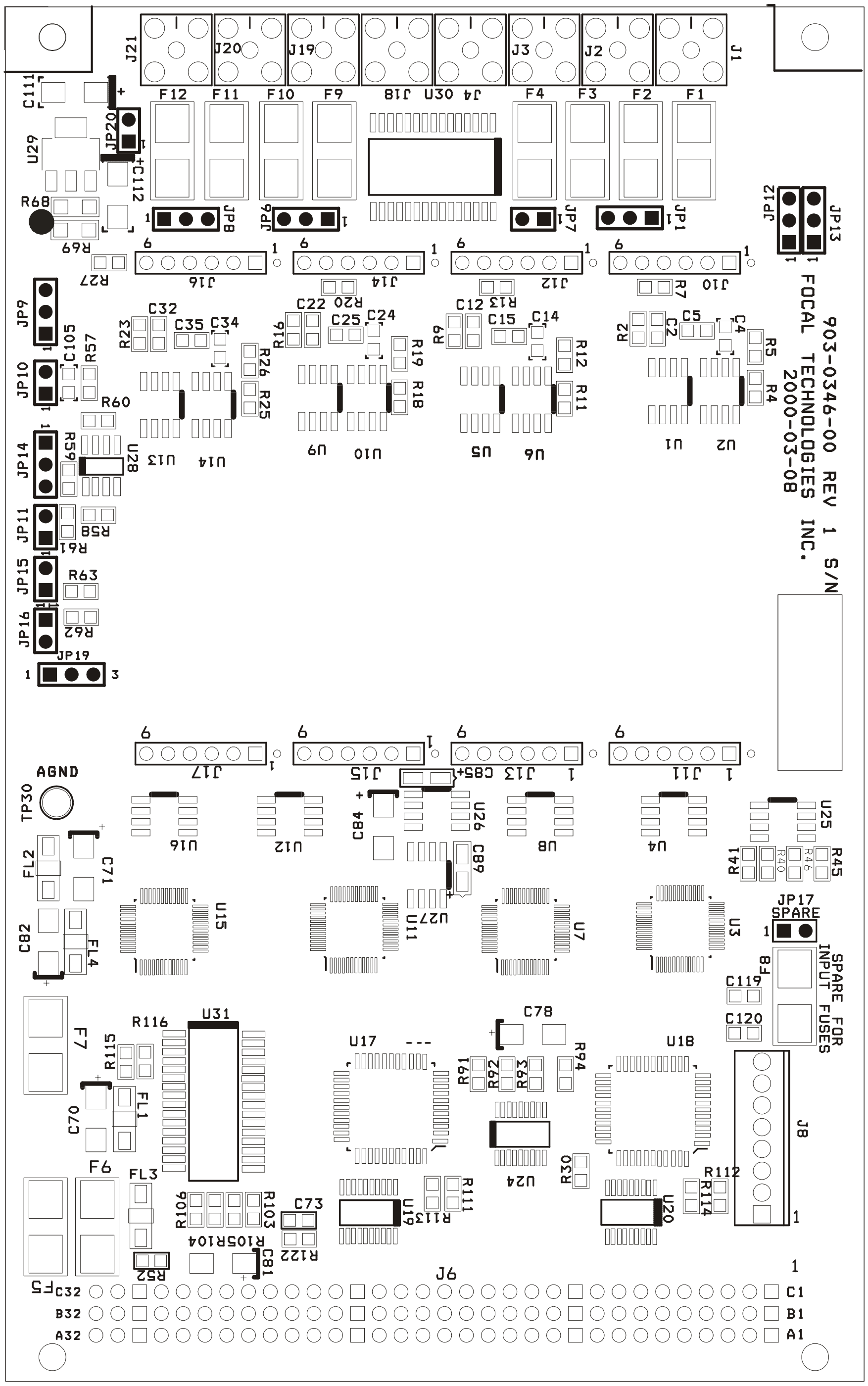


Figure 4.1-4: VIB-TX-8 PCBA

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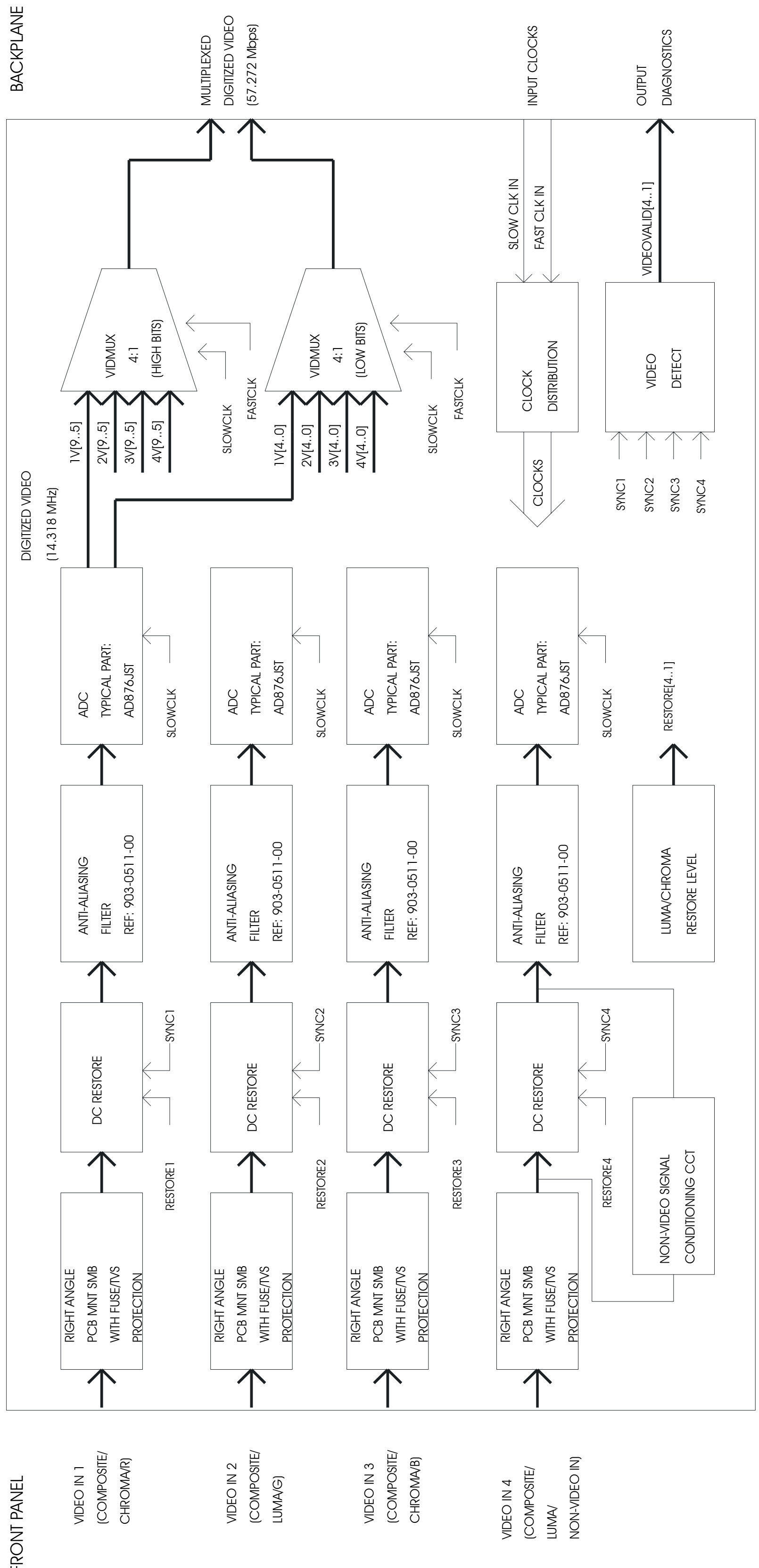


Figure 4.1-5: VIB-TX Block Diagram

4.2 VIB-RX Video Output Board (Console)

The video output card (VIB-RX) performs the complementary function of the video input card (VIB-TX). Video output channels must be jumper configured to match the format of the corresponding channels at the input.

4.2.1 Output

Each VIB-RX video output card transmits four standard NTSC or PAL composite video signals (1V_{pp} nominal, 75 ohms) or other types of video signals through the front panel SMB connectors shown in Figure 4.2-1 below. Channel 4 may be configured for non-video signals. An optional VIB-RX-VS card is available to select video input source (camera A or B) for each channel when used with the VIB-TX-8 card at the remote end of the system. Some systems provide these switch lines as a backplane header for connection to remote switches.

Digitized video is received by the fiber multiplexer and routed to the video card through the backplane. Video output card circuits convert the 8- to 10-bit samples to analog form. Each signal is then filtered, DC-restored, and transmitted out the front panel SMB connectors. Output impedance on all channels is 75 ohms. Video channels on the VIB-RX card must be configured to match the video configuration of the corresponding remote module card.

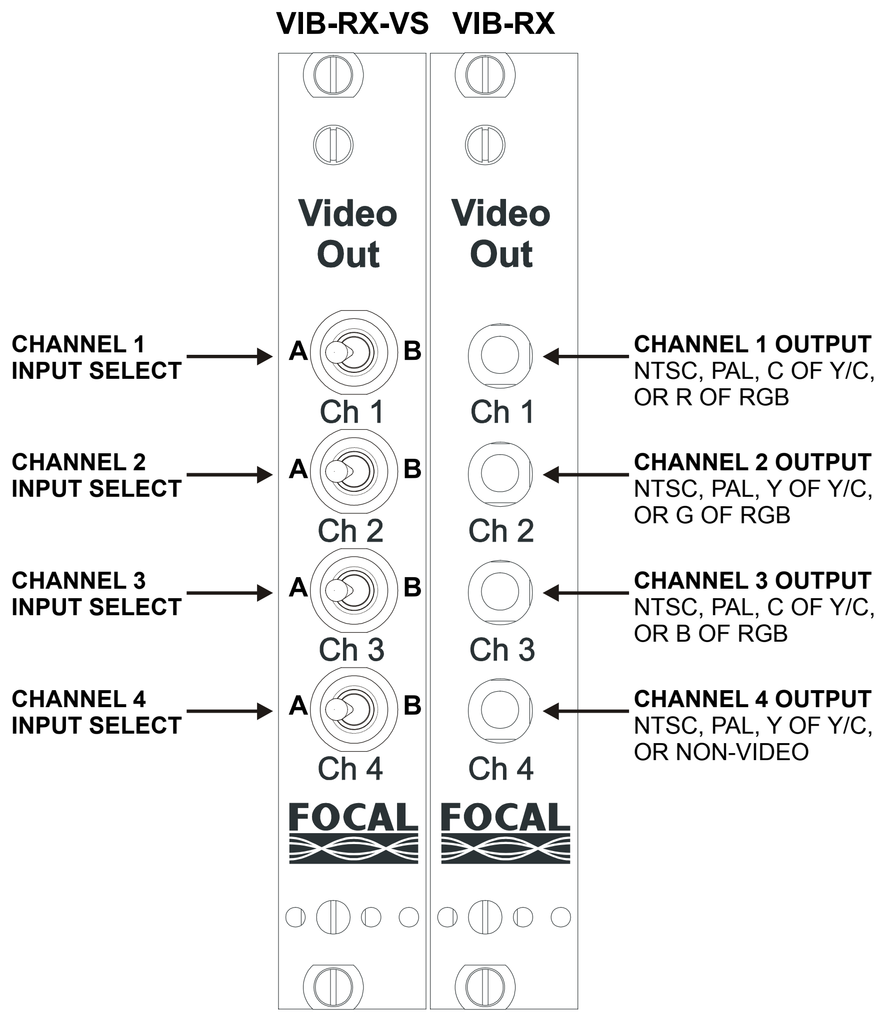


Figure 4.2-1: VIB-RX Front Panels

4.2.2 Configuration/Settings

The default configuration for all four video channels is composite video. There are several other possible configurations:

1. Channels 1 and 2 and/or 3 and 4 may be configured for Y/C video.
2. Channels 1, 2, and 3 may be configured for RGB video, with sync on G.
3. Channel 4 may be configured for generic non-video signals.

Table 4.2-1 describes locations of shorting terminals (shunts) for configuring the video output formats of channels 1-3. Refer to the signal configuration drawing in Appendix B for as-built channel settings.

Table 4.2-1: Video Output Configuration Jumpers (Channels 1-3)

Channel 1 Output Format	JP1
Composite	2-3
C of Y/C (Channel 2 = Y)	1-2
R of RGB	1-2

Channel 2 Output Format	No jumper setting changes required
Composite	
Y of Y/C (Channel 1 = C)	
G of RGB	

Channel 3 Output Format	JP6
Composite	2-3
C of Y/C (Channel 4 = Y)	1-2
B of RGB	JP6:2-JP7:1

Table 4.2-2 summarizes jumper settings for channel 4, including non-video signals. Non-video signals can be high-speed TTL data, analog signals, and various types of sonar signals, such as the KSML SM2000 (use < 1.4 VAC setting). The full 6 MHz bandwidth of the video channel is available. Blank entries indicate the jumper setting does not matter for the selected format.

Table 4.2-2: Channel 4 Output Jumper Configurations

Channel 4 Input Format	JP2	JP3	JP4	JP15	JP19
Composite		1-2		1-2	Open
Y of Y/C (Channel 3 = C)		1-2		1-2	Open
Non-Video: < 1.4 Vpp (AC)	Open	2-3	Open	Open	1-2
Non-Video: 0-5 VDC	1-2	2-3	1-2	Open	1-2
Non-Video: -2.5 to +2.5 VDC	1-2	2-3	1-2	Open	1-2

Output impedance for the non-video channel may be configured per the settings in Table 4.2-3. Default setting for composite video is 75 ohms.

Figure 4.2-2 is a schematic of the output circuit; Figure 4.2-3 is a PCB view of the VIB-RX card, with jumper locations shown. Figure 4.2-4 is a block diagram of the VIB-RX board.

Table 4.2-3: Channel 4 Output Impedance Jumpers

Channel 4 Output Impedance	JP20	JP21	JP22
Low Impedance	1-2	1-2	1-2
50 Ohms	1-2	1-2	Open
75 Ohms	1-2	Open	Open
600 Ohms	Open	1-2	1-2

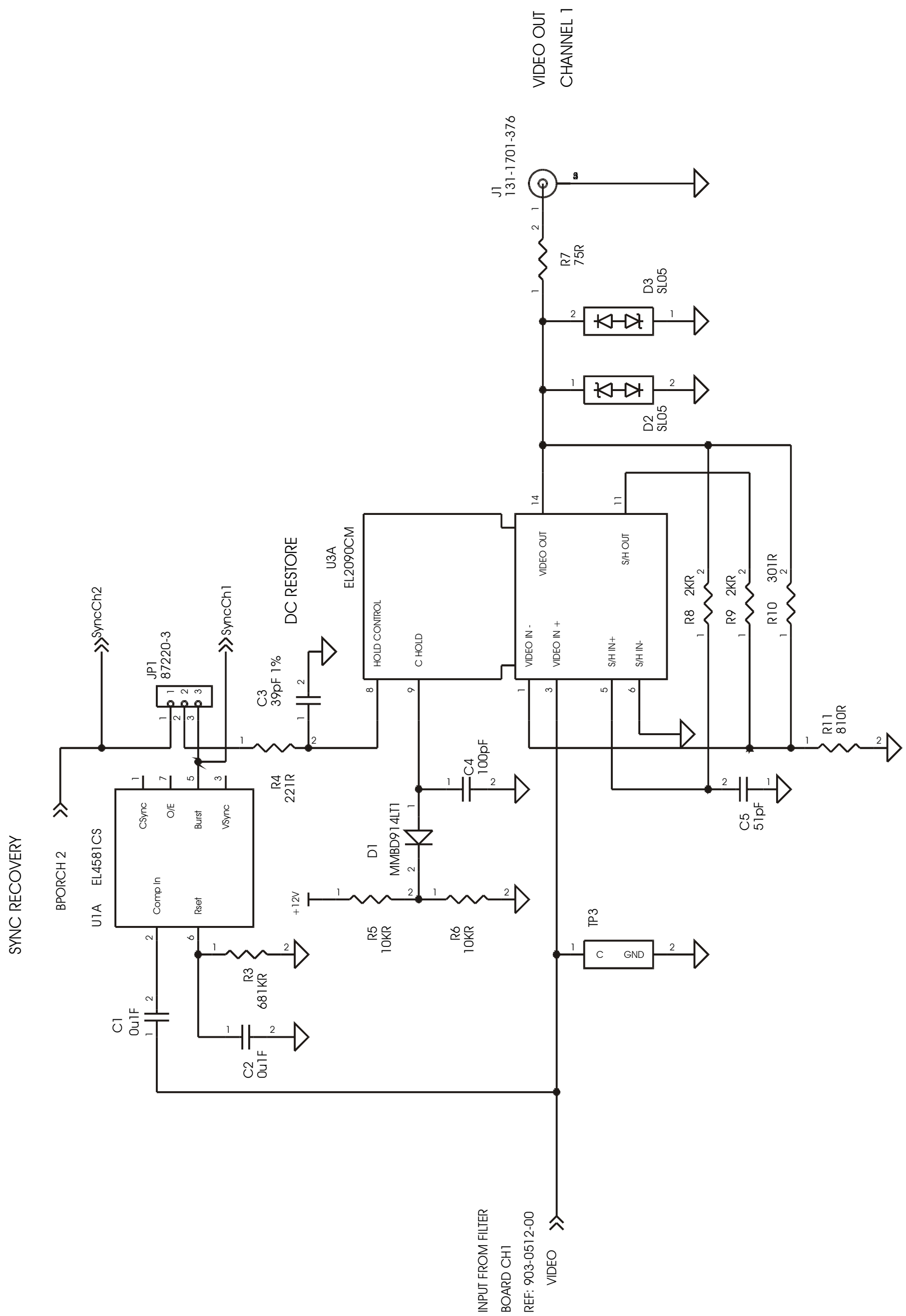


Figure 4.2-2: VIB-RX (Console) Output Schematic

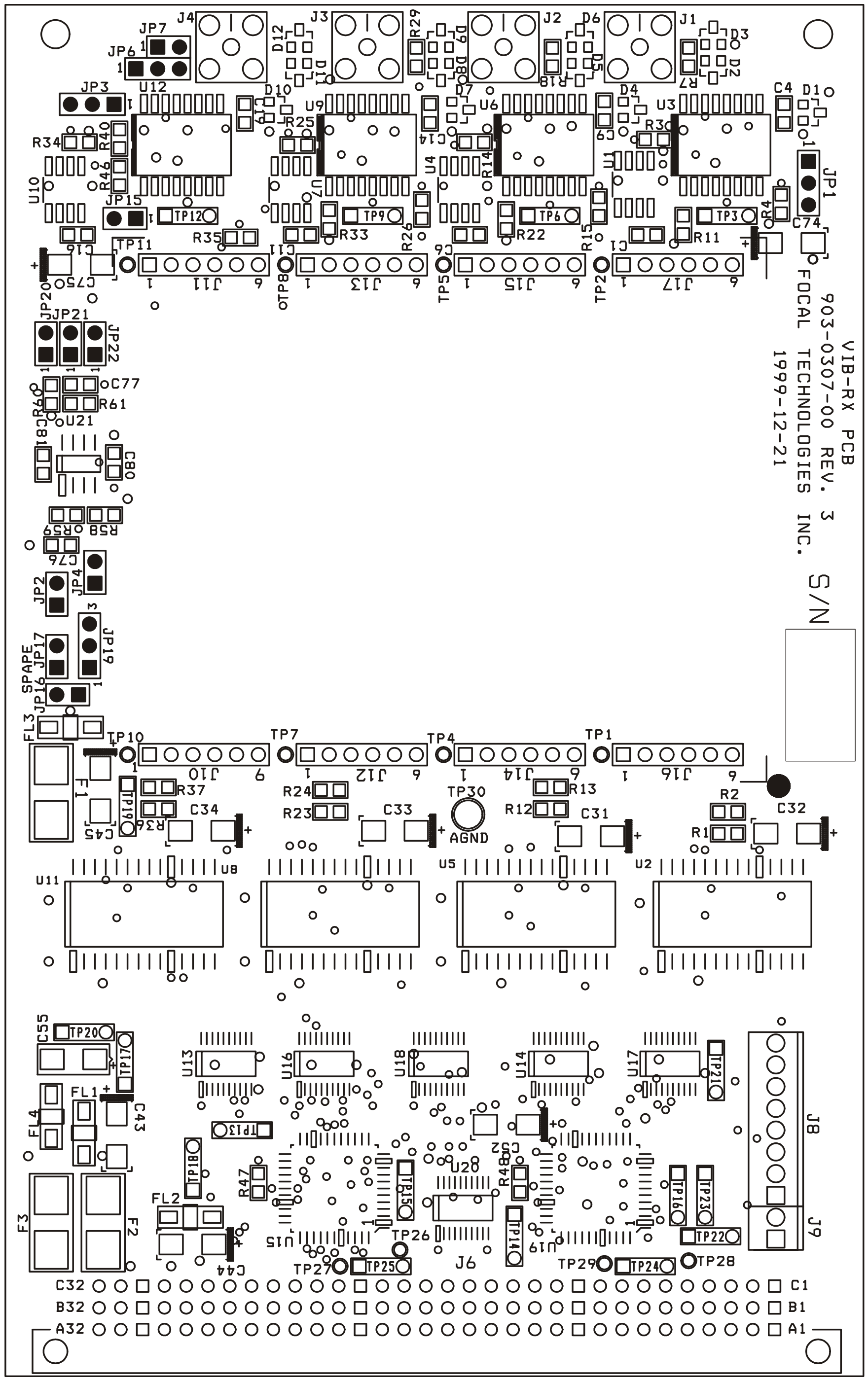


Figure 4.2-3: VIB-RX PCBA

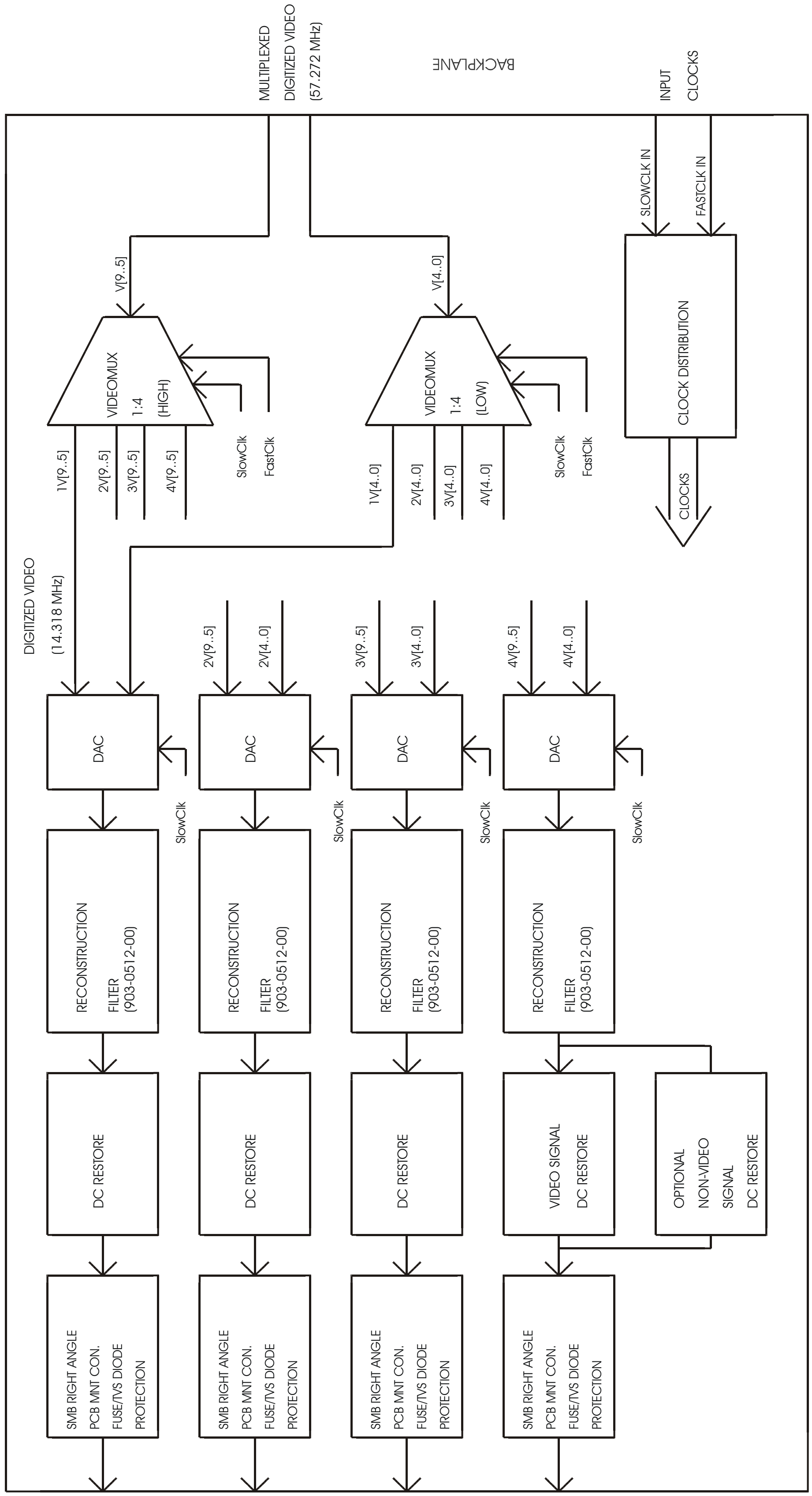


Figure 4.2-4: VIB-RX Block Diagram

4.3 DIB-232 - RS-232 Interface Board

The RS-232 Data Interface Boards (DIB-232) support bidirectional RS-232 signals. DIB-232 cards may be used at either end of the system in any available data slot, including the high-speed slot, although RS-232 signals are limited to 120 kbaud regardless of which slot type is used.

4.3.1 Input/Output

The five front panel connectors, as shown in Figure 4.3-1, are all three pin, right angle, 733 series WAGO connectors (mate: WAGO 733-103). All five channels are separately isolated and can operate to a maximum bit rate of 120 kbaud. All channels are protected by 250 mA fuses and transient voltage suppression diodes. One spare fuse is provided on the board. The black dot at the top of the front panel marks channel 1.

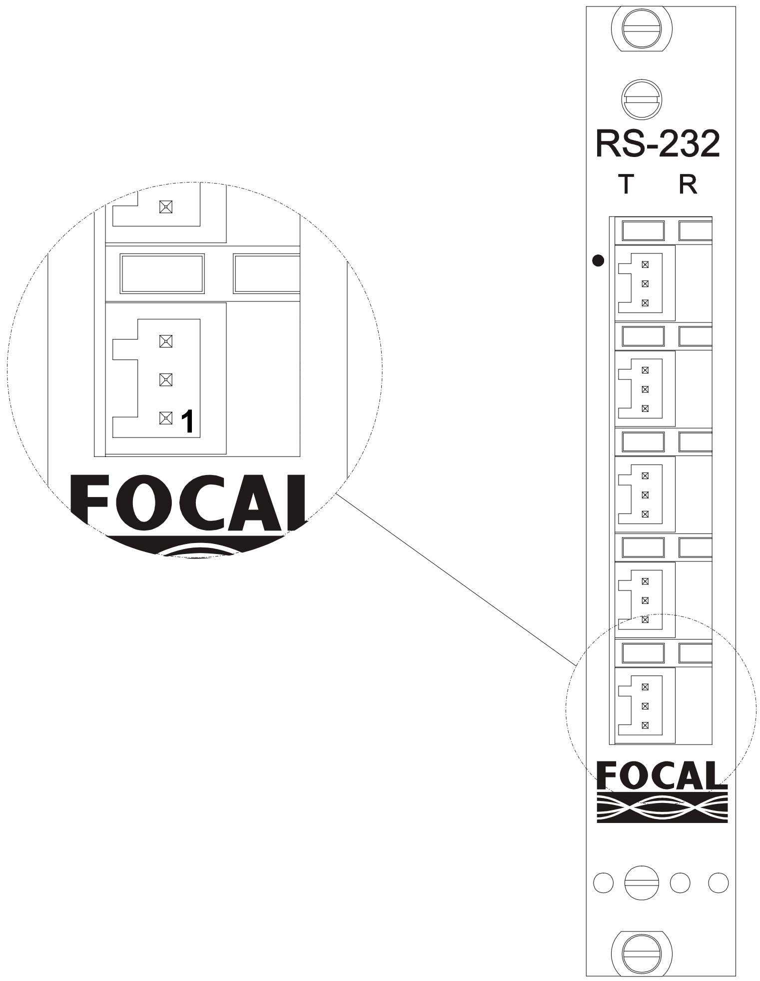


Figure 4.3-1: DIB-232 Front Panel

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

4.3.2 Configuration/Settings

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

The pin-out convention for the WAGO connectors (733-103) used for each RS-232 channel is shown in Figure 4.3-2. The WAGO connectors should be used with wire gauges 20 - 28 AWG at a maximum current of 0.25A. Pin designations are given in Table 4.3-1.

A view of the DIB-232 PCB is given in Figure 4.3-3.

Figure 4.3-2: RS-232 3-Pin WAGO Connector

Table 4.3-1: Pin Designations for DIB-232 Connectors

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

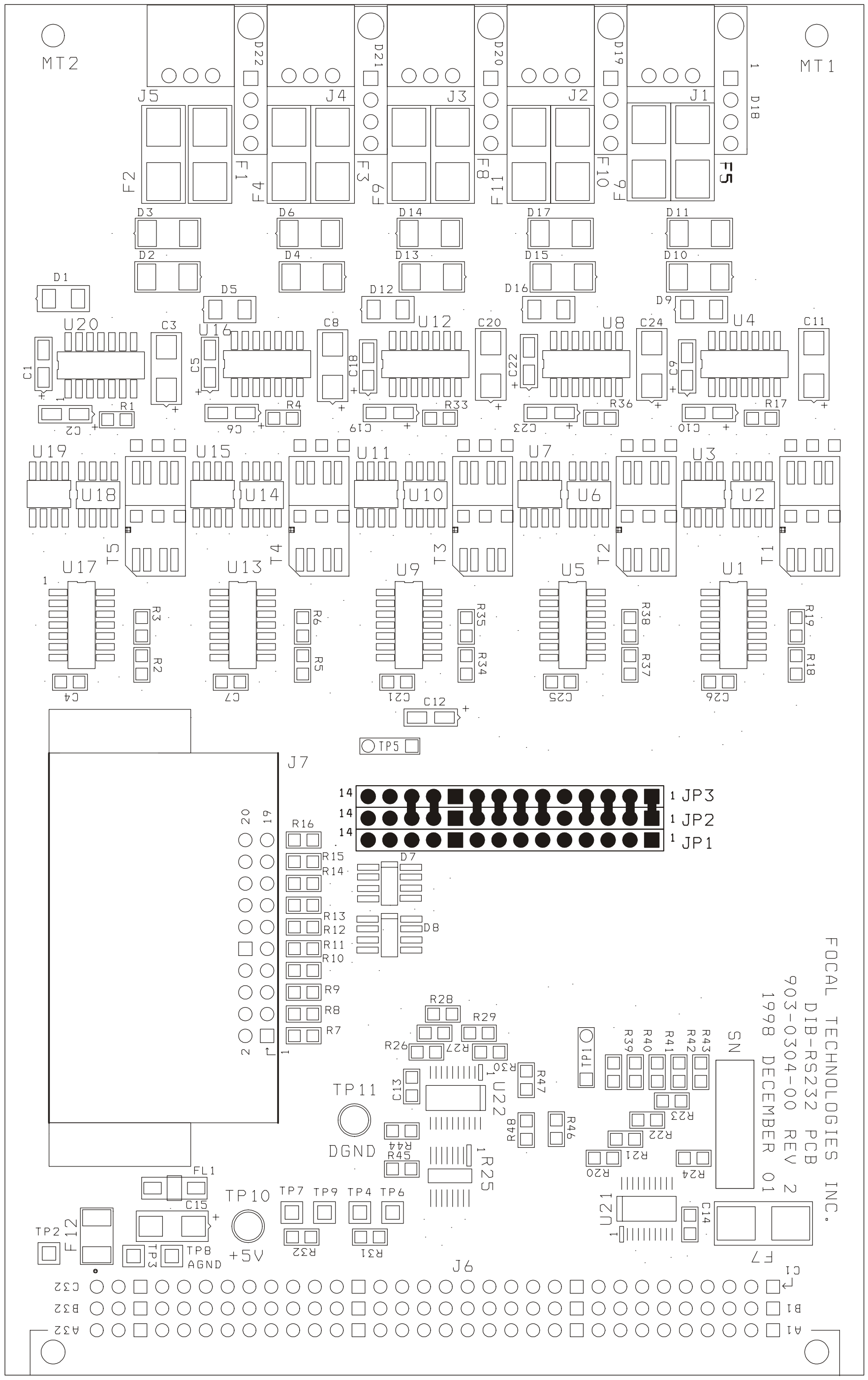


Figure 4.3-3: DIB-232 PCB

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

The High Density RS-232 card (DIB-232-16) supports sixteen bidirectional channels of RS-232 data. Channels 1-8 are located on the motherboard; channels 9-16 are located on a daughtercard. The front panel connector is a high density, 62-pin D-subminiature type, as shown below in Figure 4.4-1. Pin connections are given in Appendix D.

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

Maximum RS-232 NRZ data rate is 57.6 kbps when the card is installed in the low speed data slots and 115 kbps when used in the high-speed slot (D). Switch S1:1 should be set "off" (open) for operation in the high-speed slot or "on" (closed) for use in standard data slots. Figure 4.4-2 shows the DIB-232-16 motherboard PCBA, including location of switch S1. If the daughtercard is replaced for some reason, ensure that the alignment dot on the daughtercard matches the location of the alignment dot on the motherboard. Figure 4.4-3 shows a block diagram of the DIB-232-16 motherboard; Figure 4.4-4 shows the input/output schematic for channels 1 and 2. (The other 14 channels are identical.)

Options for breakout boxes and harnesses are available from the factory.

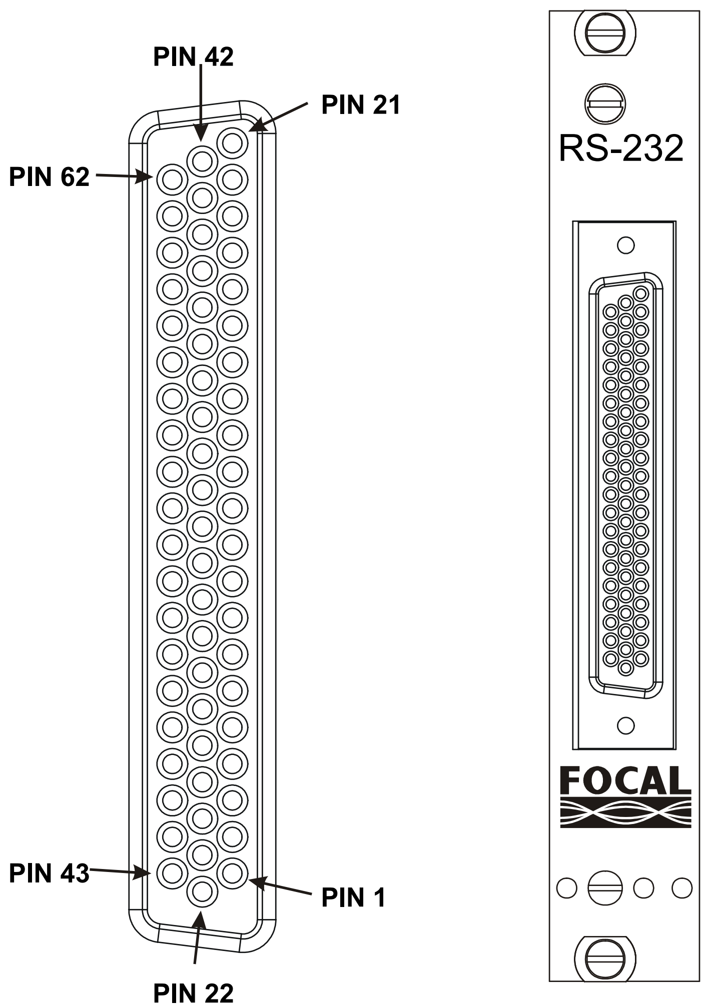


Figure 4.4-1: DIB-232-16 High Density RS-232 Board

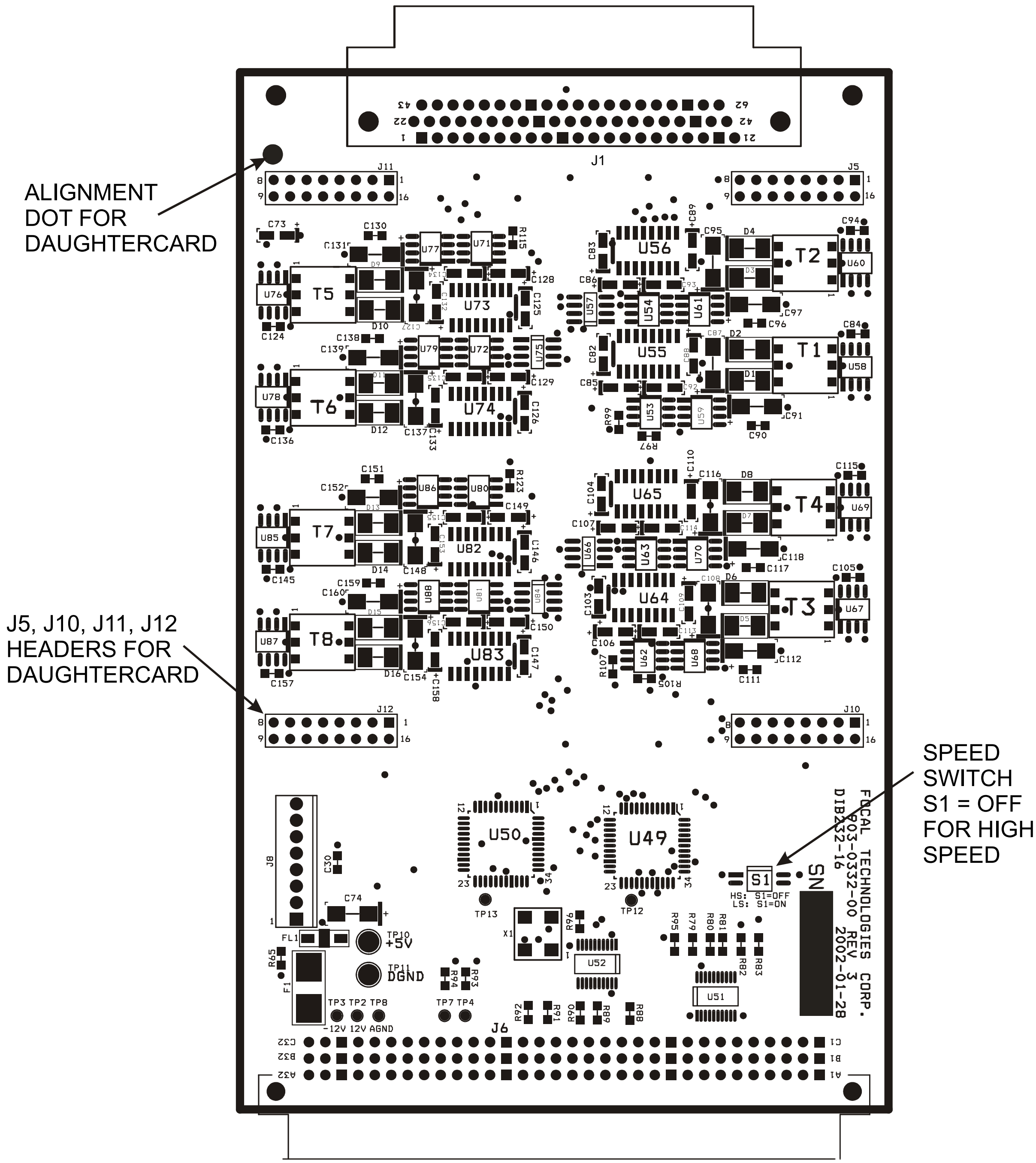


Figure 4.4-2: DIB-232-16 Motherboard (Daughtercard Not Shown)

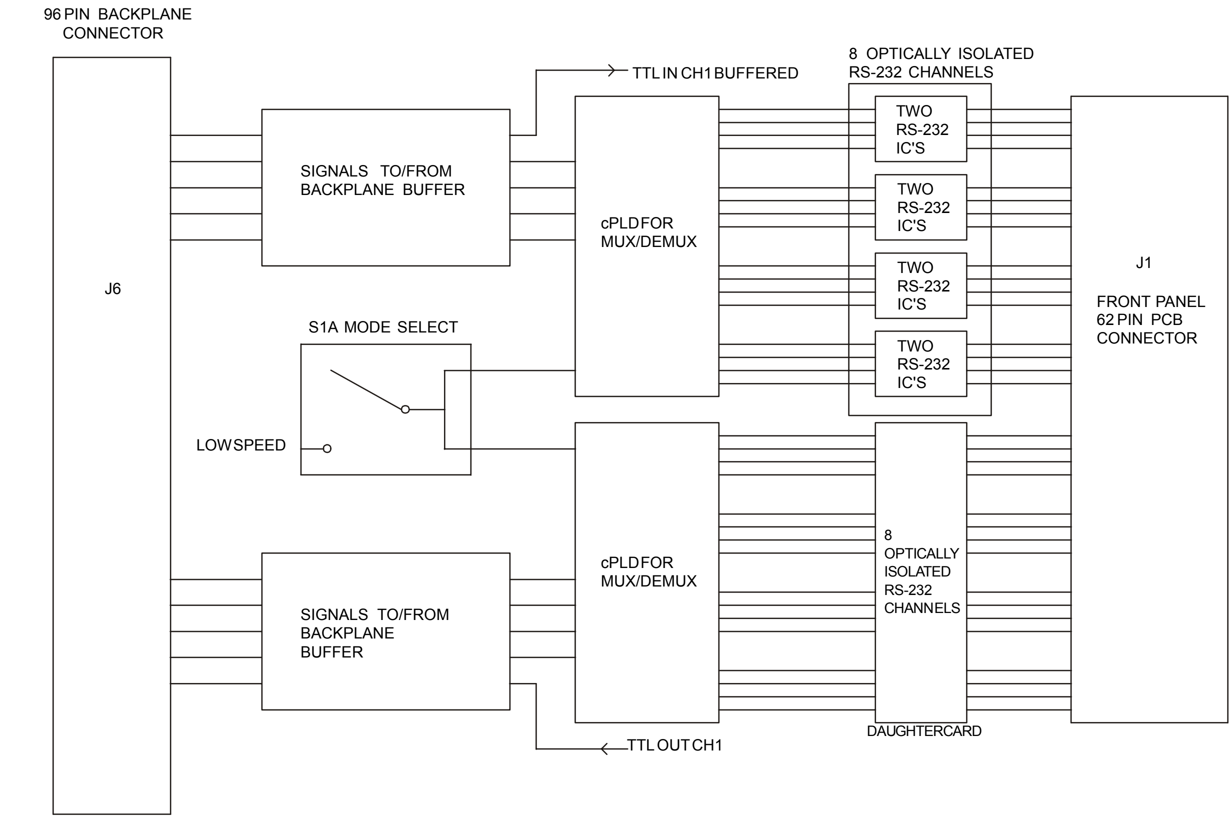


Figure 4.4-3: DIB-232-16 Block Diagram

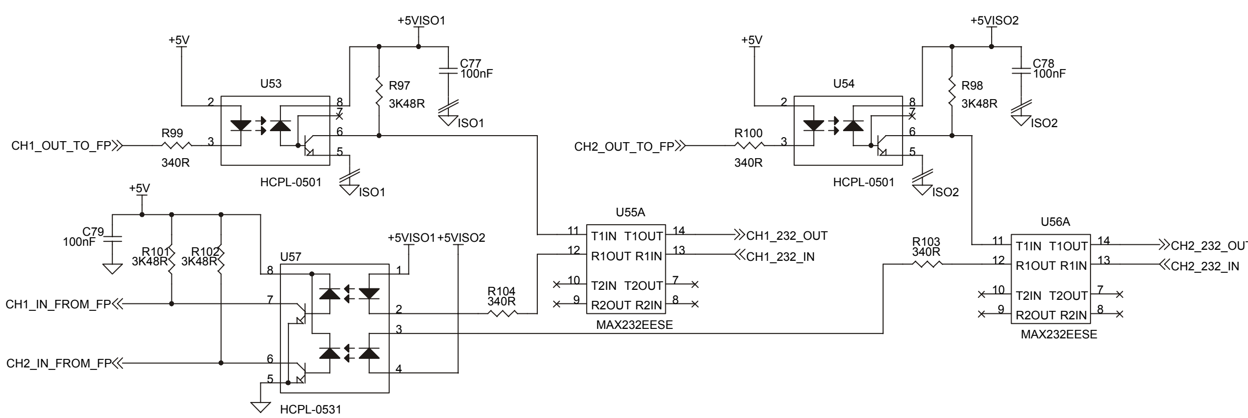


Figure 4.4-4: DIB-232-16 Input/Output Schematic (Channels 1 and 2)

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

RS-422/485 Data Interface Boards (DIB-485) are compatible with several types of bidirectional RS-422, RS-485, and TTL signals. The DIB-485 cards may be installed at either end of the system in any slots available for data boards.

4.5.1 Input/Output

All lines of the five front panel connectors shown in Figure 4.5-1 are protected by 250 mA fuses and transient voltage suppression diodes. Channel 1, denoted with a black dot, is slew rate limited, which minimizes sensitivity to noisy lines while allowing operation at data rates up to 250 kbaud. Channel 1 may also be configured for compatibility with AC-coupled, or transformer-coupled, RS-485 used by such devices as Kraft manipulators. (Channel 1 is unavailable on a DIB-485 card in the high-speed slot on an extended chassis.)

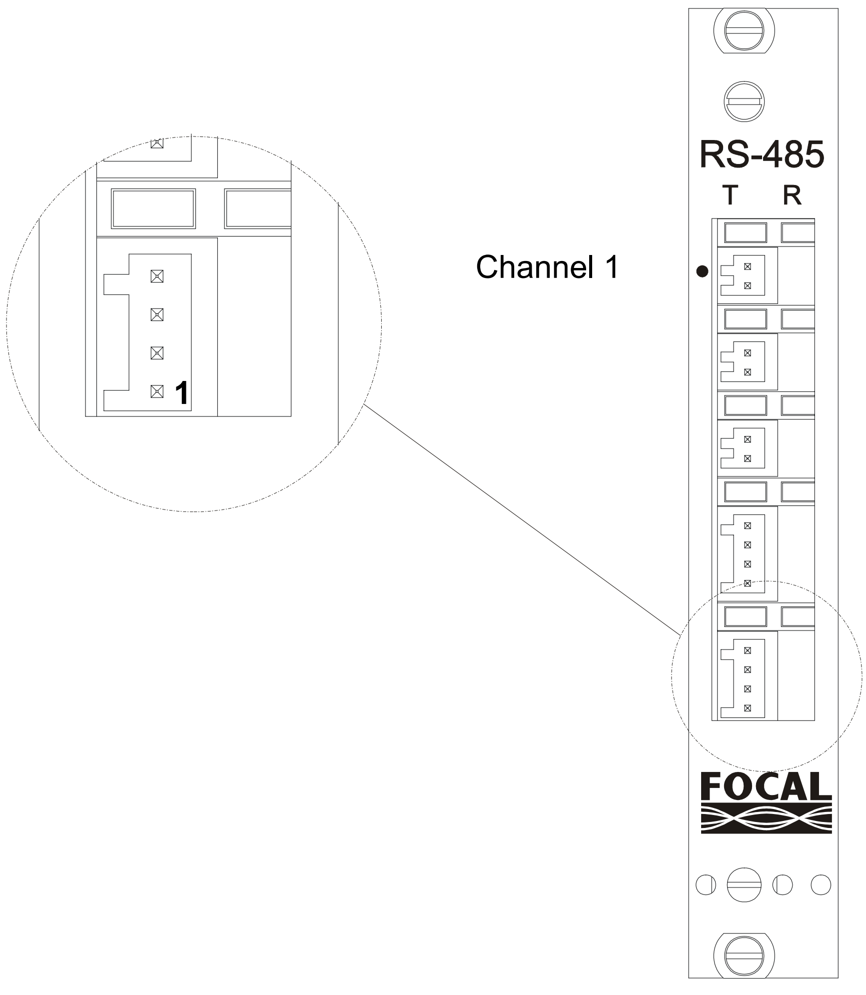


Figure 4.5-1: DIB-485 Front Panel

Channels 2 through 5 are not slew rate limited and can operate at asynchronous data rates up to 625 kbaud in a standard data slot and up to 2.5 Mbaud when used in the high-speed slot. Channels 1, 2, and 3 are 2-wire RS-485 half duplex channels; channels 4 and 5 are 4-wire full duplex RS-422 channels, which can be configured as 2-wire RS-485 channels. Channel 5 can also be configured for TTL.

All channels have LEDs indicating data transfer: the red LED indicates data being received by the DIB channel and the green LED indicates data exiting the DIB channel at the front panel. Connectors are all right angle 733 series WAGO connectors. The full duplex channels use 4 pin connectors (mate: WAGO 733-104), and the half duplex channels use the two pin type (mate: WAGO 733-102). Channel configurations are given in Table 4.5-1. A view of the mating 4-pin WAGO connector is given in Figure 4.5-2. The WAGO connectors should be used with wire gauges 20 - 28 AWG at maximum current of 0.25A.

Table 4.5-1: DIB-485 Channel Configuration

CHANNEL	PCB CONNECTOR DESIGNATOR	DESCRIPTION
1	J1	Half-duplex DC or AC coupled
2	J2	Half-duplex
3	J3	Half-duplex
4	J4	Full-duplex or Half-duplex
5	J5	Full-duplex, TTL or Half-duplex

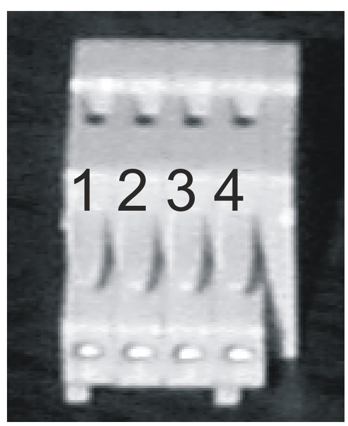


Figure 4.5-2: WAGO RS-422/485 data connector (P/N 733-104)

Table 4.5-2: WAGO Pin Designations

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

4.5.2 Configuration/Settings

Channels 1-3 have the following possible settings: RS-485 autosense (half duplex), RS-485 unidirectional transmitter (simplex Tx), and RS-485 unidirectional receiver (simplex Rx). Channels 4 and 5 additional have the option for RS-422 (full duplex, four-wire connection) and Channel 5 has the option for full duplex TTL. Configuration settings for the switches and jumpers are shown in Table 4.5-1. For DIP switches, a "1" indicates a switch is "on" or "closed" and a "0" indicates a switch is "off" or "open". For 2-pin jumpers, a "shunt" indicates the pins are connected with a shorting terminal and "open" indicates the shorting terminal is removed. For 3-pin jumpers, the table entry indicates which pins are shorted together.

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

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

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

DIB-485 boards are default configured with channels 1-3 as RS-485 half duplex (autosense = 9600 baud) and channels 4, 5 as RS-422.

Table 4.5-3: DIB-485 Configuration Settings

<table>
<tr><th colspan="9">CHANNELS 1-3 MODE CONFIGURATION</th></tr>
<tr><th rowspan="2">FUNCTION</th><th colspan="4">CHANNEL 1</th><th colspan="2">CHANNEL 2</th><th colspan="2">CHANNEL 3</th></tr>
<tr><th>JP1</th><th>JP2</th><th colspan="2">JP3, JP4, JP5</th><th>JP6</th><th>JP7</th><th>JP8</th><th>JP9</th></tr>
<tr><td>RS-485 Half Duplex (Autosense)</td><td>2-3</td><td>2-3</td><td colspan="2">SHUNT</td><td>2-3</td><td>2-3</td><td>2-3</td><td>2-3</td></tr>
<tr><td>RS-485 Simplex Tx</td><td>1-2</td><td>1-2</td><td colspan="2">SHUNT</td><td>1-2</td><td>1-2</td><td>1-2</td><td>1-2</td></tr>
<tr><td>RS-485 Simplex Rx</td><td>OPEN</td><td>OPEN</td><td colspan="2">SHUNT</td><td>OPEN</td><td>OPEN</td><td>OPEN</td><td>OPEN</td></tr>
<tr><td>Kraft (AC RS-485)</td><td>2-3</td><td>2-3</td><td colspan="2">OPEN</td><td colspan="4">Not Applicable</td></tr>
<tr><th colspan="9">CHANNEL 4 MODE CONFIGURATION</th></tr>
<tr><th>FUNCTION</th><th>JP10</th><th>JP11</th><th>JP12</th><th>JP13</th><th>JP14</th><td colspan="3" rowspan="5"></td></tr>
<tr><td>RS-485 Half Duplex (Autosense)</td><td>2-3</td><td>2-3</td><td>OPEN</td><td>SHUNT</td><td>SHUNT</td></tr>
<tr><td>RS-485 Simplex Tx</td><td>1-2</td><td>1-2</td><td>OPEN</td><td>SHUNT</td><td>SHUNT</td></tr>
<tr><td>RS-485 Simplex Rx</td><td>OPEN</td><td>OPEN</td><td>OPEN</td><td>SHUNT</td><td>SHUNT</td></tr>
<tr><td>RS-422 Full Duplex</td><td>OPEN</td><td>1-2</td><td>SHUNT</td><td>OPEN</td><td>OPEN</td></tr>
<tr><th colspan="9">CHANNEL 5 MODE CONFIGURATION</th></tr>
<tr><th>FUNCTION</th><th>JP15</th><th>JP16</th><th>JP17</th><th>JP18</th><th>JP19</th><th>JP20</th><th>JP21</th><td rowspan="6"></td></tr>
<tr><td>RS-485 Half Duplex (Autosense)</td><td>2-3</td><td>2-3</td><td>OPEN</td><td>SHUNT</td><td>SHUNT</td><td>1-2</td><td>2-3</td></tr>
<tr><td>RS-485 Simplex Tx</td><td>1-2</td><td>1-2</td><td>OPEN</td><td>SHUNT</td><td>SHUNT</td><td>1-2</td><td>2-3</td></tr>
<tr><td>RS-485 Simplex Rx</td><td>OPEN</td><td>OPEN</td><td>OPEN</td><td>SHUNT</td><td>SHUNT</td><td>1-2</td><td>2-3</td></tr>
<tr><td>RS-422 Full Duplex</td><td>OPEN</td><td>1-2</td><td>SHUNT</td><td>OPEN</td><td>OPEN</td><td>1-2</td><td>2-3</td></tr>
<tr><td>TTL Full Duplex</td><td>OPEN</td><td>1-2</td><td>OPEN</td><td>OPEN</td><td>OPEN</td><td>2-3</td><td>1-2</td></tr>
<tr><th colspan="9">AUTOSENSE BAUD RATE FOR SW1, SW2, SW3, SW4, SW5 DIP SWITCHES
(SW1 = CH1, SW2 = CH2, SW3 = CH3, SW4 = CH4, SW5 = CH5)</th></tr>
<tr><th>BAUD RATE CCT#</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th></tr>
<tr><td>9600</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>19200</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>28800</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>57600</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td></tr>
<tr><td>115.2K</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>≥230.4K</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>KRAFT (CH 1 only)</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
</table>

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

4.6 AIB-4 - Adaptable Interface Board

The Adaptable (or Analog) Interface Board (AIB-4) provides four generic channels of data with four sockets that may be populated with any mixture of available plug-in modules. These include analog interfaces for hydrophones, sonars (MS900), and sensors, in addition to digital interfaces, such as RS-232, RS-485/422/TTL, and Tritech sonar ARCNET. Figure 4.6-1 below shows the location of pin 1 on the WAGO connectors when viewed from the front panel. Channel 1 is at the top of the column of connectors, as marked by the black dot along the left-hand side of the panel.

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

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

Figure 4.6-2 shows the AIB motherboard, and Figure 4.6-3 shows the block diagram for the AIB motherboard.

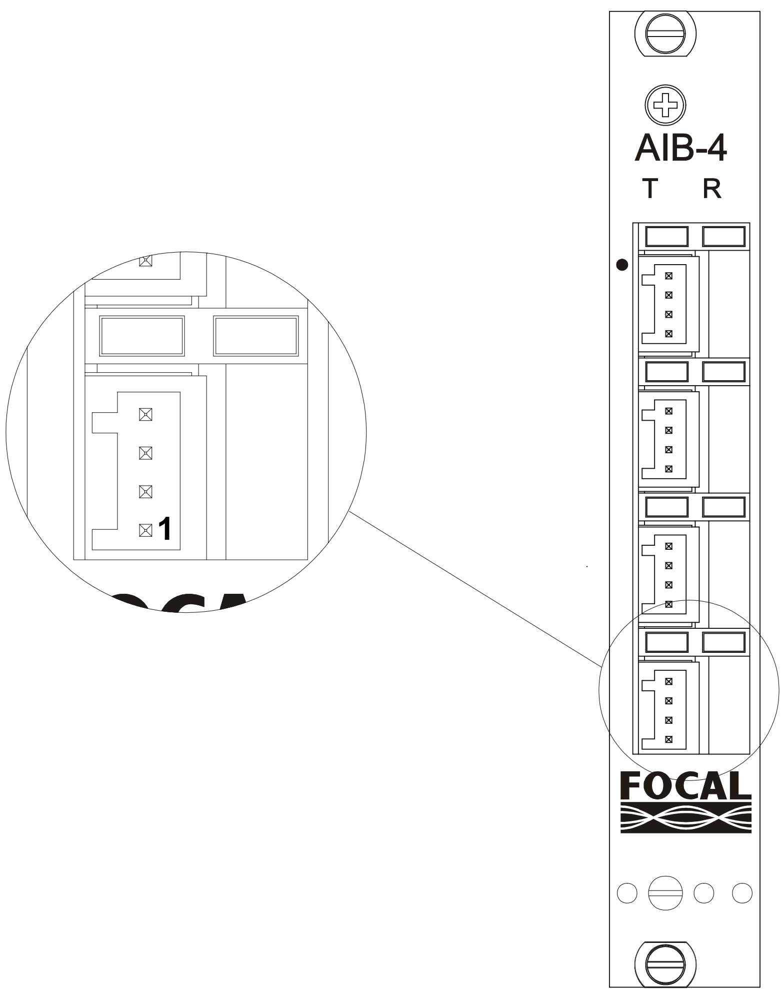


Figure 4.6-1: Adaptable Interface Board (AIB-4) Front Panel

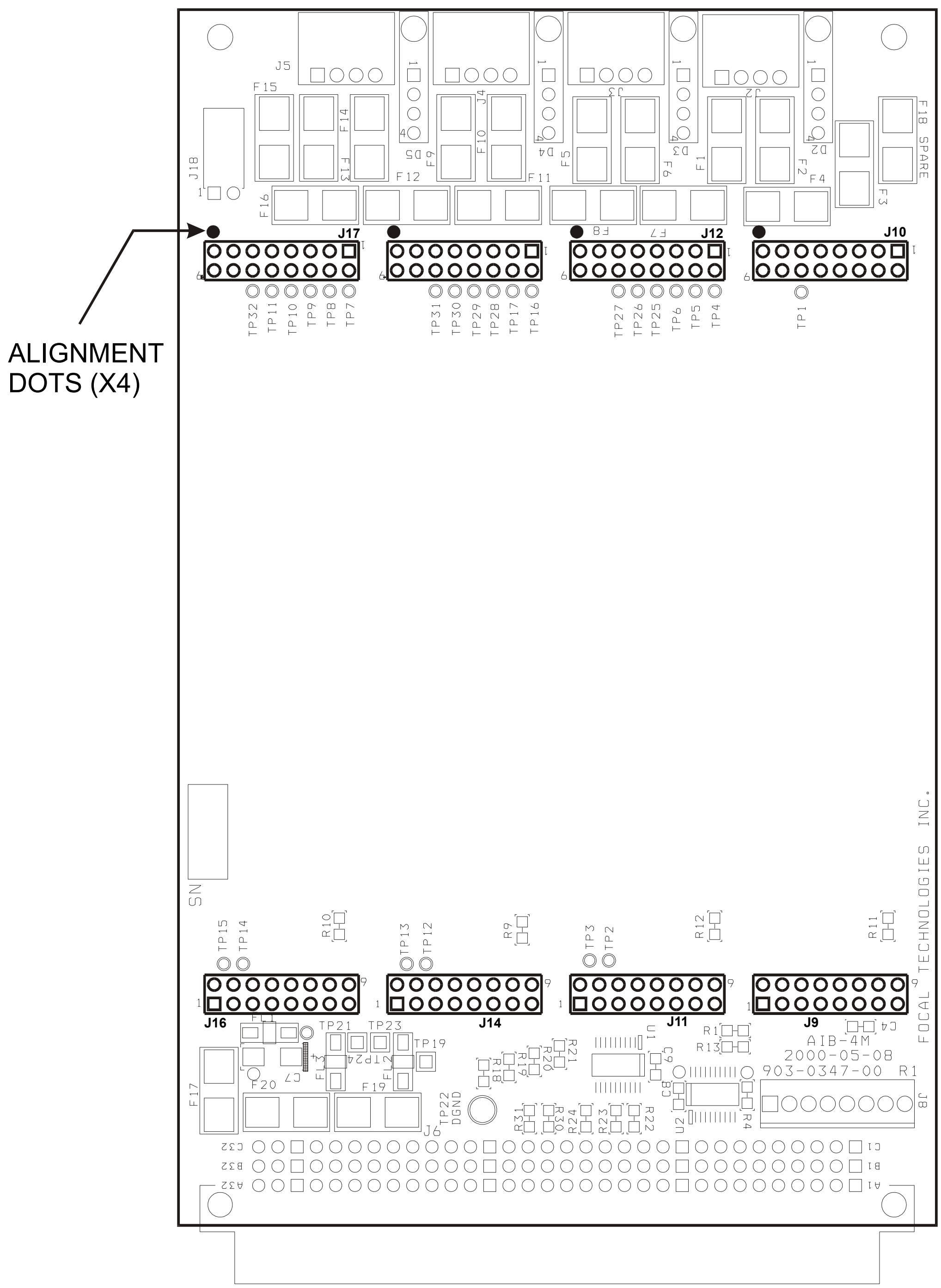


Figure 4.6-2: Adaptable Interface Board (AIB-4) PCB

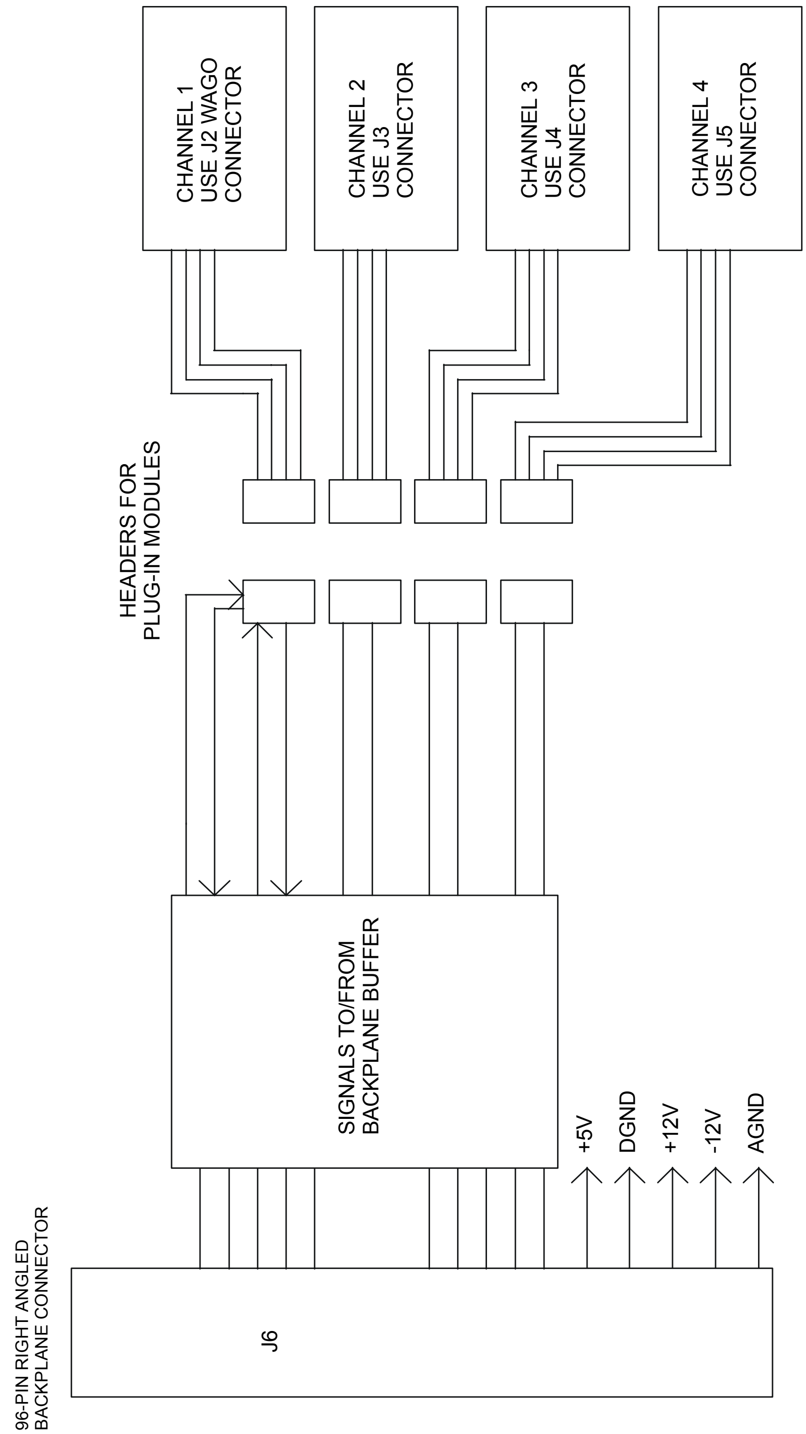


Figure 4.6-3: Block Diagram of Adaptable Interface Board (AIB-4)

4.6.1 Plug-In Modules

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

4.6.2 RS-232 Plug-In

The AIB-232 plug-in module, which supports RS-232, is shown below in Figure 4.6-4. No jumper or switch settings are required since the board is used solely for RS-232 data to a maximum of 120 kbaud. In addition to the ultra-fast fuses on the AIB-4 motherboard, protection for RS-232 inputs and outputs includes transient voltage suppressors and opto-isolation

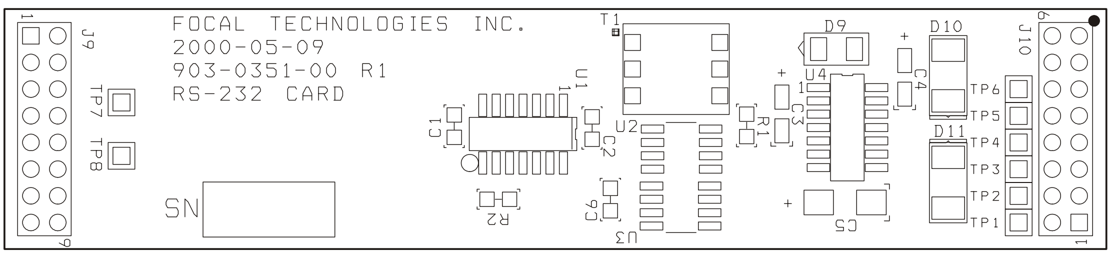


Figure 4.6-4: AIB RS-232 Plug-In Module

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

Table 4.6-1: 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.

4.6.3 RS-485/422/TTL Plug-In

The AIB-485 plug-in module, which supports RS-485, RS-422, and TTL, is shown below in Figure 4.6-5. In addition to the ultra-fast fuses on the AIB-4 motherboard, protection for RS-485/422/TTL inputs and outputs includes transient voltage suppressors and opto-isolation.

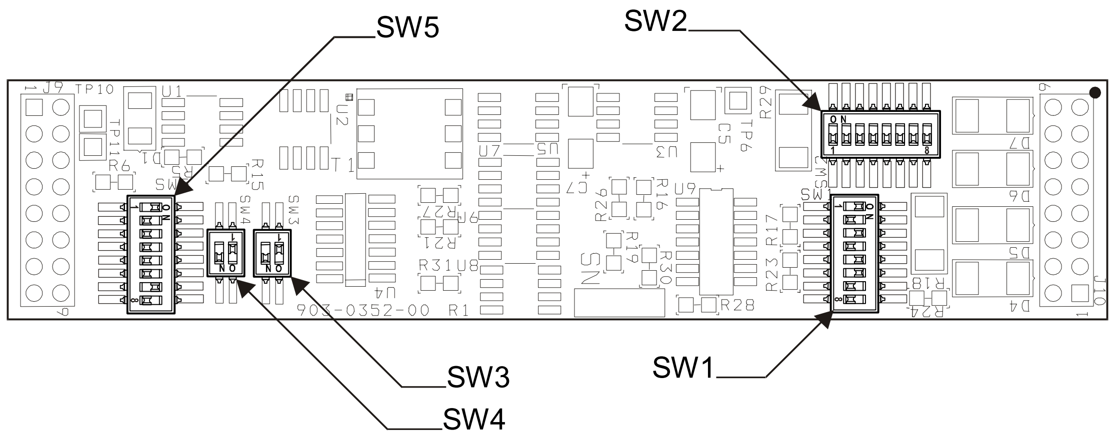


Figure 4.6-5: AIB RS-485 Plug-In Module

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

The equivalent input/output schematic for an RS-422 configuration is shown in Figure 4.6-6, based on default switch settings. The switches are not shown for clarity. AIB-485 plug-in modules are default configured for RS-485, in which case the transmit and receive circuits of the RS-422 driver IC are connected together.

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

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

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

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

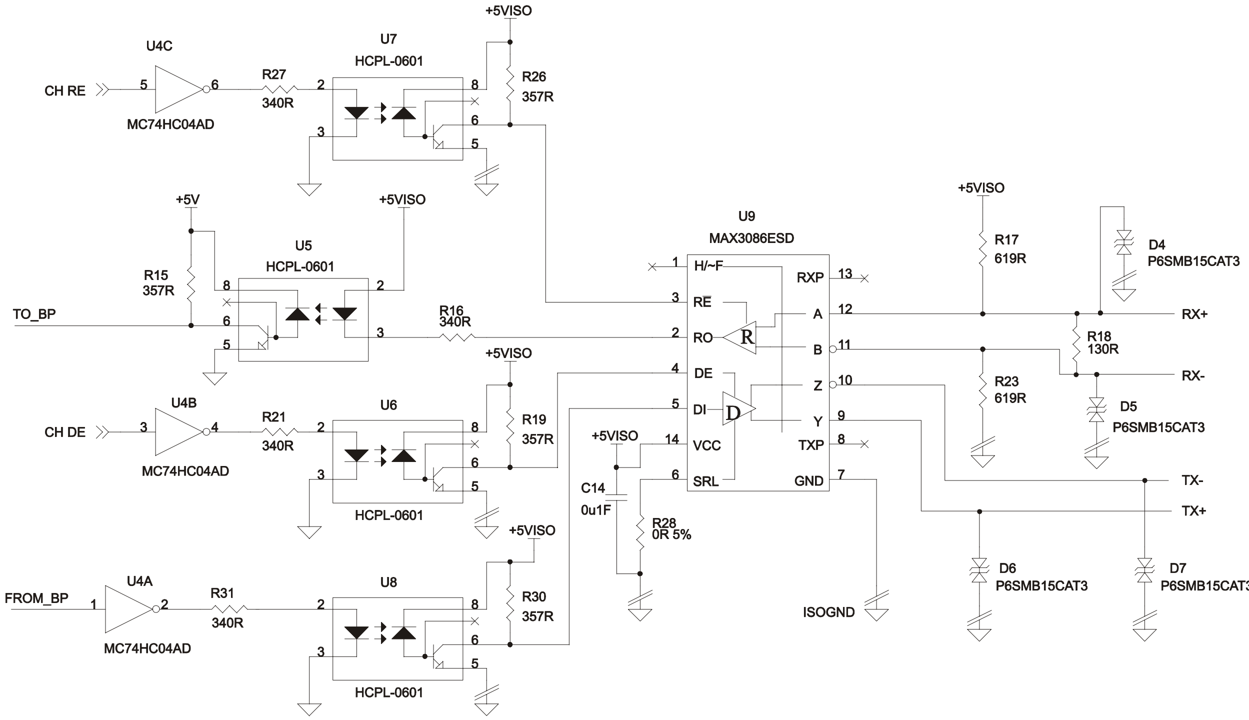


Figure 4.6-6: AIB RS-422 Interface Schematic

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

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

Table 4.6-2: AIB-485 Pin Designations

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

Switch settings for the various configurations are given in Table 4.6-3. When using the module in RS-422 or TTL input configuration, the autosense mode (SW3, SW4) should be set for full-duplex operation. Autosense baud rate settings (SW5) are ignored when the module is in full-duplex or simplex modes.

Table 4.6-3: 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

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

4.6.4 Tritech Sonar ARCNET Plug-In

The AIB-ARCNET plug-in module, which supports the version of ARCNET used by Tritech sonars, is shown below in Figure 4.6-7. In addition to the ultra-fast fuses on the AIB-4 motherboard, protection for Tritech inputs and outputs includes transient voltage suppressors and AC-coupled isolation through capacitors and transformers.

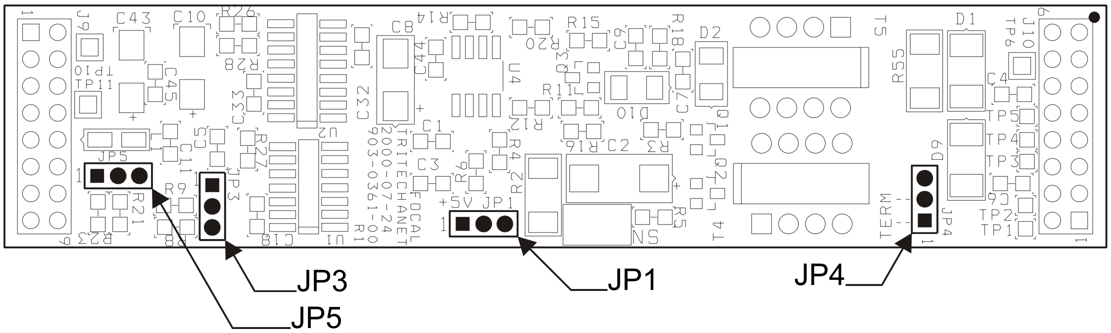


Figure 4.6-7: AIB Tritech ARCNET Plug-In Module

The Tritech sonar interface may be configured for +5 V (default) or +12 V drive levels and a data rate of 156.2 kbps (default) or 78.1 kbps, as shown in Table 4.6-2. The +12 V setting may be needed for long cable runs to the sonar equipment, but is typically not required. The lower data rate setting is available for compatibility with existing sonars configured for 78.1 kbps operation.

Table 4.6-4: Configuration Settings for AIB Tritech Module (Defaults Shaded)

OUTPUT DRIVE LEVEL				
VALUE	JP1	JP3	JP5	JP4
+5 V Output	1-2	*	*	*
+12 V Output	2-3	*	*	*
BAUD RATE				
78.1 kbaud	*	1-2	1-2	*
156.2 kbaud	*	2-3	2-3	*
TERMINATION				
68 Ohms	*	*	*	1-2
Unterminated	*	*	*	2-3

*setting does not affect given parameter

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

Default settings above are for systems with short cables between the sonar components and the multiplexer modules. For systems with a long run of cable between the sonar head and remote module, the recommended configuration is the following:

- +12V drive signals on both console and remote plug-ins
- 68 ohm terminators used on both console and remote plug-ins
- 39 ohm terminator block used on sonar head
- 270 ohm terminator block NOT used on sonar processor unit

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

Table 4.6-5: AIB-ARCNET Pin Designations

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

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

4.6.5 Hydrophone/Analog Plug-In

The AIB-HYDRO hydrophone plug-in module, shown below in Figure 4.6-8, is suitable for use with many hydrophones and other types of low-level analog signals. The board is used at both ends of the system and must be jumper configured, typically, as an input for the remote (subsea) module or as an output for the console (surface) module per the settings in Table 4.6-6

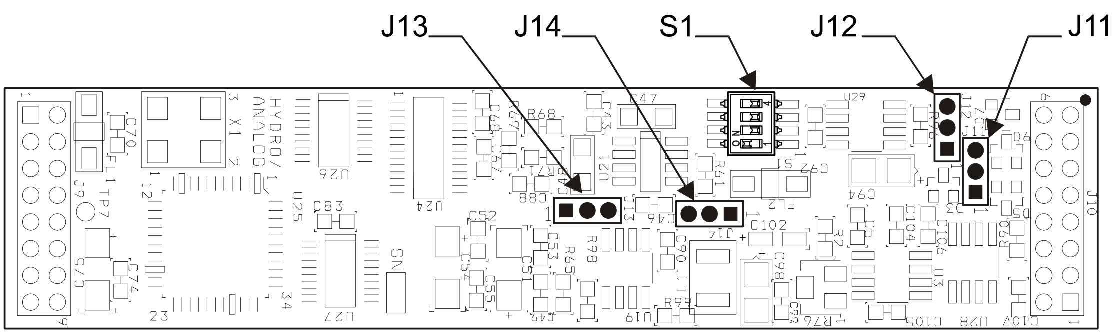


Figure 4.6-8: AIB Hydrophone Plug-In Module

Table 4.6-6: Configuration Settings for AIB Hydrophone Module *

BOARD SET UP	**JUMPER CONFIGURATION**			
	J11	**J12**	**J13**	**J14**
Input Board (Remote)	2-3	2-3	2-3	2-3
Output Board (Console)	1-2	1-2	1-2	1-2

*** place shunts across the indicated pins of each jumper**

The hydrophone board input circuits include a front-end preamplifier with a fixed 36 dB gain and additional gain supplied by switch bank S1. Inputs are protected with diode clamps and current limiting resistors as well as ultrafast fuses on the AIB motherboard. Table 4.6-7 shows the switch S1 gain settings and corresponding maximum input voltage.

Table 4.6-7: 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

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

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

Table 4.6-8: AIB-HYDRO Pin Designations

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

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

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

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

4.6.6 MS-900 Analog Sonar Plug-In

The MS900 Analog Sonar Interface AIB plug-in (AIB-MS900) uses only one configuration jumper, J11, shown below in Figure 4.6-9. Pin 1 of J11 is the square pin, which is also marked with a silkscreen "C". If the jumper is placed across pins 1 - 2, the board is configured for the console module, which interfaces with the MS900 controller. With the jumper across pins 2 - 3 of J11, the board is configured for the remote module, which interfaces with the Model 971 sonar head. No other jumper settings are required.

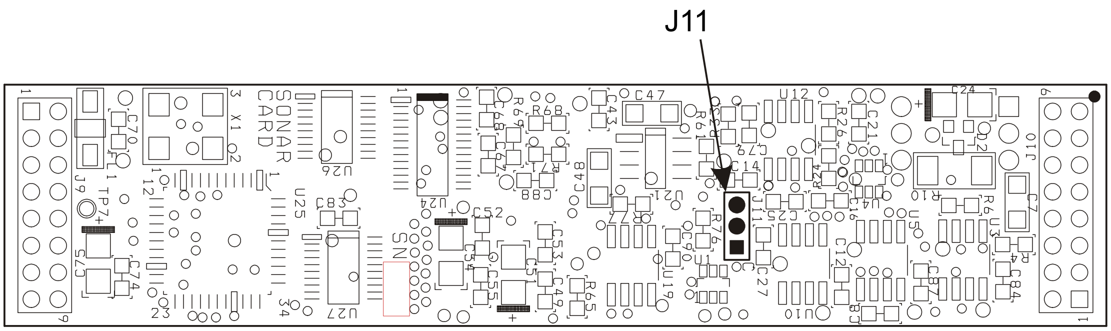


Figure 4.6-9: MS-900 Plug-In Module (Top View)

The MS900 interface must be installed on a motherboard supporting AIB plug-ins, such as the AIB-4 or the HDB-TX. Ensure the alignment dot, shown at the upper left of the figure below, matches the dot on the motherboard.

Because of the high-speed sampling required, the MS900 plug-in can only be employed with a motherboard installed in a high-speed data slot.

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

Table 4.6-9: 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.

4.7 CIB-10 Control Interface Board

The CIB-10 control interface board, as shown in Figure 4.7-1 below, provides 10 bidirectional independent control lines, also known as TOR (tout ou rien) channels. Each TOR input controls the corresponding output at the other end of the system. When the input is "on", the output solid state relay acts like a closed switch for a maximum of 24 VDC and 100 mA. When the input is "off", the output is in an open state.

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

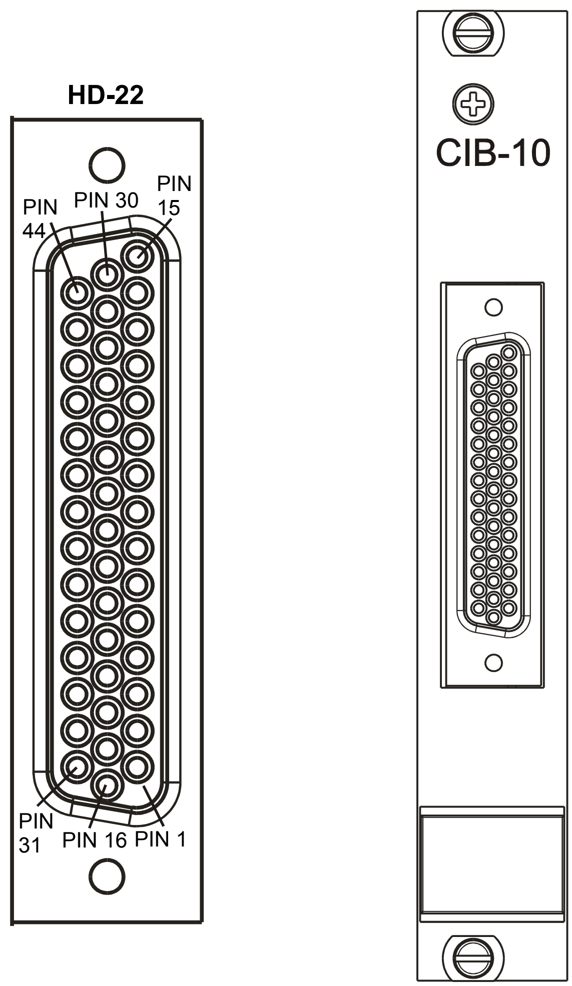


Figure 4.7-1: CIB-10 Front Panel

Schematics for channel 1 TOR input and output are shown in Figure 4.7-2, with the Type 1 (both dual switches open) shown. The other TOR channels are identical, where channel 2 input is configured by switches SW3 and SW4, channel 3 input is configured by switches SW5 and SW6, etc. Both switches must be “open” (off) for Type 1 and “closed” (on) for Type 2 configuration. Note that SW2, SW4, SW6... SW20 are single pole double throw (SPDT) switches with no common, where circuit 1 is “open” and circuit 2 “closed”, or vice versa. Setting SW2, for example, to “open” refers to circuit 1 being open. Figure 33 shows SW1 and SW2 both “open” (off). Refer to the signal configuration drawing in Appendix B for the as-built settings.

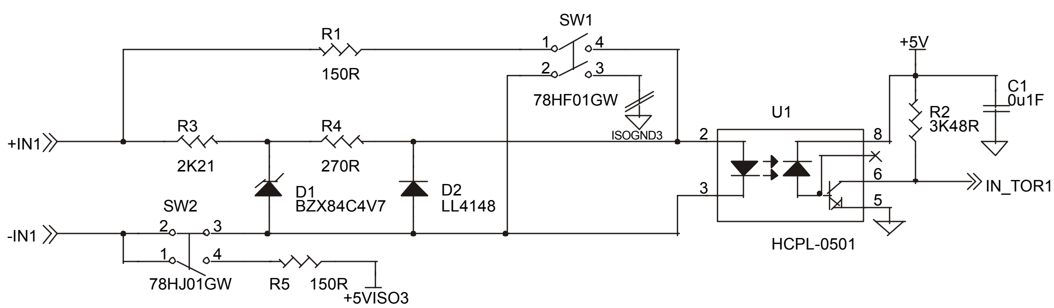
TOR inputs are polled at regular intervals by a microcontroller and encoded in a frame on a single 9600 baud data stream, which is sampled by the Model 903 multiplexer. The microcontroller at the other end of the system reads the demultiplexed 9600 baud data stream and sets the TOR outputs according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

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

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

Figure 4.7-3 shows a view of the CIB-10 PCBA with location of configuration switches.

TOR INPUT (TYPE 1 OR 2)



TOR OUTPUT

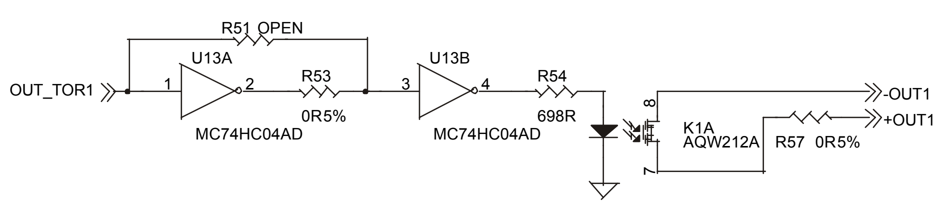


Figure 4.7-2: CIB-10 TOR Input and Output

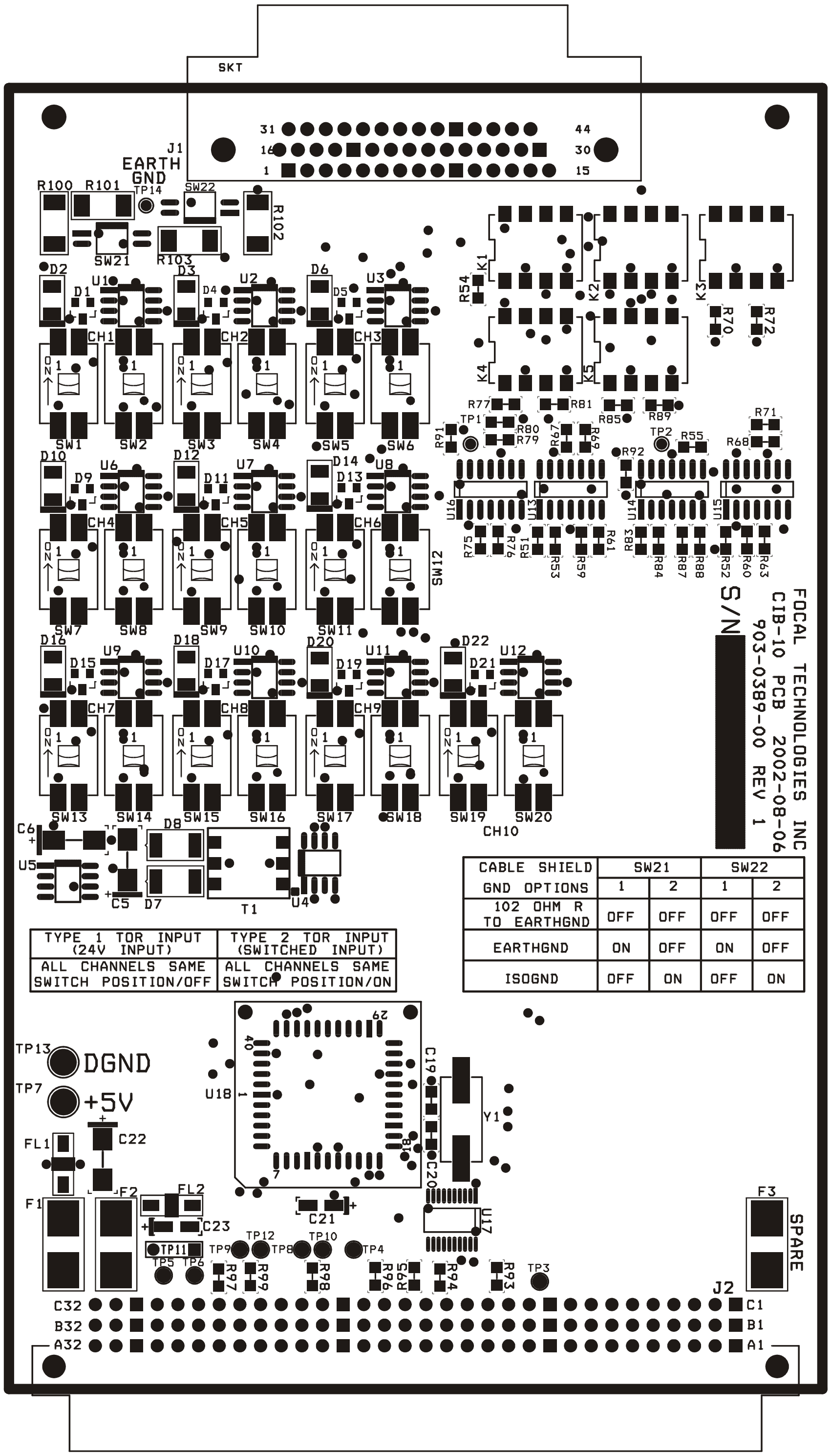


Figure 4.7-3: CIB-10 PCBA

Figure 4.7-4 below shows a block diagram of the CIB-10 board.

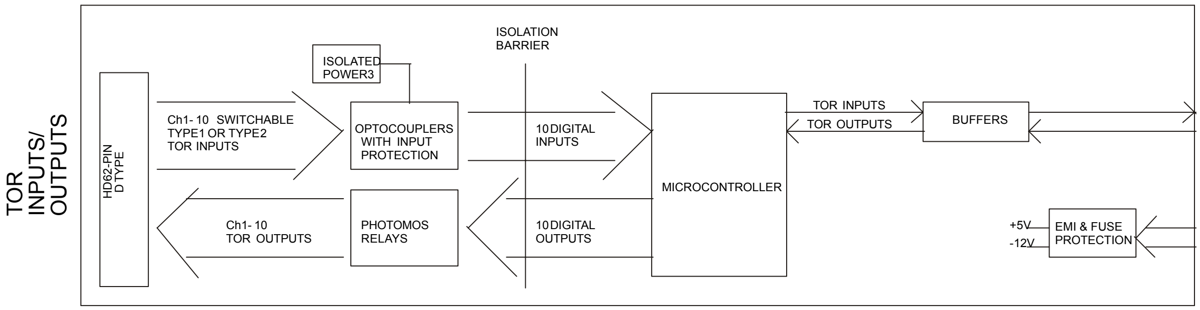


Figure 4.7-4: CIB-10 Block Diagram

Two pins are provided for shield connections: TOR In Shield = pin 41; TOR Out Shield = pin 42. Both of these pins may each be shorted directly to chassis ground or ISOGND3, which is the common ground for Type 2 inputs. The default configuration is with all shield switches open, as shown in Figure 4.7-5.

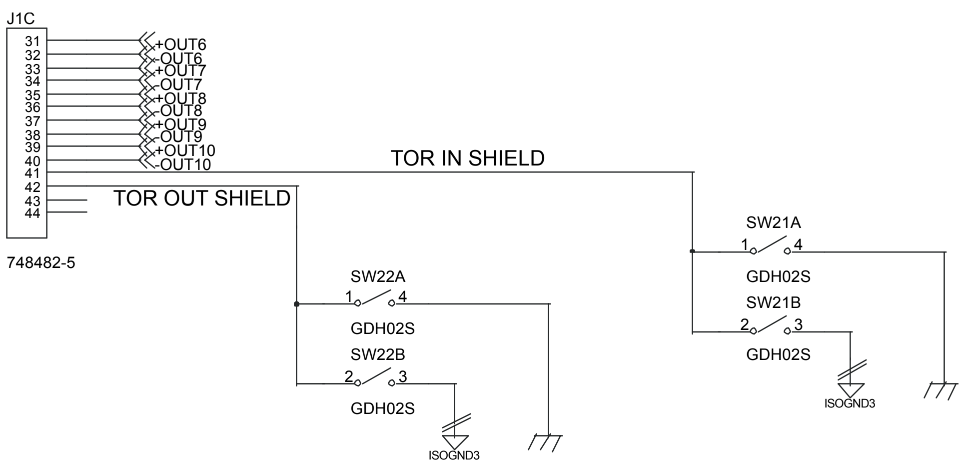


Figure 4.7-5: CIB-10 Shield Options

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

4.8 EIB-10BT - Ethernet Interface Board (10Base-T)

The EIB-10BT Ethernet hub board allows 10 Mbps Ethernet signals (IEE802.3, 10BaseT) to be transmitted through the Model 903 system. Since EIB-10BT cards are inherently high-speed, they must be installed in the high-speed slot at both ends of the system.

Each EIB-10BT board contains a four port 10BaseT repeating hub with three ports available at the front panel and the fourth port routed through the Model 903 multiplexer system. As a physical layer interface, the EIB-10BT minimizes latency for fiber links of up to two kilometers. An external bridge or switch may be required if fiber lengths are longer than the 2 km collision domain limit of Ethernet.

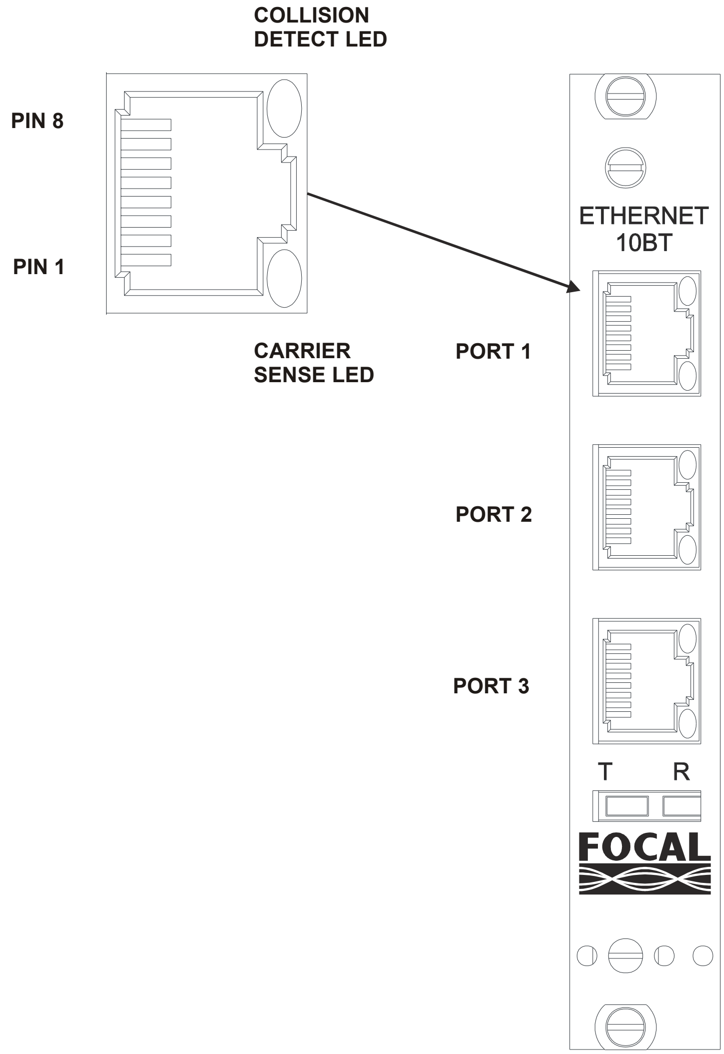


Figure 4.8-1: EIB-10BT Front Panel

4.8.1 Input/Output

The three ports on the front panel accept industry standard RJ-45 UTP (Unshielded Twisted Pair) connectors. All of the twisted pair ports are transformer-coupled to the internal hub, which has additional on-board filtering. Data sent into one of the front panel ports will be transmitted back out of the other two ports as well as out of the three ports at the other end of the Model 903 system. Effectively, the Model 903 system acts like a fiber segment connecting two hubs, one at the remote unit and one at the console unit.

Front panel connectors are wired as DCE ports. External DTE devices, such as PCs, should be connected to the EIB-10BT's DCE ports with RJ-45 cables wired "straight through". If connection to an external DCE port is required, such as to another hub, use an RJ-45 cable with "crossed-over" wiring. Alternatively, port 3 may be configured with board jumpers as a DTE device, or "uplink" port, allowing a straight-through cable to be used with an external DCE port from another hub, bridge, or switch.

The pin assignments in the RJ-45 jack are summarized in Table 4.8-1.

Table 4.8-1: RJ-45 Pin Assignments

RJ45 Contact	DTE	DCE
1	TXD+	RXD+
2	TXD-	RXD-
3	RXD+	TXD+
4	n/c	n/c
5	n/c	n/c
6	RXD-	TXD-
7	n/c	n/c
8	n/c	n/c

Each RJ-45 jack has two LED indicators: carrier sense is green and collision detection is yellow. In addition, there are two LEDs at the bottom of the front panel to indicate traffic on the receive and transmit lines on the fourth port through the multiplexer. These traffic LEDs are in the standard red/green format found on other boards, where green is for data transmitted from the front panel into the multiplexer and red is for data from the multiplexer and out of the front panel.

4.8.2 Configuration Settings

Four jumpers on the board allow port 3 wires to be crossed over, changing the port from a DCE device to a DTE device. In the DCE (default) configuration all four jumpers should be in the 2-3 position. In the DTE configuration, all four jumpers should be in the 1-2 position. Table 4.8-2 shows the jumper settings for Port 3 configuration.

Table 4.8-2: Port 3 Configuration Jumpers

Pins	JP9	JP10	JP11	JP12	State
1-2	Shunt	Shunt	Shunt	Shunt	Port 3 is DTE
2-3	Open	Open	Open	Open	
1-2	Open	Open	Open	Open	Port 3 is DCE (default)
2-3	Shunt	Shunt	Shunt	Shunt	

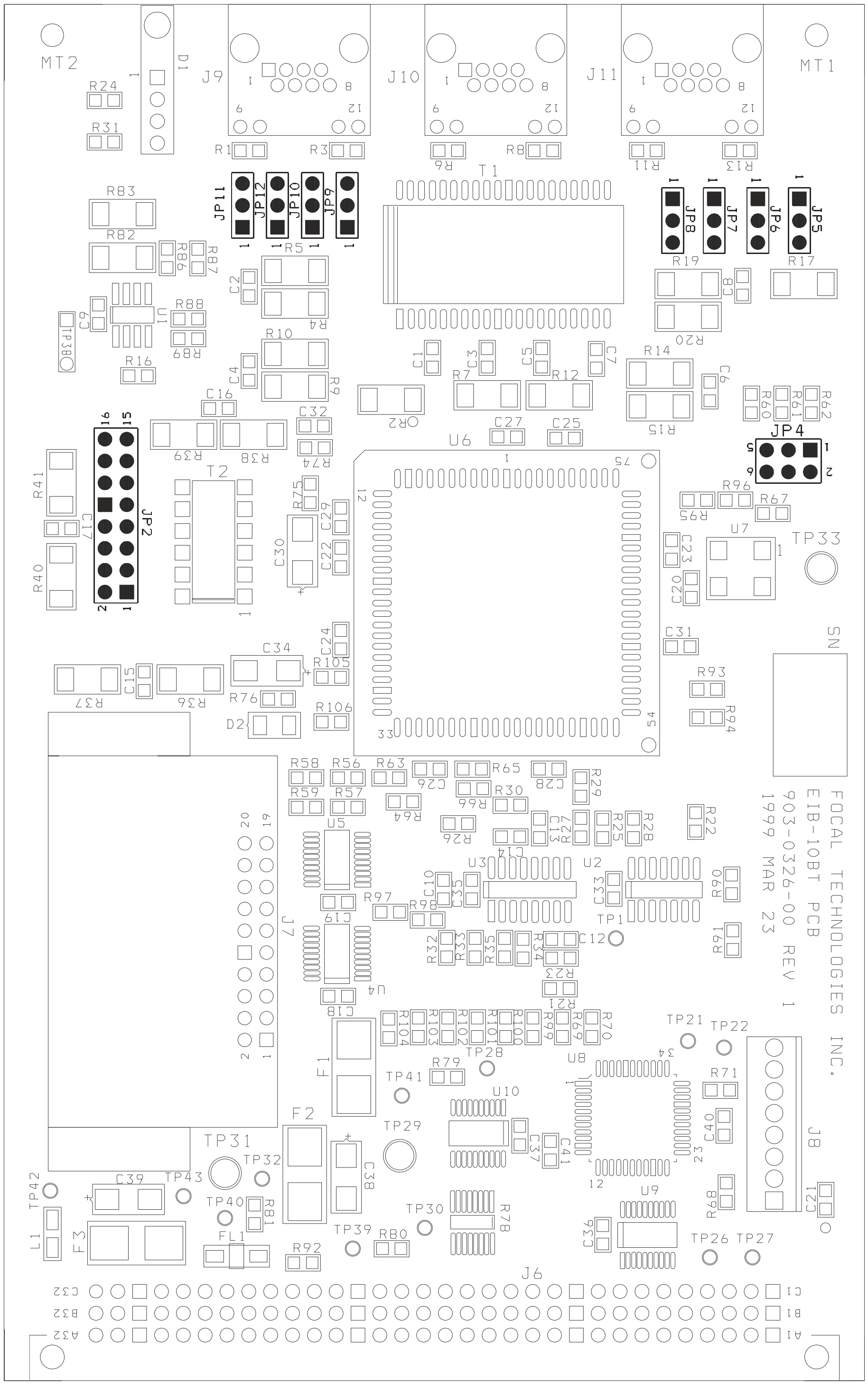


Figure 4.8-2: EIB-10BT PCB

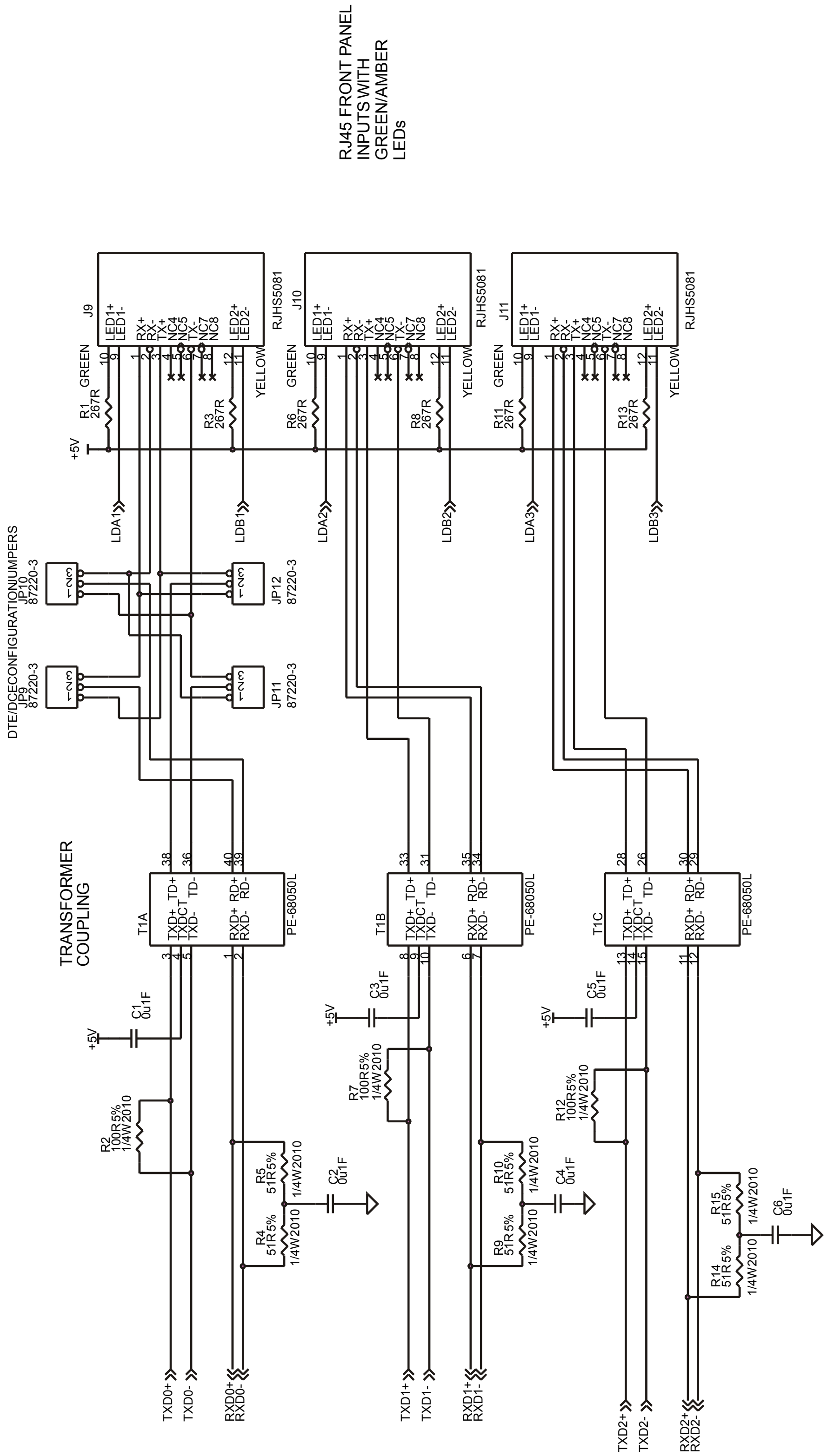


Figure 4.8-3: EIB-10BT Input/Output Schematic

4.9 EIB-10/100 Ethernet Interface Board

The EIB-10/100 Ethernet board is an electrical or optical interface card providing three RJ-45 ports of 10Base-T (10 Mbps) or 100Base-TX (100 Mbps) Ethernet inputs to an internal switching hub (switch). Each port auto-negotiates the data rate and duplex mode of the input. A front panel view of the card in Figure 4.9-1 shows pin and LED locations on the RJ-45 jacks.

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

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

Electrical versions of the EIB-10/100 card must be installed in a high-speed data slot. Although the front panel RJ-45 ports are compatible with both 10 and 100 Mbps traffic, the backplane link operates solely in a full-duplex, 10Base-T compatible mode. The backplane interface, the electrical version of the EIB-10/100 cards may also be operated over 10 km or more of optical fiber, albeit with the throughput of a full-duplex, 10 Mbps Ethernet link.

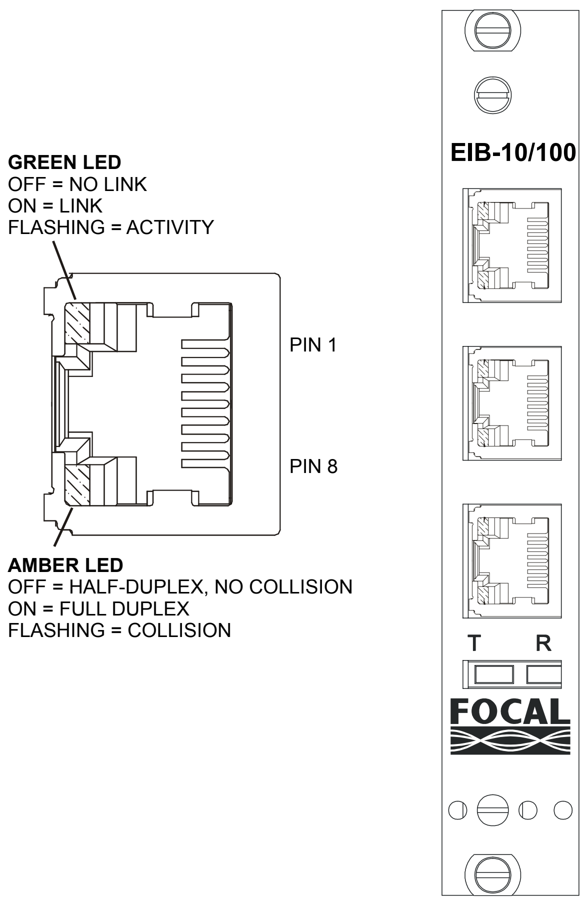


Figure 4.9-1: EIB-10/100 Front Panel

4.9.1 Input/Output

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

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

The pin assignments of the RJ-45 jacks are summarized in Table 4.9-1. Typically, the switch port should be in MDI configuration for connection to NICs (network interface cards) and in MDI-X configuration for connection to other repeating hubs and switches.

Table 4.9-1: RJ-45 Pin Assignments

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

The green LED on each RJ-45 jack is on when there is a link pulse present, indicating an external device is connected with a valid Ethernet link. The green LED flashes during packet transfers.

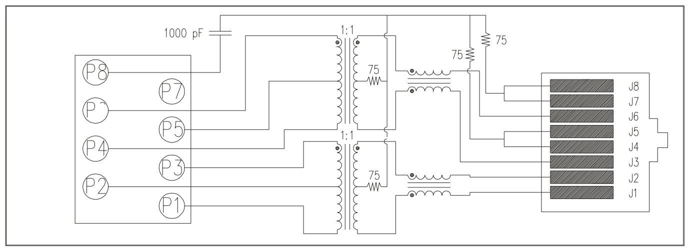
The amber LED on each RJ-45 jack is on if the link is full duplex and off if the link is half duplex. When operating in half-duplex mode, the LED flashes when there is a collision. Normally the amber LEDs should be on at all times when the external equipment supports full-duplex operation. Some equipment, such as web cameras and older Ethernet gear, do not support full-duplex operation.

The T and R LEDs at the bottom of the panel indicated traffic through a fourth port on the switching hub connected to the backplane. On electrical versions of the EIB-10/100, the green TX LED indicates data traffic arriving from the backplane and leaving the front panel, and the red RX LED indicates data traffic coming in the front panel and being sent to the backplane. These backplane LEDs are off in optical configurations.

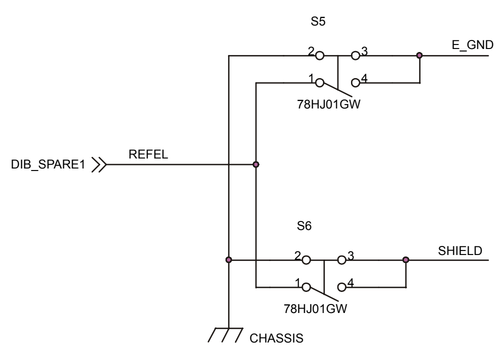
4.9.2 Configuration Settings

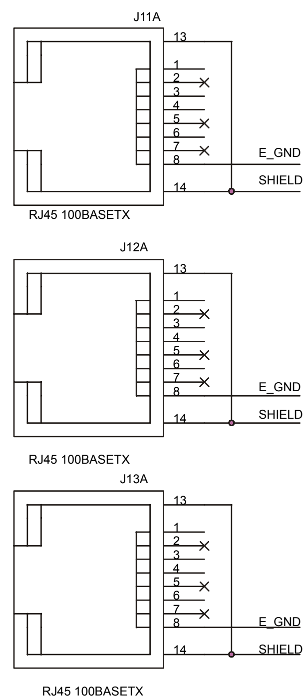
Internal connections of the RJ-45 PCB jack are shown below in Figure 4.9-2. Inside each jack, RJ-45 pins 4, 5, 7, 8 are connected through 75 ohm resistors and a capacitor to a ground reference (E_GND) on pin 8 of the PCBA header. (All three jacks share the same E_GND reference.) Switch S5 on the board allows E_GND to be shorted to either chassis ground (default) through the front panel or REFEL. Similarly, case pins 13 and 14 on all jacks are connected to a common shield reference that may be shorted to either chassis or REFEL with switch S6. If the external RJ-45 connector is shielded, the cable shield will contact the case of the RJ-45 socket. REFEL is a special voltage reference only available on custom backplanes and typically not used in most systems.

RJ-45 INTERNAL WIRING



RJ-45 GROUNDING OPTIONS





GROUNDING OPTIONS (X=DON'T CARE)	S5	S6
E_GND TO CHASSIS	0	X
E_GND TO REFEL	1	X
SHIELD TO CHASSIS	X	0
SHIELD TO REFEL	X	1

Figure 4.9-2: EIB-10/100 RJ-45 Grounding Options

A view of the EIB-10/100 PCBA is given in Figure 4.9-3. Although many configurations are available for the switching hub chip, the default settings from the factory should normally be used.

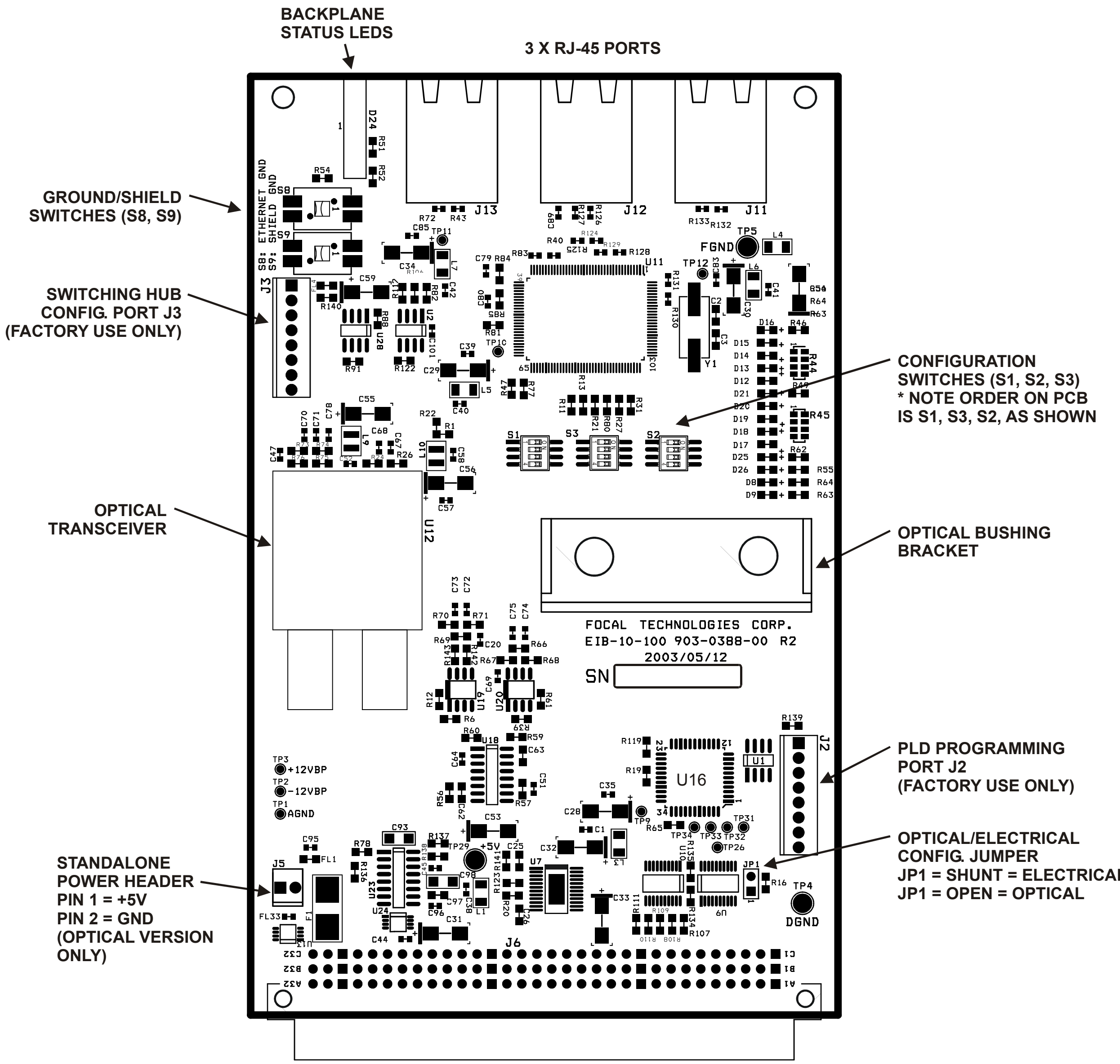


Figure 4.9-3: EIB-10/100 PCBA

Table 4.9-2 shows the settings for auto-negotiate or forced protocol. Auto-negotiate automatically configures the data rate and duplex mode of the port to match the external device connected and typically occurs within a few seconds after making a connection. Each port may be independently forced to one of the configurations listed.

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

Table 4.9-2: RJ-45 Individual Port Settings

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

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

Table 4.9-3 shows additional global settings that may be switch configured. These settings apply to all ports simultaneously.

Table 4.9-3: Global Port Settings

PARAMETER	Switch	Settings
Flow Control	S1:4	1 = DISABLED, 0 = ENABLED (DEFAULT)
Broadcast Protection	S2:4	1 = DISABLED, 0 = ENABLED (DEFAULT)
Backwards Compatibility	S3:4	1 = DISABLED (DEFAULT), 0 = ENABLED
RJ-45 Port Grounding	S5	1 = REFEL (REF. GND), 0 = CHASSIS (DEFAULT)
RJ-45 Shield Grounding	S6	1 = REFEL (REF. GND), 0 = CHASSIS (DEFAULT)

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

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

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

4.9.3 Flow Control

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

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

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

The switch will not forward the following types of packets:

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

4.9.4 Optical Configuration

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

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

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

Figure 4.9-4 shows the CWDM optical connections on the EIB-10/100 cards. Typical bypass loss is less than 2.5 dB for wavelengths passed through the EIB-10/100 to other cards, such as FMBs. When integrated with an FMB card at the factory, optical jumpers are internally routed between the FMB and the EIB-10/100. When integrated with an FMB in the field, optical jumpers may be routed externally between the front panel bushings of the FMB and the EIB-10/100.

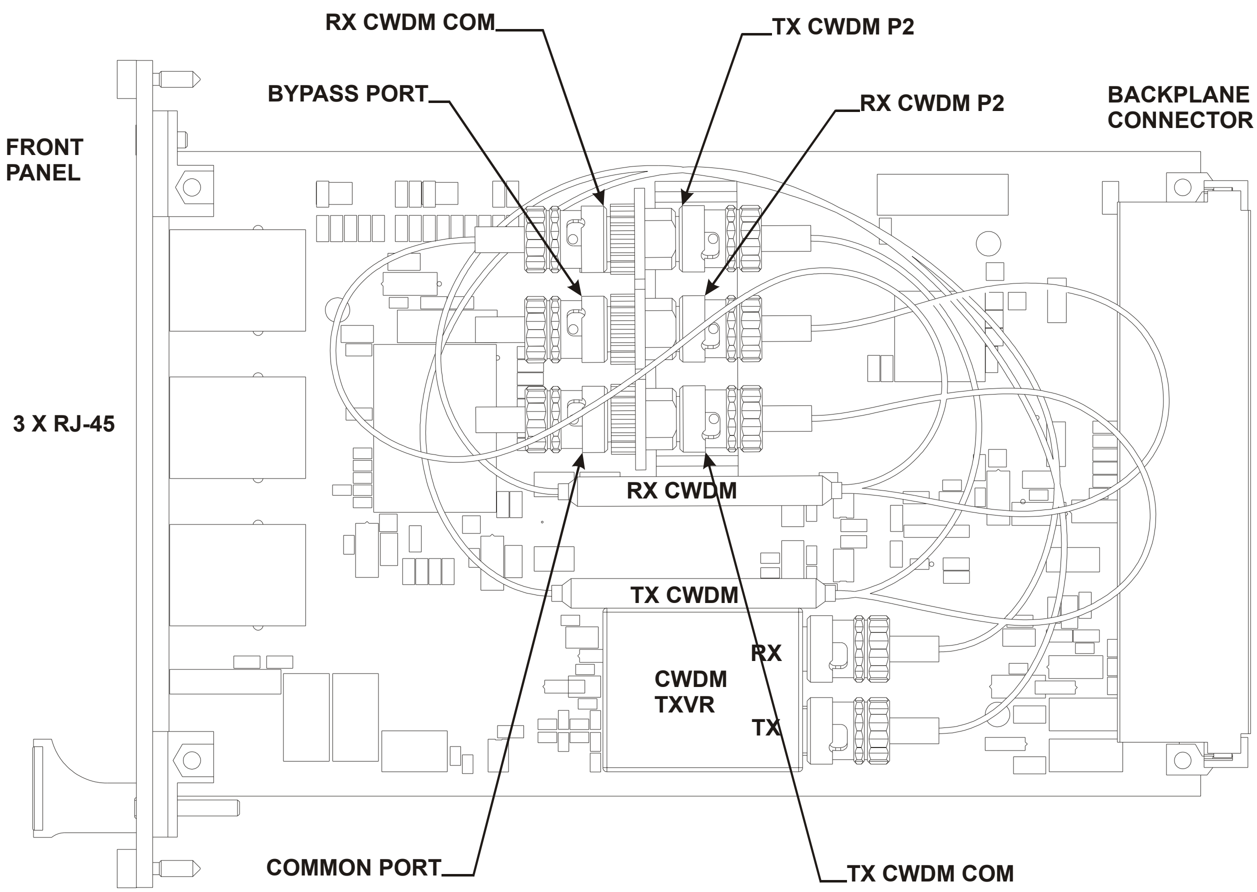


Figure 4.9-4: EIB-10/100 Optics Configuration

4.10 ECL-01R/C - ECL Interface Board

The ECL-01 ECL interface board is an optical interface card providing fiber optic transmission of one high-speed ECL signal, typically sonar, between the remote and console modules. Each card is configured either as an ECL input at the remote end, for connection to a sonar head, or an ECL output at the console end for connection to a sonar processing unit. The ECL-01 may be installed in any data card slot or in a standalone mode with it's own small enclosure.

A front panel view of the card in Figure 4.10-1 shows connector and LED locations. ECL inputs and outputs use a pair of SMB connectors. In single ended configurations, such as the Reson 81xx, only the ECL+ input/output SMB connector is used. Two WAGO connectors are available for two optional AIB plug-in modules, which operate in the same fashion as described in section 4.6. The green LED on each AIB connector indicates presence of data going into the front panel (red LED) or out of the front panel (green LED), in exactly the same manner as for the AIB-4 card. For serial data links, the LEDs are on when the corresponding line is in the "space" state. With no plug-in cards installed, both LEDs are on.

Supported sonars include the Reson 81xx series, Klein, and Kongsberg EM2000 and EM3000. Inputs may be switch configured for single-ended 75 ohm impedance or for single-ended or differential 50 ohm impedance. Input lines are AC-coupled, allowing the ECL input to be standard ECL, PECL, or Pseudo-ECL. Input cabling should be chosen with the same impedance as the ECL inputs. Output lines are AC-coupled with approximately 0.8 Vpp amplitude. As-built optical and input/output configuration is given by installation drawings in Appendix B.

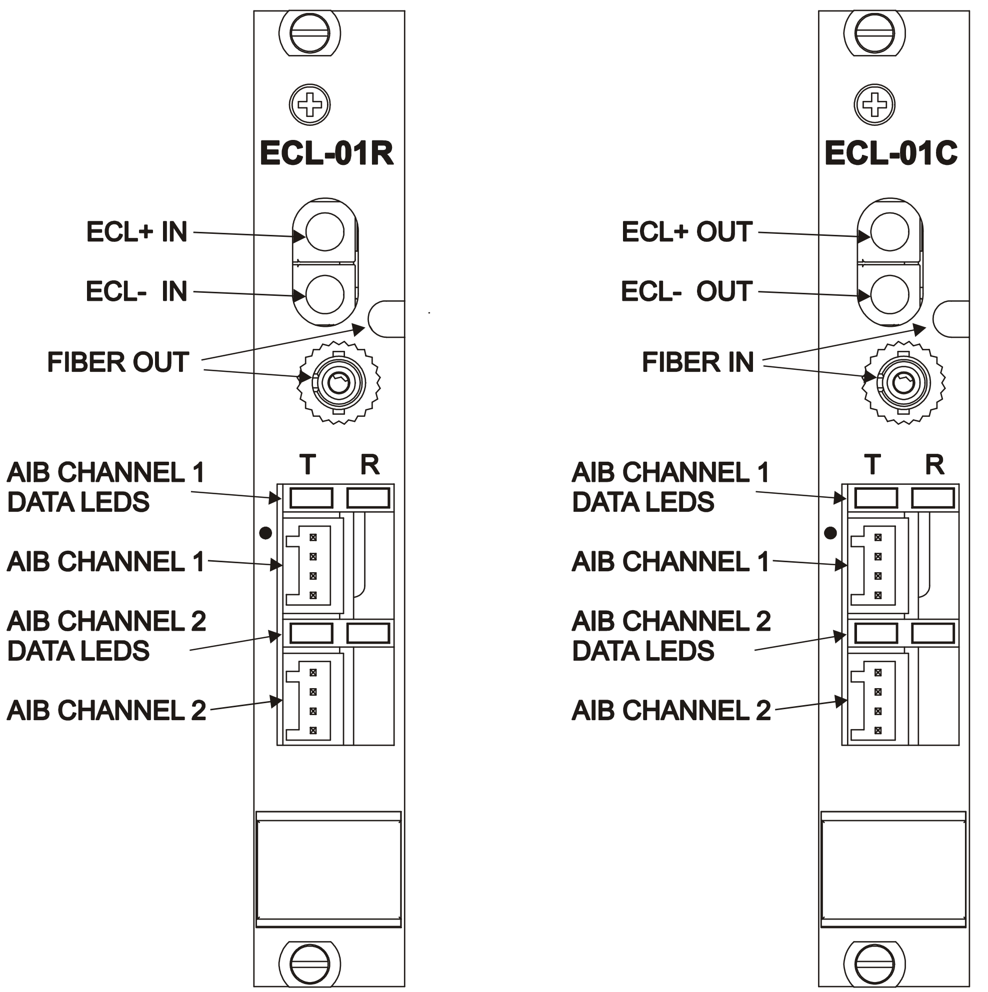


Figure 4.10-1: ECL-01R, ECL-01C Front Panels

Table 4.10-1 below shows the switch settings for the high-speed sonar configurations. The ECL link supports data rates from 30-150 Mbps. The AIB plug-in modules support data rates consistent with the plug-ins used and the type of data slot in which the card is installed.

Table 4.10-1: ECL-01R/C Configuration Switch Settings

Switch	ECL-01R		ECL-01C	
	SINGLE ENDED INPUT, 75 OHM (Reson 81XX)	DIFFERENTIAL INPUT, 50 OHM (Klein, EM2000/3000)	SINGLE ENDED OUTPUT, 75 OHM (Reson 81XX)	DIFFERENTIAL OUTPUT, 50 OHM (Klein, EM2000/3000)
SW1:1	Closed	Closed	Open	Open
SW1:2	Open	Closed	Open	Open
SW2:1	Closed	Open	N/A	N/A
SW2:2	Closed	Open	N/A	N/A
SW3:1	Open	Closed	N/A	N/A
SW3:2	Open	Closed	N/A	N/A
SW4:1	Open	Open	Closed	Closed
SW4:2	Open	Open	Open	Closed

The ECL-01 card uses a separate optical wavelength, typically in an uplink configuration. (Consult Focal for other possible configurations.) The channel may be transmitted on a separate external fiber than that used by the FMB card or, by using CWDM wavelengths, tapped on to the existing fiber used by the FMB, which requires internal or external fiber jumpers. External access is configured for either the front panel fiber bushings or through the small panel cutout for passing a fiber directly through to an internal bushing on the board. Internal jumpers, if used, are connected to bushings on the ECL card and routed through the bottom of the rack to the FMB card.

Typically, on factory-installed systems, internal jumpers are installed inside the rack to tap the ECL optical signal into the FMB fiber. ECL-01 cards installed in field systems after shipment usually use a single external fiber jumper from the FMB card to the top bushing or cut-out on the ECL card, with a second fiber leaving the bottom bushing or cut-out to carry the combined FMB/ECL optical signals to the sea cable. When used in this fashion, the ECL card bypass typically adds <1.5 dB loss to the FMB flux budget. Dual FMB systems must use internal fiber jumpers for ECL optical integration. Refer to Appendix B for as-built optical configuration.

A view of the ECL-01R/C PCBA is given in Figure 4.10-2 showing locations of the configuration switches. Circuit 1 corresponds to the switch at the pin 1 end of the DIP package. Pin 1 is marked by a rectangular pad on the PCB and a "1" on the DIP package itself.

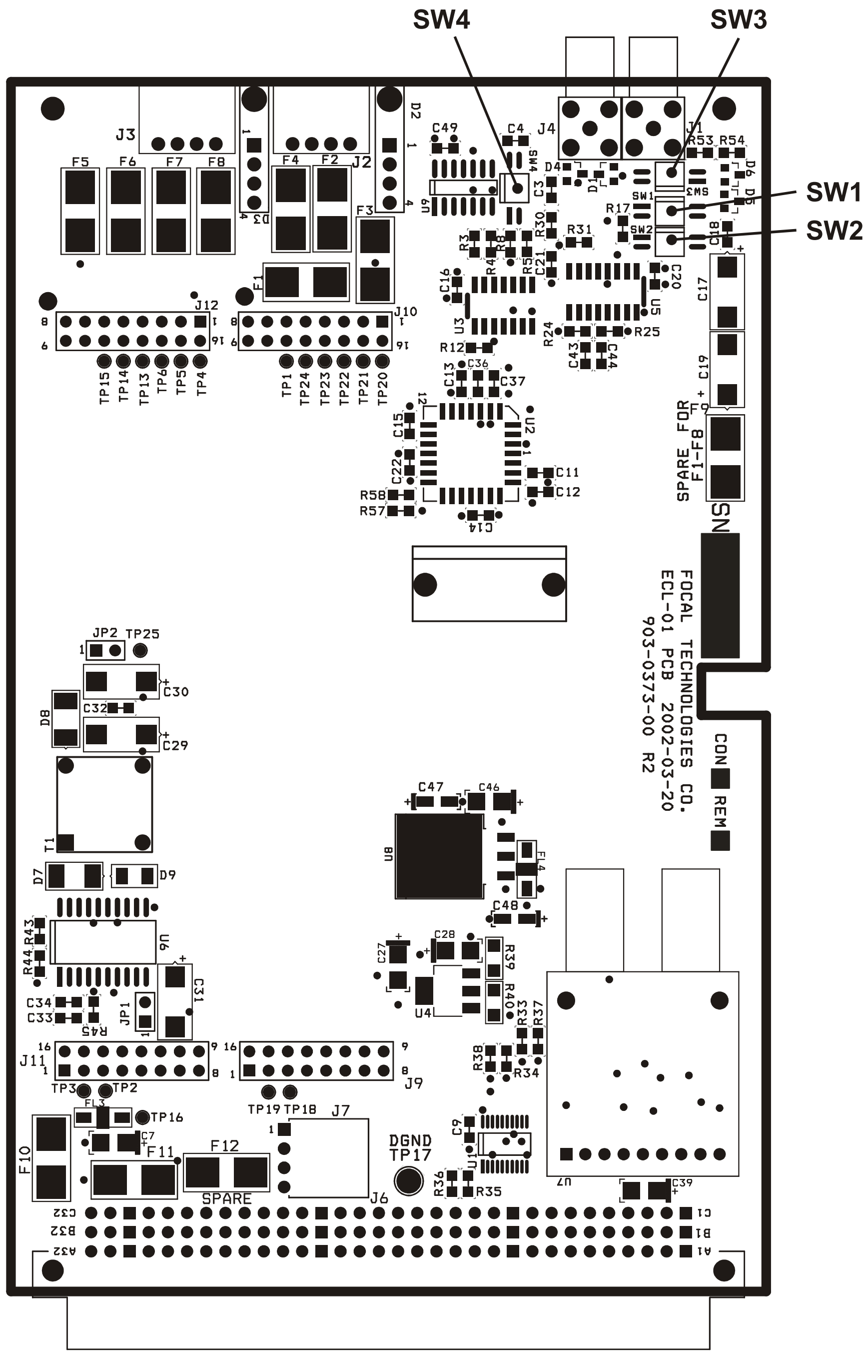


Figure 4.10-2: ECL-01 PCB

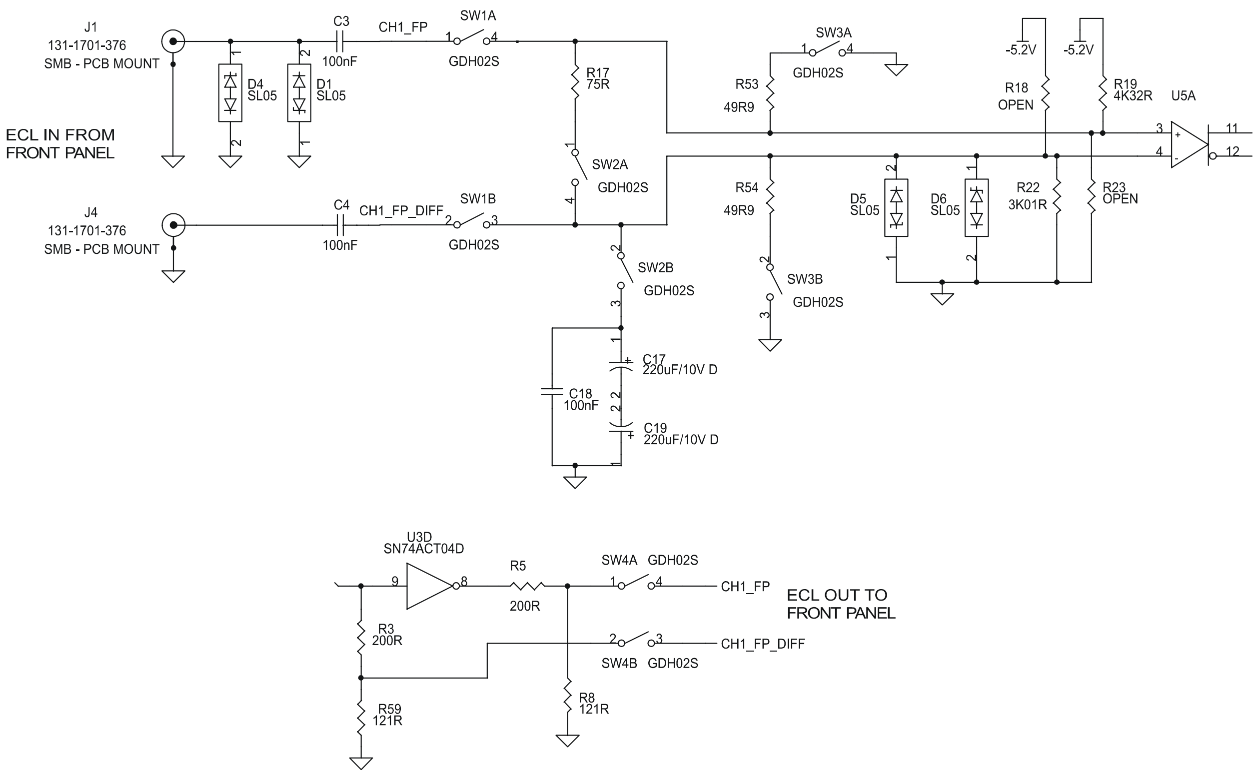


Figure 4.10-3: ECL-01R Input Schematic (Top), ECL-01C Output Schematic (Bottom)

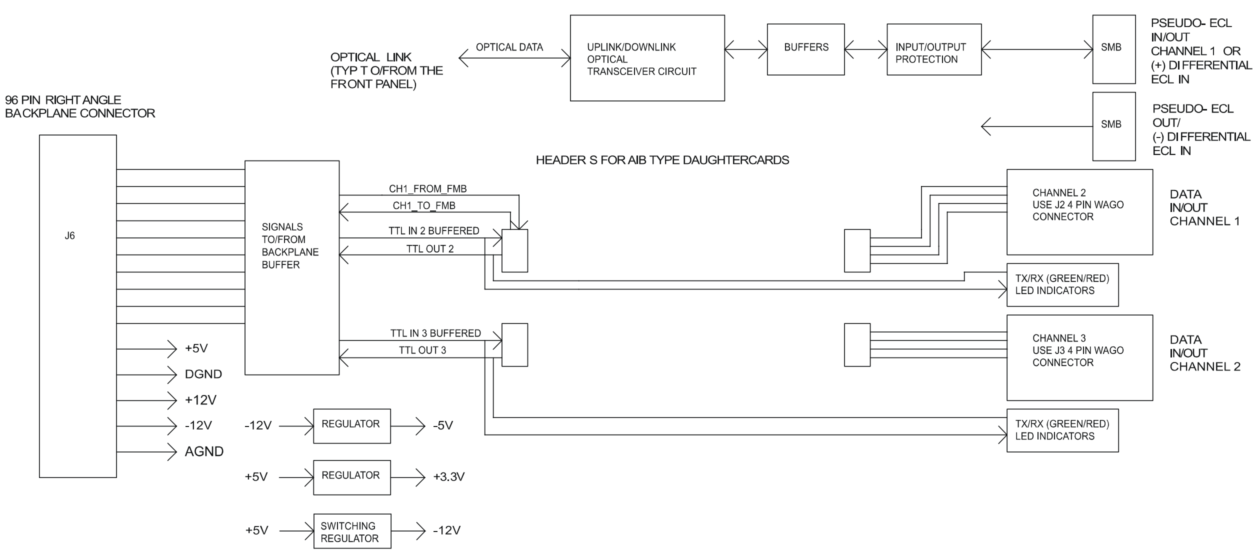


Figure 4.10-4: ECL-01 Block Diagram

4.11 ECL-02 - Dual ECL Interface Board

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

A front panel view of the card in Figure 4.11-1 shows connector and LED locations. The data mode LEDs by each channel indicate the current optical and signal mode: red LEDs mark an ECL input, usually on the remote card, and green LEDs mark an ECL output, usually on the console card. Both channels A and B have dual SMB connectors. In single ended configurations, such as the Reson 81xx, only the ECL+ input/output SMB connectors are used.

Supported sonars include the Reson 81xx series, Klein, and Kongsberg EM2000 and EM3000. Inputs and outputs may be switch configured for 50 ohm or 75 ohm input and for single ended or differential ECL inputs. Input lines are AC-coupled, allowing the ECL input to be standard ECL, PECL, or Pseudo-ECL. Input cabling should be chosen with the same impedance as the ECL inputs. Output lines are AC-coupled with approximately 0.8 Vpp amplitude. As-built optical and input/output configuration is given by installation drawings in Appendix B.

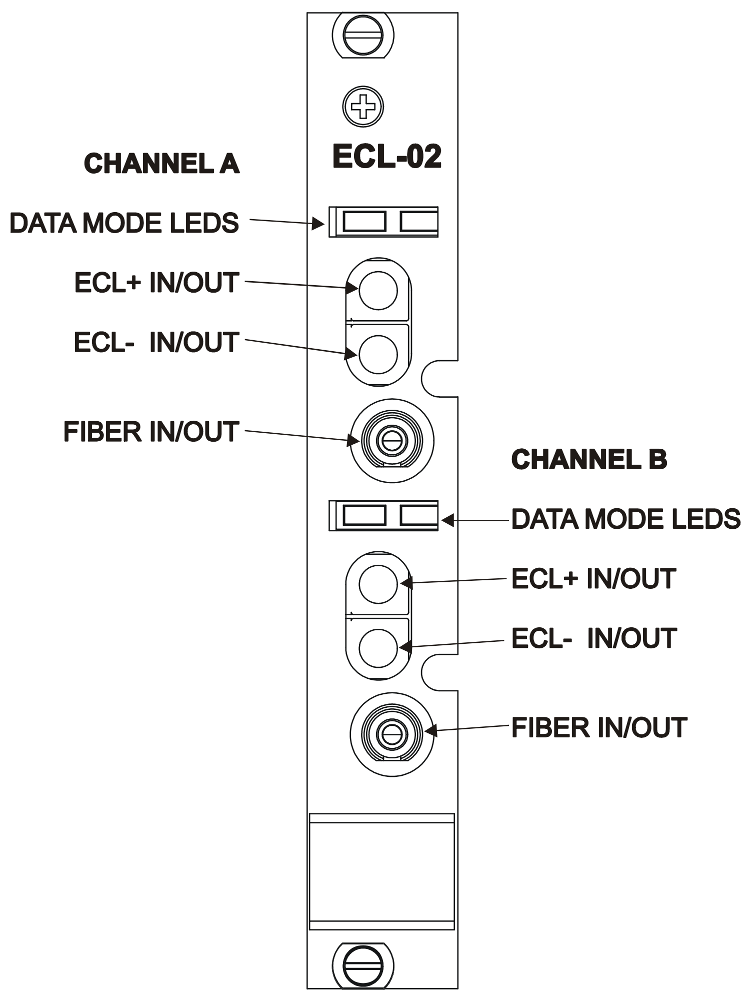


Figure 4.11-1: ECL-02 Front Panel

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

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

Table 4.11-1 below shows the switch settings for the ECL configurations. The ECL link supports data rates from 30-150 Mbps. Figure 4.11-2 is a view of the PCBA showing the location of the switches. Circuit 1 corresponds to the switch at the pin 1 end of the DIP package. Pin 1 is marked by a rectangular pad on the PCB and a "1" on the DIP package itself.

Table 4.11-1: ECL-02R/C Configuration Switch Settings

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

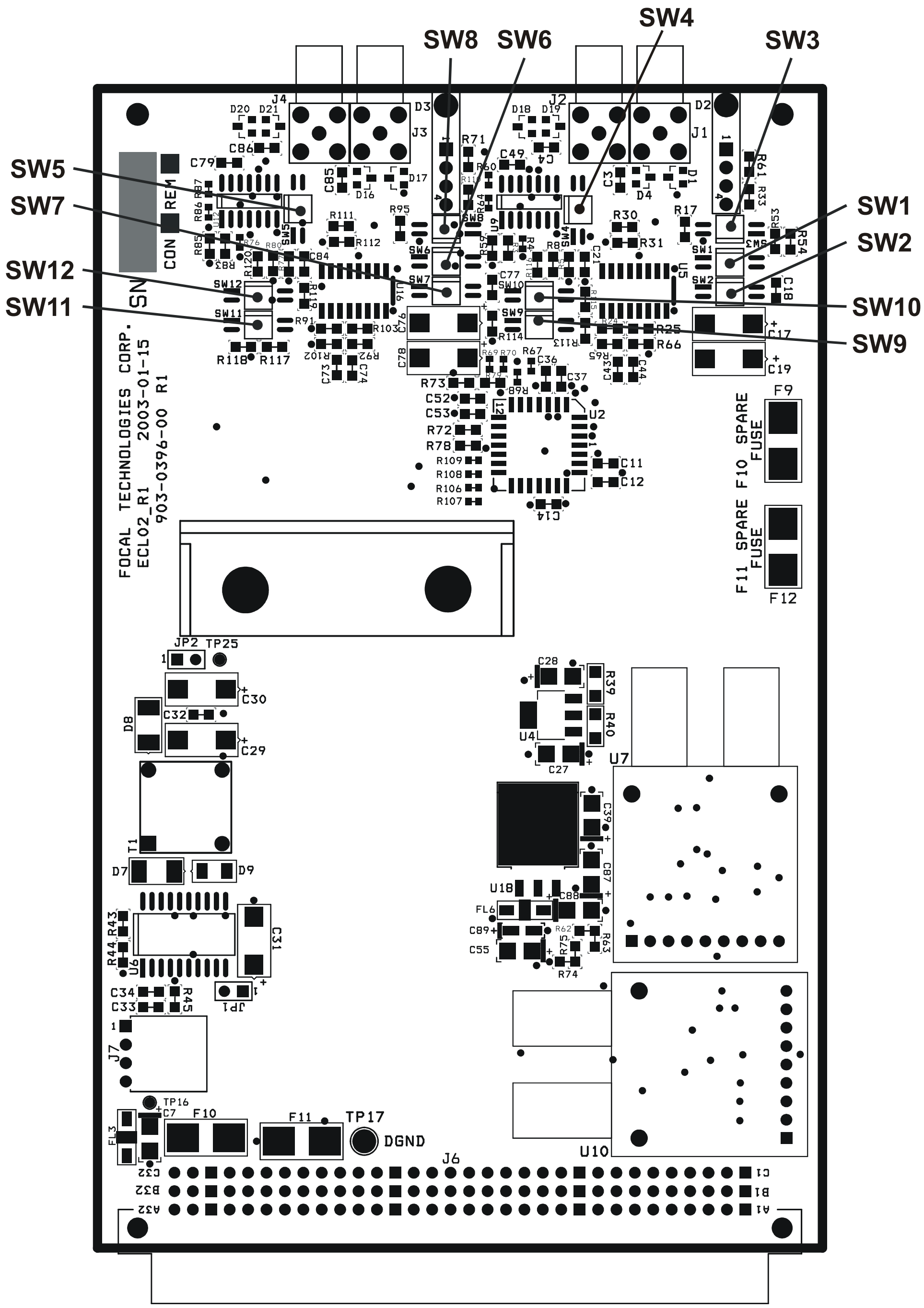


Figure 4.11-2: ECL-02 PCBA

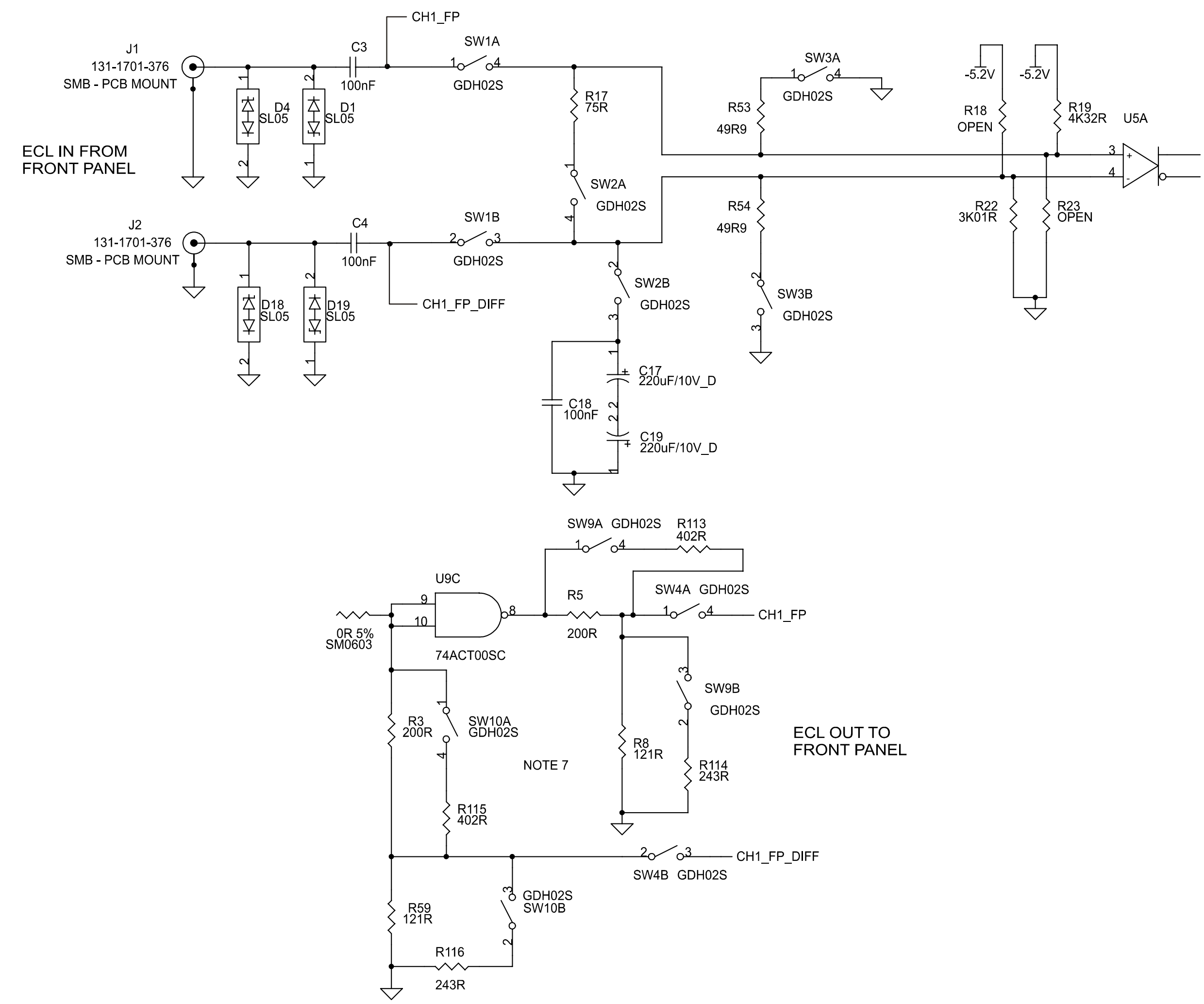


Figure 4.11-3: ECL-02 Input Schematic (Top) and Output Schematic (Bottom)

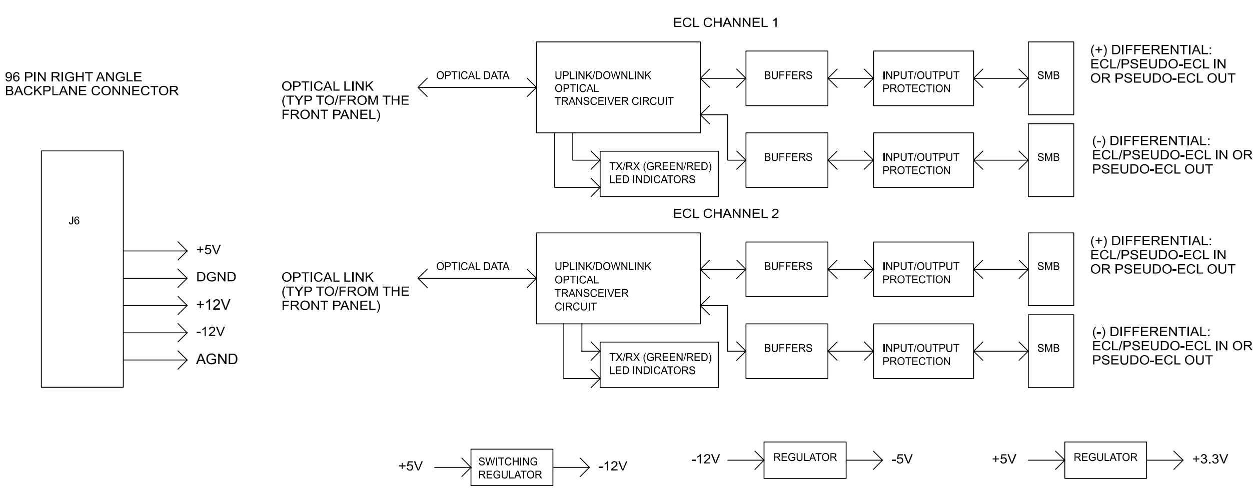


Figure 4.11-4: ECL-02 Block Diagram

5.0 Fiber Optics

5.1 Safety

Both 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, to provide a single fiber optic interface to a user's cable or umbilical. A block diagram of a typical system is provided in the following figure. The system is designed to work with up to two fiber optic rotary joints and up to 10 km of SMF-28 singlemode fiber or up to 4 km of multimode fiber, depending on the fiber's bandwidth. Front panel connectors may be FC-PC, FC-APC, or ST-PC, per customer specifications.

System design consists largely of preparing a flux 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. A sample flux budget calculation is given in Table 5.1-1.

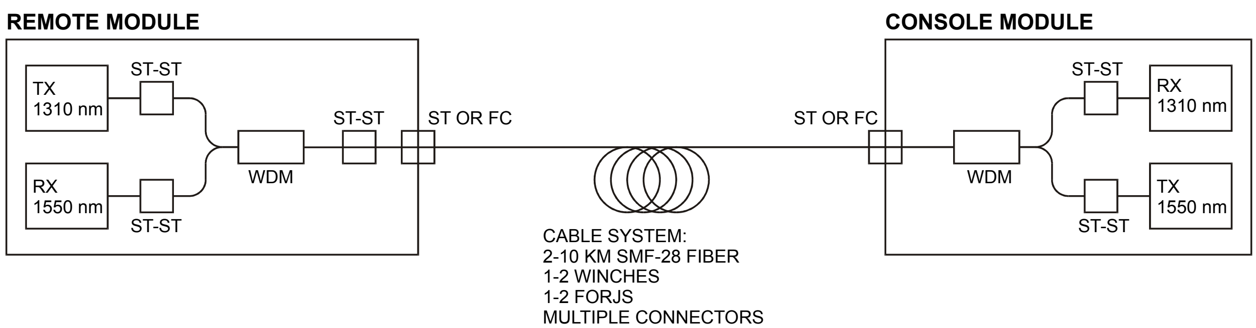


Figure 5.1-1: Block Diagram of Model 903 Fiber Optic Transmission System

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

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

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

Table 5.1-1: Typical ROV System Flux Budget

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

LINK	**VIDEO/DATA**	**DATA**	
Rate	1375 MBaud	172 MBaud	
Direction	ROV to Surface	Surface to ROV	
Wavelength	1310 nm	1550 nm	
Typical Output Power at Front Panel Connector	**-4.0**	**-8.0**	**dBm**
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	**-18.4**	**-21.4**	**dBm**
Dispersion Penalty	-1.0	-1.0	dB
Required Sensitivity (At Front Panel)	**-19.4**	**-22.4**	**dBm**
Typical sensitivity at front panel	-29.0	-33.0	dBm
Available Margin	9.6	10.6	dB

6.0 Installation And Operation

6.1 Mounting

The console module is intended to be rack-mounted with the side flanges. Extender pieces, which are available separately, may be used for mounting to a standard 19" equipment rack. Refer to Figure 6.1-1 and the installation drawing in Appendix B for spacing and dimensions.

The remote module should be mounted to a frame in the ROV electronics pressure case. Side flanges, supplied separately, may be used. The four PEM nuts are installed on each side plate, per Figure 6.1-2 and installation drawings, allow for other mounting arrangements. If the PEM nuts are used, ensure mating hardware does not extend past the PEM nut threads, as this may cause interference or damage with internally mounted cards.

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

6.2 Cooling

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

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

6.3 Diagnostics

The Model 903 is provided with an advanced diagnostics program with an intuitive display interface to monitor the basic condition of the multiplexer system. A DB-9F COM port on the Model 903 console module can be connected to a PC with the cable provided. The diagnostic program monitors the system power supply voltages at both the remote and console modules, the temperature on the board surface of each FMB, and the condition of the two optical links between the two modules, including transmitted and received optical power. In addition, the program also indicates the presence of valid composite video signals (four on each video or high density board) at both the console and remote ends of the system.

For further detail on the installation and operation of the diagnostic and monitoring software refer to Appendix C.

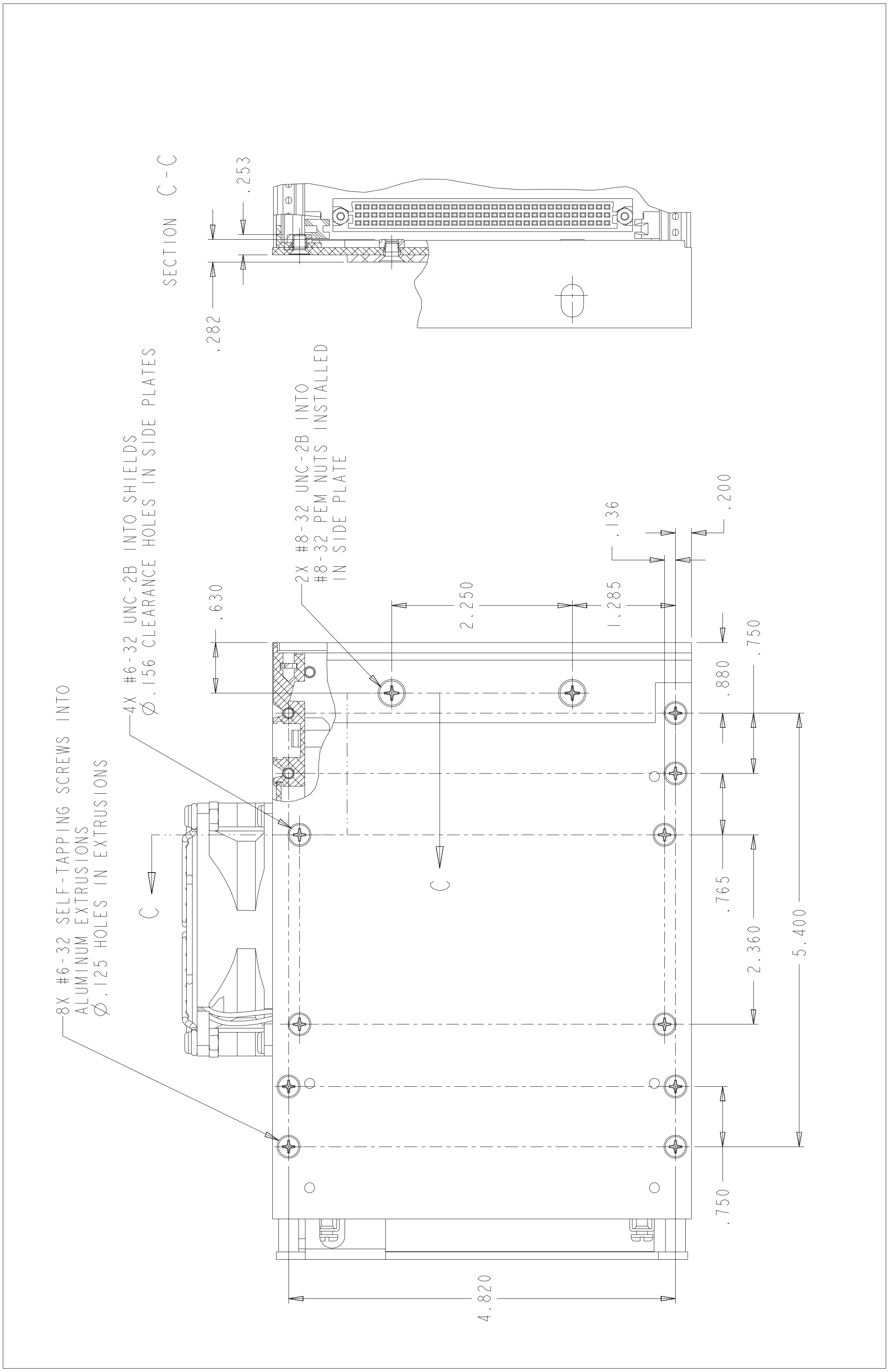


Figure 6.1-1: Side View of Model 903 Console Card Cage

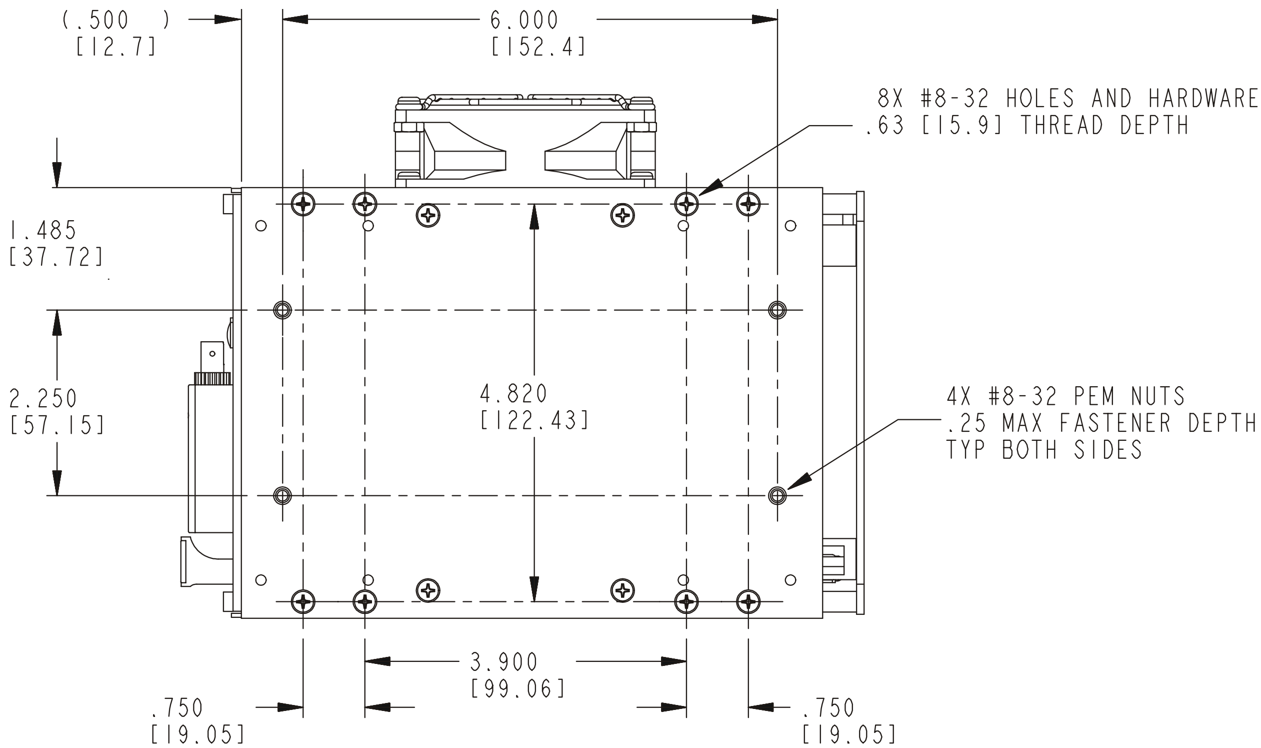


Figure 6.1-2: Side View of Model 903 Remote Card Cage

6.4 Bench Test

Basic Link Operation

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

2. The green "Link" LED on the console FMB indicates a valid uplink and is lit when data frames are being received from the remote end. The green "Link" LED on the remote FMB indicates a valid downlink and is lit when data frames are being received from the console end.

3. An unlit 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 — both link LEDs are off — 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 power FMBs directly with an ordinary fiber jumper. A minimum loss of 5 dB for medium speed uplinks and 10 dB for high-speed uplinks is required between the front panels of the console and remote units when using the high power FMBs to ensure the receivers are not saturated or damaged.

Flux Budget Test

1. To verify the uplink flux budget, measure the 1310 nm transmit power of the remote FMB by connecting a bushing directly to a calibrated optical power meter using a short, low loss singlemode or 50/125 um multimode jumper, as appropriate.

2. Remove the test jumper and install a variable optical attenuator (VOAT) between the remote and console FMBs with a minimum 5 -10 dB loss. Adjust the VOAT until a link LED on either one of the modules starts to flicker or go out, then reduce the loss to the point where both link LEDs are continuously on. (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.

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

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

The diagnostics software, as described in Appendix C, is also helpful during bench testing. Presence of data errors on the program's display screen may be used instead of the link LEDs to determine the receiver thresholds. This provides a more accurate flux budget, since as received power drops, errors occur in the data frames before synchronization is lost. Bit Error Rate (BER) is estimated by dividing the number of errors for the uplink or downlink by the number of bits transmitted for the duration of the test.

Assuming errors are relatively infrequent and accounting for the percentage of detectable single bit frame errors (1 in 6 for the uplink, 1 in 5 for the downlink), one error per hour measured by the software translates to a BER of roughly 10^{-11} for the downlink and 10^{-12} for the uplink. The accumulated error display is useful for long duration testing, since the screen does not have to be monitored for the entire test. The diagnostics software can also log data to a file for future reference.

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 than 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 up) 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 acetone or isopropyl alcohol, and a lint free cloth to carefully wipe any dirt off the face of the ceramic ferrules prior to making a connection. Always replace dust caps on the Model 903 fiber optic bushings when removing connectors. If bushings are left open, they should be cleared of dust with compressed air prior to connection.

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.

BOARD REMOVAL AND INSTALLATION

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

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

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

GENERAL HANDLING

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

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

Special Considerations For FMB-VTX/VRX, EIB-10/100, ECL-01, ECL-02 Optical Cards

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

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

If new FMB cards are installed in a system, recalibrate the software per Appendix C.

APPENDICES

APPENDIX A - DATA SHEETS

APPENDIX B - INSTALLATION DRAWINGS

APPENDIX C - DIAGNOSTIC SOFTWARE

APPENDIX D - CONNECTOR PART NUMBERS AND PIN ASSIGNMENTS

Location on Model 903	Source	Part Number, Description	Mating Part
AIB-4 Data Connectors	WAGO	733-364 4-pin RA Header	733-104 4-pin Connector
Backplane Power Terminals	Keystone	8191	Standard #6 Ring Lug
CIB-10 Control I/O Connector	AMP	748482-5 44-Pin HD-22 RA Hdr. Female D-Sub	748366-1 44-pin HD-22 Male D-Sub (or equivalent)
DC-DC Converter Module 1 x DC Input	Molex	26-60-5020 2-pin, 0.156" pin RA Header	09-50-8023 (shell) 08-50-0106 (crimp pins
DC-DC Converter Module 1 x DC Output	Molex	26-60-5060 6-pin, 0.156" pin RA Header	09-50-8063 (shell) 08-50-0106 (crimp pins)
DIB-232 Data Connector	WAGO	733-363 3-pin RA Header	733-103 3-pin Connector
DIB-232-16 Data Connector	AMP	748394-6 62-pin RA D-Sub Hdr., Female	180-062-102-001 (mate) 207473-1 (RA shell)
DIB-485 Channels 1-3	WAGO	733-362 2-pin RA Header	733-102 2-pin Connector
DIB-485 Channels 4-5	WAGO	733-364 4-pin RA Header	733-104 4-pin Connector
ECL-01R/C AIB Connectors	WAGO	733-364 4-pin RA Header	733-104 4-pin Connector
ECL-01R/C ECL Connectors	Johnson	131-1701-376 SMB Jack, RA	131-1403-116 SMB Plug Connector (RA)
ECL-02 ECL Connectors	Johnson	131-1701-376 SMB Jack, RA	131-1403-116 SMB Plug Connector (RA)
EIB-10/100 Ethernet Connectors	Stewart (+ others)	Standard RJ-45 Jack	Standard RJ-45 Plug
EIB-10BT Ethernet Connectors	Amphenol (+ others)	Standard RJ-45 Jack	Standard RJ-45 Plug
FMB-VRX Diagnostics Connector	Amphenol (+ others)	Standard 9-pin Male D-Sub Connector	Standard 9-pin Female D-Sub Connector
FMB-VTX/-VRX Fiber Bushings	Molex	86152-1000 FC-FC Bushing or 86110-1000 ST-ST Bushing	Standard FC/PC Connector or Standard ST/PC Connector
VIB-RX Video Output Connectors	Johnson	131-1701-376 SMB Jack, RA	131-1403-016 SMB Plug Connector (Str.)
VIB-TX Video Input Connectors	Johnson	131-1701-376 SMB Jack, RA	131-1403-116 SMB Plug Connector (RA)

CONNECTOR PIN ASSIGNMENTS

Board	Connector	Signal Type	Pin #	Designation
AIB-232 AIB-4 Plug-In	4-pin WAGO	RS-232 (DCE)	1 2 3 4	ISOGND Receive (RX) Transmit (TX) N/C or Chassis
AIB-485 AIB-4 Plug-In	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 AIB-4 Plug-In	4-pin WAGO	Tritech Sonar ARCNET	1 2 3 4	Chassis LAN+ LAN- N/C
AIB-HYDRO AIB-4 Plug-In	4-pin WAGO	Hydrophone, Analog Signals	1 2 3 4	Chassis (Optional) N/C - Signal (GND on output) + Signal
AIB-MS900 AIB-4 Plug-In	4-pin WAGO	MS900 Analogue Sonar	1 2 3 4	Chassis (Optional)** N/C Sonar Data Sonar Data
CIB-10	HD-22, 44-Pin D-Sub Connector (Female)	TOR Input [TOR Output]	1 [11] 2 [12] 3 [13] 4 [14] 5 [15] 6 [31] 7 [33] 8 [35] 9 [37] 10 [39] 16 [26] 17 [27] 18 [28] 19 [29] 20 [30] 21 [32] 22 [34] 23 [36] 24 [38] 25 [40] 41 [42] 43-44	Channel 1 +In [+Out] Channel 2 +In [+Out] Channel 3 +In [+Out] Channel 4 +In [+Out] Channel 5 +In [+Out] Channel 6 +In [+Out] Channel 7 +In [+Out] Channel 8 +In [+Out] Channel 9 +In [+Out] Channel 10 +In [+Out] Channel 1 -In [-Out] Channel 2 -In [-Out] Channel 3 -In [-Out] Channel 4 -In [-Out] Channel 5 -In [-Out] Channel 6 -In [-Out] Channel 7 -In [-Out] Channel 8 -In [-Out] Channel 9 -In [-Out] Channel 10 -In [-Out] Shield [Shield] N/C

DC-DC Converter	2-pin Molex 6-pin Molex	DC Power Input DC Power Output	1 2 1 2 3 4 5 6	+VDC In GND DGND +5 V -12 V AGND +12 V N/C
DIB-232	3-pin WAGO	RS-232 (DCE)	1 2 3	Ground Receive (RX) Transmit (TX)
DIB-232-16	62-Pin D-Sub Connector (Female)	RS-232	21, 20, 41 19, 18, 39 62, 61, 40 60, 59, 38 16, 15, 36 14, 13, 34 57, 56, 35 55, 54, 33 11, 10, 31 9, 8, 29 52, 51, 30 50, 49, 28 4, 3, 25 2, 1, 23 46, 45, 24 44, 43, 22	Ch1 RS-232 In, Out, Gnd Ch2 RS-232 In, Out, Gnd Ch3 RS-232 In, Out, Gnd Ch4 RS-232 In, Out, Gnd Ch5 RS-232 In, Out, Gnd Ch6 RS-232 In, Out, Gnd Ch7 RS-232 In, Out, Gnd Ch8 RS-232 In, Out, Gnd Ch9 RS-232 In, Out, Gnd Ch10 RS-232 In, Out, Gnd Ch11 RS-232 In, Out, Gnd Ch12 RS-232 In, Out, Gnd Ch13 RS-232 In, Out, Gnd Ch14 RS-232 In, Out, Gnd Ch15 RS-232 In, Out, Gnd Ch16 RS-232 In, Out, Gnd
DIB-485	2-pin WAGO 4-pin WAGO	RS-485 RS-422 RS-485 TTL (Channel 5 Only)	1 2 1 2 3 4 1 2 3 4 1 2 3 4	+ TX/RX - TX/RX + RX - RX + TX - TX + TX/RX - TX/RX N/C N/C TTL In N/C TTL Out ISOGND
ECL-01	SMB 4-pin WAGO	ECL, PECL, Pseudo Various	Core Shield 1, 2, 3, 4	ECL Signal Ground Per AIB section above
ECL-02	SMB	ECL, PECL, Pseudo	Core Shield	ECL Signal Ground

EIB-10/100	RJ-45	Ethernet 10Base-T or 100Base-TX	1 2 3 4, 5 6 7 8 Body	RX+ RX- TX+ N/C TX- N/C 0V Shield
EIB-10BT	RJ-45	10Base-T Ethernet	1 2 3 4, 5 6 7 8	RX+ RX- TX+ N/C TX- N/C 0V
FMB-VRX	DB-9P	Diagnostic Port	1 2 3 4 5 6-9	N/C Receive (RXD) Transmit (TXD) N/C Ground (Isolated) N/C
VIB-RX	SMB	Video	Core Shield	Video Signal Ground
VIB-TX VIB-TX-8	SMB	Video	Core Shield	Video Signal Ground

APPENDIX E - FUSES

MODEL 903 FUSE PROTECTION

REMOTE MODULE RACK

Qty.	PSU/Fan	Fuse Part Number	Rating	Fuse Type	Mftr.	Comments
1	120 VAC 240 VAC	GMD-1	1 A	Metric Time Delay	Bussmann	Located at the top of the module on the backplane, this fuse protects the primary AC or DC voltage input.
	24 VDC	GMD-2	2 A			
	48 VDC	GMD-1.5	1.5 A			
	DC-DC Converter Module	GMD-3	3 A			Fuse located on the DC-DC module board mounted on back cover plate.
2	12VDC Fan	miniSMD050	0.5A	Resettable	Raychem	SMT fuse on back-plane underneath back cover plate. Used for 12VDC fans.

CONSOLE MODULE RACK

Qty.	PSU/Fan	Fuse Part Number	Rating	Fuse Type	Mftr.	Comments
1	120 VAC 240 VAC	GMD-1	1 A	Metric Time Delay	Bussmann	Located at the top of the module on the backplane, this fuse protects the primary AC or DC voltage input.
	24 VDC	GMD-2	2 A			
	48 VDC	GMD-1.5	1.5 A			
2	12VDC Fan	miniSMD050	0.5A	Resettable	Raychem	SMT fuse on back-plane underneath back cover plate. Used for 12VDC fans.

AIB-4

Qty.	Fuse Part Number	Current Rating	Comments
1	R452001	1.0A	SMT fuse to protect on-board +5VDC (F17)
2	R452.500	0.5A	SMT fuse to protect on-board +/-12VDC (F19/F20)
15	R451.250	0.25A	SMT fuse (with fuse holder) for i/o protection (F1-F16). Spare on-board fuse (F18).

CIB-10

Qty.	Fuse Part Number	Current Rating	Comments
1	R452.500	0.5A	SMT fuse to protect on-board +5VDC (F1)
1	R452.500	0.5A	SMT fuse to protect on-board -12VDC (F2)

DIB-232

Qty.	Fuse Part Number	Current Rating	Comments
1	R452.500	0.5A	SMT fuse to protect on-board +5VDC (F12)
11	R451.250	0.25A	SMT fuse (with fuse holder) for input/output RS-232 protection (F1-F6, F8-F11). Spare on-board fuse (F7).

DIB-485

Qty.	Fuse Part Number	Current Rating	Comments
1	R452001	1.0A	SMT fuse to protect on-board +5VDC (F15)
15	R451.250	0.25A	SMT fuse (with fuse holder) for input/output RS-485 protection (F1-F14). Spare on-board fuse (F16).

DIB-232-16

Qty.	Fuse Part Number	Current Rating	Comments
1	R452001	1.0A	SMT fuse to protect on-board +5VDC (F1)

ECL-01

Qty.	Fuse Part Number	Current Rating	Comments
1	R45201.5	1.5A	SMT fuse to protect on-board +5VDC (F10)
1	R45201.5	1.5A	SMT fuse to protect on-board -12VDC (F11)
9	R451.250	0.25A	SMT fuse (with fuse holder) for i/o protection on two AIB channels (F1-F8). Spare on-board fuse (F9).

ECL-02

Qty.	Fuse Part Number	Current Rating	Comments
1	R452003	3A	SMT fuse to protect on-board +5VDC (F10)
1	R45201.5	1.5A	SMT fuse to protect on-board -12VDC (F11)

EIB-10BT

Qty.	Fuse Part Number	Current Rating	Comments
1	R452001	1.0A	SMT fuse to protect on-board +5VDC (F2)
1	R452.500	0.5A	SMT fuse to protect on-board +12VDC (F3)

EIB-10/100

Qty.	Fuse Part Number	Current Rating	Comments
1	R452003	3A	SMT fuse to protect on-board +5VDC (F1)

FMB-VTX

Qty.	Fuse Part Number	Current Rating	Comments
1	R452003	3A	SMT fuse to protect on-board +5VDC (F2)
2	R452.500	0.5A	SMT fuse to protect on-board +/-12VDC (F1/F3)

FMB-VRX

Qty.	Fuse Part Number	Current Rating	Comments
1	R452003	3A	SMT fuse to protect on-board +5VDC (F1)
2	R452.500	0.5A	SMT fuse to protect on-board +/-12VDC (F2/F3)

VIB-RX

Qty.	Fuse Part Number	Current Rating	Comments
1	R45201.5	1.5A	SMT fuse to protect on-board +5VDC (F2)
2	R452.500	0.5A	SMT fuse to protect on-board +/-12VDC (F1/F3)

VIB-TX

Qty.	Fuse Part Number	Current Rating	Comments
1	R45201.5	1.5A	SMT fuse to protect on-board +5VDC (F6)
2	R452.500	0.5A	SMT fuse to protect on-board +/-12VDC (F5/F7)
5	R451.250	0.25A	SMT fuse (with fuse holder) for input protection (F1-F4). Spare on-board fuse (F8).

VIB-TX-8

Qty.	Fuse Part Number	Current Rating	Comments
2	R45201.5	1.5A	SMT fuse to protect on-board +5VDC (F6)
1	R452.500	0.5A	SMT fuse to protect on-board +/-12VDC (F5/F7)
9	R451.250	0.25A	SMT fuse (with fuse holder) for input protection (F1-F4, F9-F12). Spare on-board fuse (F8).

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. R451, R452, R154 type fuses are manufactured by Littelfuse.
4. R452 type SMT fuses are time delay fuses.
5. R451 type SMT fuses are fast acting fuses.