Model 907

Fiber Optic Video/Data Multiplexer

User's Guide

Part No. 907-0601-00 Rev. C

June 20, 2011

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Document Revision History

Document Revision	Details of Revision	Author	Date
Rev 1	Preliminary release for review.	SST	April 15, 2008
Rev A	Production release.	SST/IBM	May 7, 2008
Rev B	- General update, new format. Added/deleted figures and fixed typos. - Added 907-SER, 907-GBE2, 907-HDM2 and 907-CWDM cards. - Added new reference documents and acronyms and abbreviations. - Updated appendix A (fuses table). - Added appendix B to show a summary of the Model 907 cards with description and configuration drawing part number.	ACC/IM	May 28, 2010
Rev C	- Added new 907-GEM motherboard section. - Update appendix A and B to add fuse and card information of the 907-GEM. - Added information to 907-MC, 907-USB, 907-SER and 907-DIAG sections. - Added note in section 8.2 "Power". - Updated description of 907-SPLIT card (now Optical Splitter Card). - Updated information in 907-HDM2 section. - Updated/added information in 907-DIAG-E section. (Figure 6-11 updated. Table 6-1 added) - Changed Card ID from 907-SWITCH to 907-FOS - Changed Appendix C from "Drawings" to "Model 907 Power Current".	ACC	June 20, 2011

Reference Documents

Document Number	Document Title and Description
907-0604-00	Model 907 Diagnostics Software Manual, GUI interface for Model 907 cards that support Ethernet-based diagnostics
700-0271-00	AIB Plug-In Card Manual, describes AIB plug-in modules available for various analog and digital signal types
700-0739-00	Diagnostics Protocol Manual, describes format of diagnostics data available from Model 907 systems
907-2xxx-xx	Model 907 Card Configuration Drawings

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ACRONYMS AND ABBREVIATIONS

The list below contains the acronyms and abbreviations used in this user's guide.

AIB	Adaptable Interface Board
BER	Bit Error Rate
CWDM	Coarse Wavelength Division Multiplexer / Multiplexing
ECL	Emitter Coupled Logic (Vcc = 0V)
EIA	Electronic Industries Association
EIB	Ethernet Interface Board
ESD	Electrostatic Discharge
FC/PC	Ferrule Connector (Threaded optical connector) / Physical Contact
FORJ	Fiber Optic Rotary Joint
FPGA	Field Programmable Gate Array
Gbps	Gigabits Per Second
HD-SDI	High Definition Serial Data Interface
I/O	Input/output
kbps	Kilobits Per Second
LC/PC	Lucent Connector / Physical Contact
LED	Light Emitting Diode
Mbps	Megabits Per Second
MDI/MDIX	Automatic medium-dependent interface crossover
NRZ	Non Return to Zero (Data Signaling)
NRZI	Non Return to Zero Inverted
NTSC	National Television System Committee (North American Composite Video)
P/N	Part Number
PAL	Phase Alternating Line (European Composite Video)
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembly
PECL	Positive Emitter Coupled Logic (Vcc = +5 V)
RGB	Red, Green, Blue (Component Video)
ROV	Remotely Operated Vehicle
SFP	Small Form-factor Pluggable (Optical Transceiver)
SMB	Sub-Miniature „B" (Connector)
SMPTE	Society of Motion Picture and Television Engineers
SMT	Surface Mount Technology
ST/PC	Straight Tip optical connector / Physical Contact
TDM	Time Division Multiplexer / Multiplexing
TTL	Transistor-Transistor Logic
USB	Universal Serial Bus
VOAT	Variable Optical Attenuator
WDM	Wavelength Division Multiplexer / Multiplexing
Y/C	Luminance/Chrominance (S-Video)
YPbPr	Component Video (Y = luma, Pb = difference between Blue to luma, Pr = difference between Red to luma)

1.0   Introduction

Focal Technologies' Model 907 is a compact and rugged video/data multiplexer and fiber optic transmission system designed for Remotely Operated Vehicles (ROV) and other applications requiring the transmission of video and/or data over an optical link. The Model 907 has been optimized for low power operation and delivery of high quality video and data in a standard PC/104 form factor. A flexible design architecture supports modular reconfiguration and expansion of the multiplexer system by changing or adding cards to the system.

This document provides Model 907 users with detailed information relevant to the design, configuration, installation, and operation of the Model 907 Video/Data Multiplexing system. This manual and the appropriate reference documents should be reviewed prior to installation or reconfiguration of the multiplexer system.

Section 2 provides an overview of the complete Model 907 multiplexer system and the key technologies employed. Section 3 provides an overview of the Model 907 motherboard modules. Section 4 provides an overview of the available Model 907 media converter cards. Section 5 describes the available Model 907 expansion cards. Section 6 describes additional system module cards, e.g. optical modules, which further extend the capabilities of the Model 907 system. Section 7 follows with detailed information on the Model 907 optical system, and Section 8 provides useful installation instructions and preliminary test procedures.

Appendices include lists of fuses, a cross-reference for card configuration drawing and any system specific information, if provided, such as relevant installation drawings and configuration drawings.

2.0   System Overview

Model 907 systems are built up from four main types of cards: motherboards, expansion cards, media converters, and system module cards. A Model 907 system consists, as a minimum, of a Model 907 remote motherboard (multiplexer), intended for installation at the ROV or subsea end, and a Model 907 console motherboard, intended for installation at the shipboard or surface end. Expansion cards may be stacked on top of motherboards to provide increased number of data channels or add signal formats not supported by the motherboard directly.

Motherboards combine several video and/or data channels into a single, high-speed optical link. Video and data signals input at the remote motherboard and attached expansion cards are time division multiplexed (TDM) into a single, high-speed optical uplink. Similarly, data signals at the console end are combined via TDM into a single, high-speed optical downlink.

The uplink and downlink are typically combined on a single fiber – singlemode or multimode – with a passive optical coupler known as a wavelength division multiplexer (WDM). Basic systems usually operate with a 1310 nm uplink and 1550 nm downlink. In larger systems, multiple stacks of 907 cards may be combined on a single fiber using a coarse wavelength division multiplexer (CWDM) to take advantage of the high bandwidth of optical fiber.

Figure 2-1 illustrates an example of a system configuration using a standard, standalone 907 motherboard, which supports the multiplexing of three channels of video and six channels of bidirectional data over a single optical fiber using WDM, in this example, passed through a fiber optic rotary joint (FORJ). Typically several connectors, not shown, would add 1-3 dB of loss.
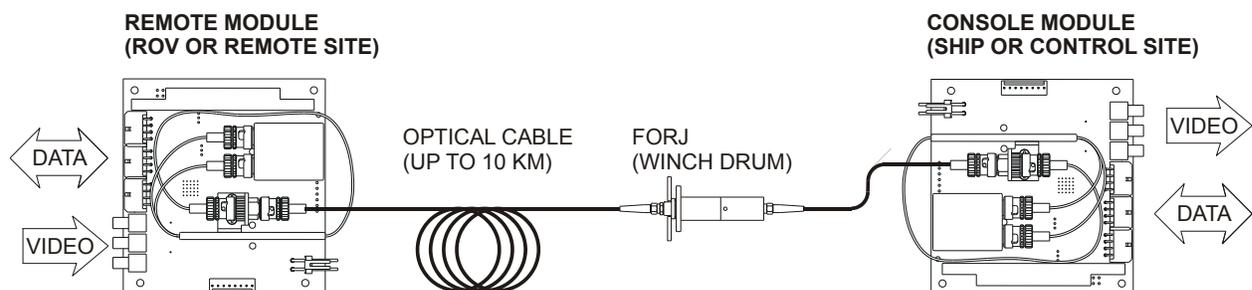
Figure 2-1: Example of a Model 907 Multiplexer System

Model 907 media converter cards provide direct conversion of a single, high-speed electrical channel, such as Gigabit Ethernet, into optical signaling at one end of the system, and conversion back into the original data format at the other. Media converters can be used as standalone cards or can be assembled in a stack with a motherboard. CWDMs can be added to combine optical signals from multiple media converters, and/or the motherboard, onto a single optical fiber.

An example of a Model 907 stack is shown below in Figure 2-2, in this case a Model 907V motherboard (907-V) with two 8-channel RS-485 expansion cards (907-485).
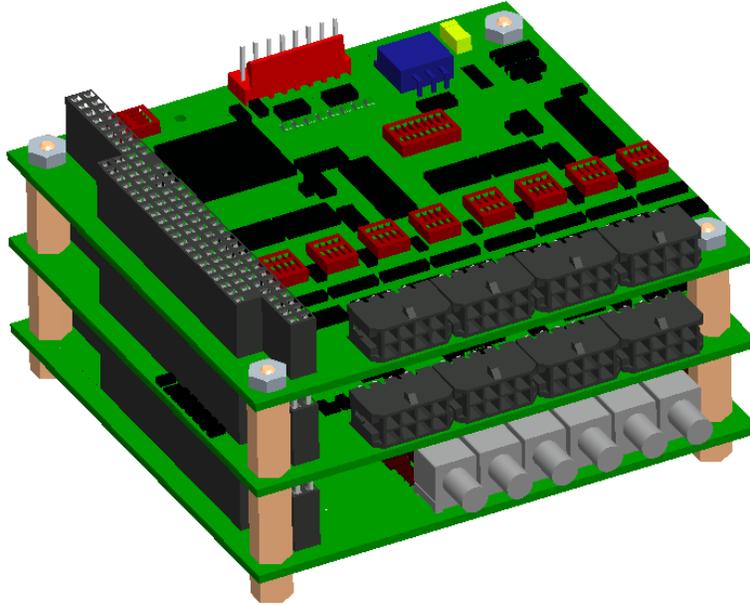
Figure 2-2: Example of a Model 907 Stack

3.0   Multiplexer Motherboard Cards

Both the remote and console ends of the optical link incorporate a 907 motherboard. The motherboards multiplex video and/or data channels, transmit the combined data over the optical link, demultiplex received data from the optical link, store system diagnostic data, and provide power to other cards in the stack. All motherboards can be operated as standalone cards or be assembled together in a stack including 907 expansion cards, media converter cards, and system modules.

Motherboards are typically supplied with a singlemode or multimode wavelength division multiplexer (WDM) for operation over a single fiber, or without a WDM for two-fiber links. In the case of two-fiber communications, optical multiplexing can be provided on another card in the stack, or the two-fibers can be used to link directly from a remote motherboard to a console motherboard. On-board and off-board optical multiplexer configurations are illustrated in Figure 3-1. Furthermore, motherboards may be configured to use CWDM wavelengths and couplers to allow data/video from other cards, which have their own optical transceivers, to be combined on the same optical fiber.
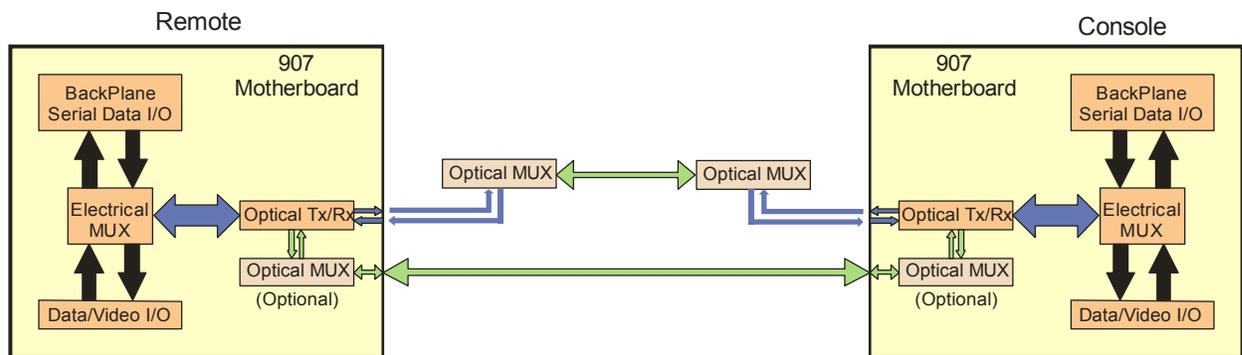
Figure 3-1: Remote & Console Motherboard Optical Configuration

The flexibility of the optical link between motherboards enables a wide range of application requirements. Cards configured to use singlemode, high-power, and high-sensitivity CWDM transceivers satisfy large-bandwidth, long-distance data and video transfer applications, whereas cards configured to use multimode, low power, and low-sensitivity transceivers satisfy applications requiring lower bandwidth, shorter distance, and lower cost.

Model 907 cards are available in pressure tolerant versions with up to 6000 psi rating.

3.1   Standard 907 Multiplexer Motherboard

The 907 motherboard multiplexes three unidirectional (typically remote to console) video channels, and six bidirectional serial data channels (four RS-232 and two high-speed RS-485/422). Each video channel provides 5.5 MHz bandwidth for NTSC and PAL composite signals, S-video (Y/C), and RGB formats. Typically all three video channels are set for 8-bit video resolution, but they can be switch configured for two 10-bit channels. Refer to the configuration drawing 907-2001-00 for details.

Each of the two RS-422/RS-485 data channels support NRZ rates up to 2.5 Mbaud, and each of the four RS-232 channels support up to 120 Kbaud. The RS-422/RS-485 channels 5 and 6 can be configured for simplex or duplex communication, and the user can enable autosense on these channels for RS-485 traffic. In addition, these two channels, which are default configured for RS-485 with autosense, can be configured instead for TTL formatted data or a configuration suitable for AC-coupled RS-485, such as used by a Kraft manipulator telemetry links.

Figure 3-2 shows a standard Model 907 multiplexer motherboard with an external wavelength division multiplexer (WDM) and Figure 3-3 shows the input/output (I/O) channels for the standard Model 907-R and 907-C multiplexer cards.

Figure 3-2: Standard Model 907 Multiplexer Motherboard with WDM

Figure 3-3: On board I/O Channels for 907-R and 907-C Multiplexer Motherboard Cards

3.1.1 Remote Multiplexer Card (907-R)

Card P/N   907-0001-XX
Config. Dwg.   907-2001-00
Diagnostics: LEDs Only

The 907-R is the remote half of the multiplexer motherboard set. Optical fiber routing may vary from assembly to assembly, however a fiber bend radius of more than 16 mm should be maintained at all times. The remote units may be configured with no WDM, with a singlemode WDM, or with a multimode WDM. Fiber access is typically via an ST/PC bushing in the middle of the card, though FC/PC options are available. If no WDM is required, fiber inputs and output fibers are connected directly to the optical transceiver Rx (receiver) and Tx (transmitter) ports. A 907-R configuration using a WDM is shown in Figure 3-4.

Figure 3-4: 907-R & 907-C Multiplexer Card

All three SMB video connectors have a 75-ohm input impedance. The input video signals are streamed through the optical link to the output video connectors of the 907-C card. Three 8-pin Molex connectors are used for the six bidirectional data channels.

3.1.2 Console Multiplexer Card (907-C)

Card P/N   907-0002-XX
Config. Dwg.   907-2001-00
Diagnostics: LEDs Only

The 907-C is the console half of the 907 motherboard pair and as with the 907-R, fiber access is typically via an ST/PC bushing in the middle of the card, though FC/PC options are available. A 907-C configuration using a WDM is shown in Figure 3-4. The 907-C has video connector outputs and the 907-R has video connector inputs.

All three SMB video connectors have a 75-ohm output impedance (AC-coupled) and provide the output video received from the input video connectors of the 907-R card. Three 8-pin Molex connectors are used for the six bidirectional data channels.

For more details about the 907-R and 907-C multiplexer cards, please refer to configuration drawing 907-2001-00.

3.2   907V Multiplexer Motherboard

The 907V (Video) multiplexer motherboards have six on-board video channels for unidirectional (remote to console) transmission of NTSC/PAL, Y/C (S-video), RGB, and YPrPb video formats. Although the 907V does not have any on-board data channels, it can multiplex up to six stacked expansion cards via the PC/104 backplane data ports.

The 907V multiplexer motherboard uses a small form-factor pluggable (SFP) optical transceiver for quick and reliable configuration of optics and an array of board-edge LEDs for diagnostic purposes. Both uplink and downlink run at 1200 Mbaud with various wavelength options available. Typical optical power budgets are 20 dB or greater. In higher budget systems, a minimum of 5 dB attenuation is recommended for bench testing to ensure the receivers are not saturated. The 907V is recommended for singlemode operation only, although short multimode links are possible (< 500 m) with appropriate transceivers.

Each 907V is switch-configured to provide data and video multiplexing. Switch SW1 is used to select one of the following modes:

- Six channels of 8-bit, unidirectional video combined with six bidirectional data ports via the PC/104 backplane (default configuration)
- Four channels of 10-bit, unidirectional video, combined with six bidirectional data ports via the PC/104 backplane
- Six channels of 10-bit, unidirectional video, with no data ports via the PC/104 backplane

Since there is no bidirectional requirement when configured in the six 10-bit video channel mode, only a single uplink fiber is required and an optical WDM is not needed unless the card is part of a CWDM configuration.

Switch SW1 on both the remote and console cards is used to set the video/data mode and optical configuration described above. Switch SW2 configures the input video format from any one of eight possible arrangements. Details of the video format options are described in the configuration drawing 907-2026-00.

The 907V remote is available in pressure tolerant versions with up to 6000 psi rating.

Figure 3-5 shows a 907V multiplexer motherboard and Figure 3-6 shows the I/O channels for the 907V-R and 907V-C multiplexer motherboard cards.
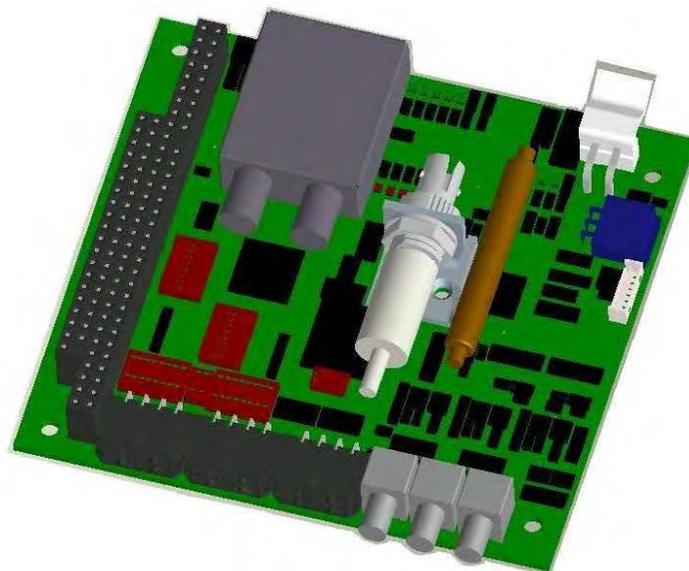

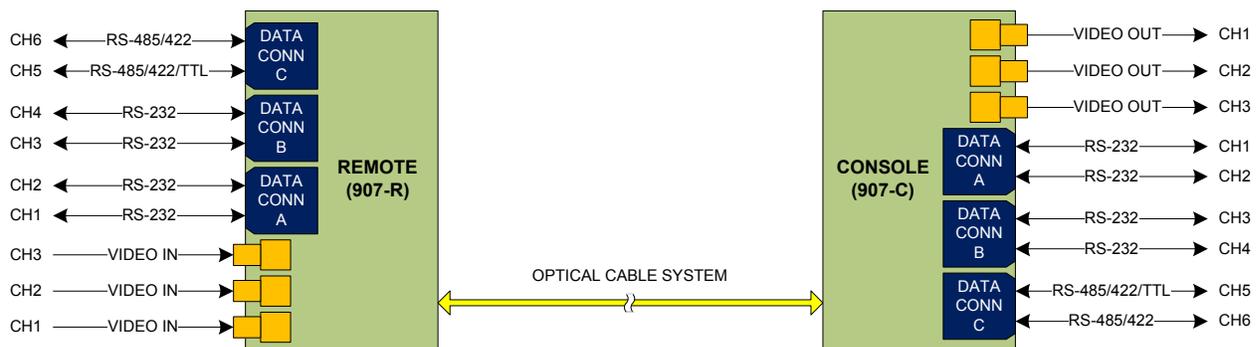**Figure 3-5: Model 907V Multiplexer Motherboard**
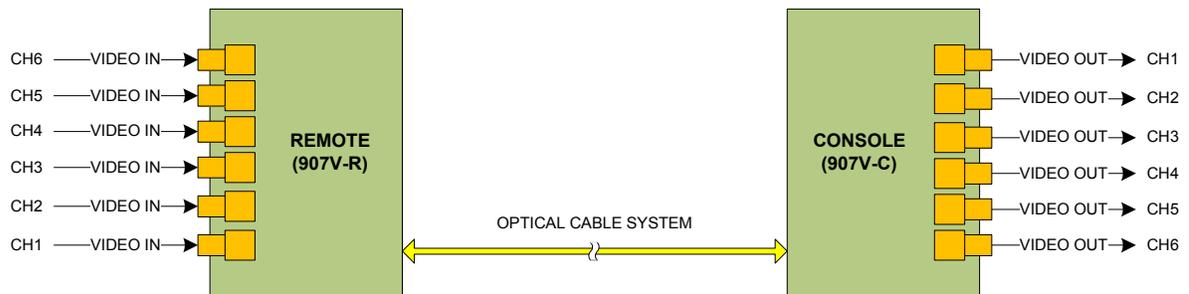
Figure 3-6: On board I/O Channels for 907V-R and 907V-C Multiplexer Motherboard Cards

3.2.1 Remote 907V Multiplexer Card (907V-R)

Card P/N   907-0023-XX
Config. Dwg.   907-2026-00
Diagnostics: 907-DIAG-E Compatible

Figure 3-7 shows top and side views of the 907V-R remote multiplexer card. The backplane PC/104 connector allows stacking of other PC/104 form-factor cards. A standard two-pin Molex power connector is used for a +5 VDC power input, which includes a fuse and protection from reverse polarity and overvoltage. Typical current draw is 0.7 A from a +5 VDC supply.

An array of diagnostic LEDs indicate board status. The Video Sync LEDs are green when proper video sync is detected and red or orange when the input voltage is out of range, i.e. exceeds 1.5 Vpp. The Optical Link LED is on when the card is receiving sufficient optical power and valid frames from the console. The Power LED is on when the input power voltage is above 4 V.
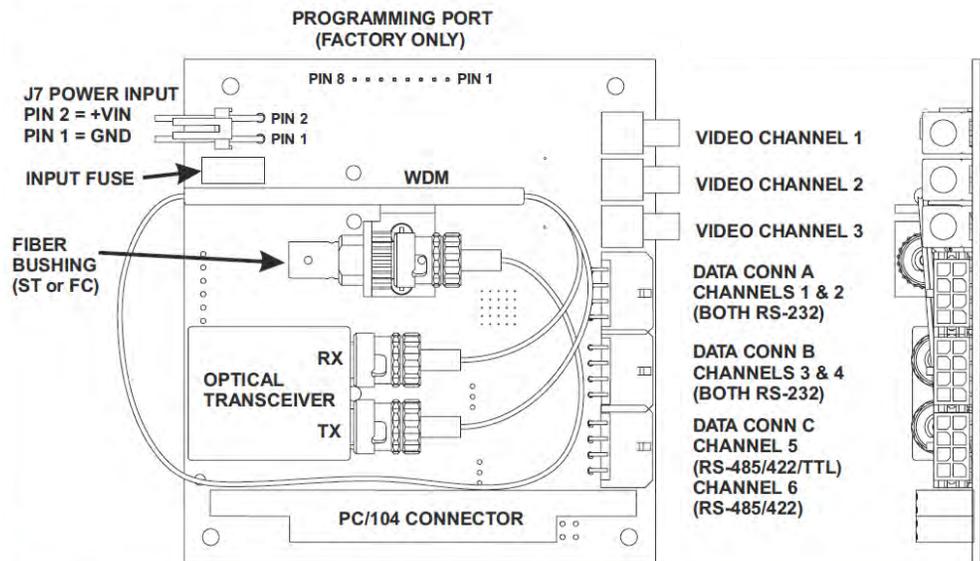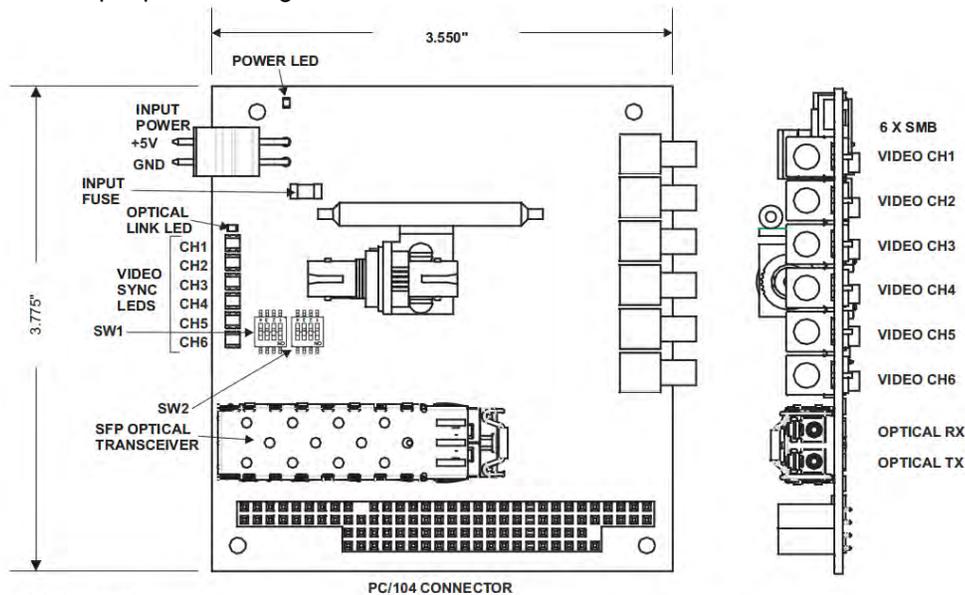

Figure 3-7: 907V-R & 907V-C Multiplexer Card

All six SMB video connectors have a 75-ohm input impedance, AC-coupled. The input video signals are streamed to the output video connectors of the 907V-C card via the optical link.

3.2.2 Console 907V Multiplexer Card (907V-C)

Card P/N   907-0024-00
Config. Dwg.   907-2026-00
Diagnostics: 907-DIAG-E Compatible

The card views for the 907V-C multiplexer card are identical to the 907V-R shown in Figure 3-7. The console card electrical interfaces, optical interfaces, and switch configurations are all identical to the remote except at the video connectors, which are outputs on the console and inputs on the remote. Output impedance for each video connector is 75 ohms, AC-coupled.

A 907-DIAG-E diagnostic card may be stacked with the 907V-C to obtain critical system diagnostics of both the remote and console stacks through an Ethernet interface. Details of the 907-DIAG-E card are provided in the System Modules section.

3.3   907Plus Multiplexer Motherboard

The 907Plus (907+) multiplexer motherboard supports four unidirectional video channels, six dedicated bidirectional serial channels (4 x RS-232, 2 x RS-485), and up to six expansion cards via the PC/104 data ports. The six on-board serial channels are always available and are not disabled by adding expansion cards.

The 907Plus motherboard uses a small form-factor pluggable (SFP) optical transceiver for quick and reliable configuration of optics and an array of board-edge LEDs for diagnostic purposes. Both uplink and downlink run at 1200 Mbaud with various wavelength options available. Typical optical power budgets are 20 dB or greater. In higher budget systems, a minimum of 5 dB attenuation is recommended for bench testing to ensure the receivers are not saturated. The 907Plus is recommended for singlemode operation only, although short multimode links (< 500 m) are possible.

Switches on the board set the signal format of the four video channels and the two RS-485 channels. The four on-board RS-232 channels do not require configuration. By default, the card is configured for four channels of NTSC/PAL composite video signals, however the system can be configured to support one RGB channel and one composite channel, two Y/C (S-Video) channels, or one YPrPb and one composite channel. The two on-board RS-485 channels can also be configured to operate as a single RS-422 channel and may be used with or without a transmission timeout. Detailed video and data settings are described by the configuration drawings 907-2035-00 (907+R) and 907-2036-00 (907+C).

Each of the RS-485 channels (CH1 & CH2) is galvanically isolated, data and power, from all other channels and from the main board ground, which is the +5 V power ground. The RS-232 channels are isolated in pairs, with channels 3 and 4 sharing a common isolated ground and channels 5 and 6 sharing a different isolated ground. The video channels all share a common ground, which is connected to the on-board power ground. If isolation is required for the video channels, a high quality video isolation transformer is recommended.

The 907Plus remote is available in pressure tolerant versions with 6000 psi rating.

Figure 3-8 shows a 907Plus multiplexer motherboard and Figure 3-9 shows the I/O channels for the 907+R and 907+C multiplexer cards.
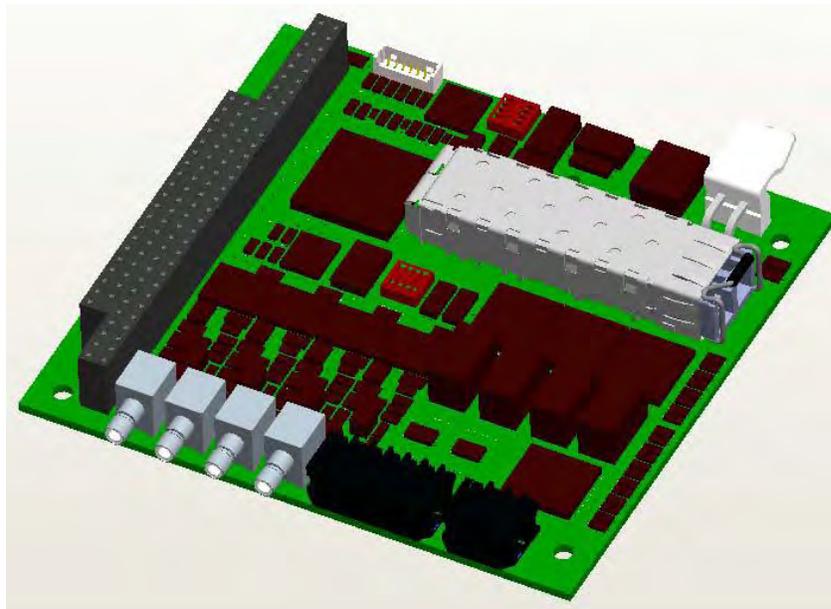
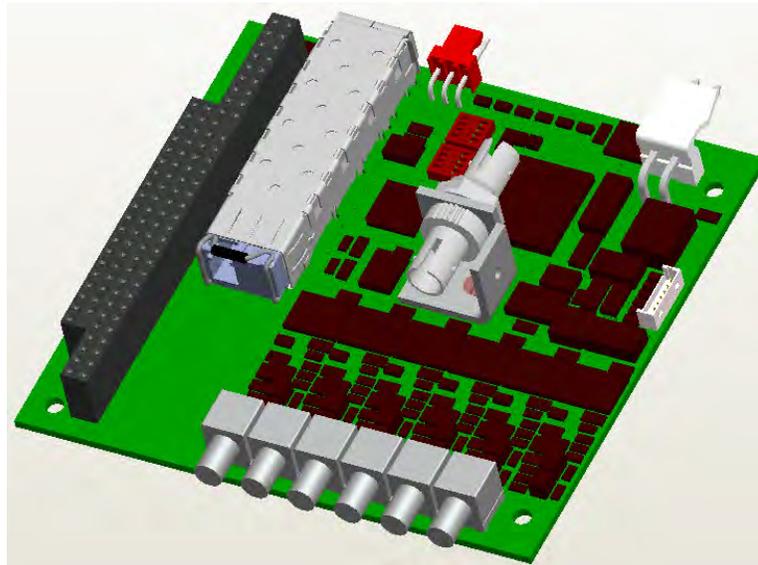**Figure 3-8: Model 907Plus Multiplexer Motherboard**
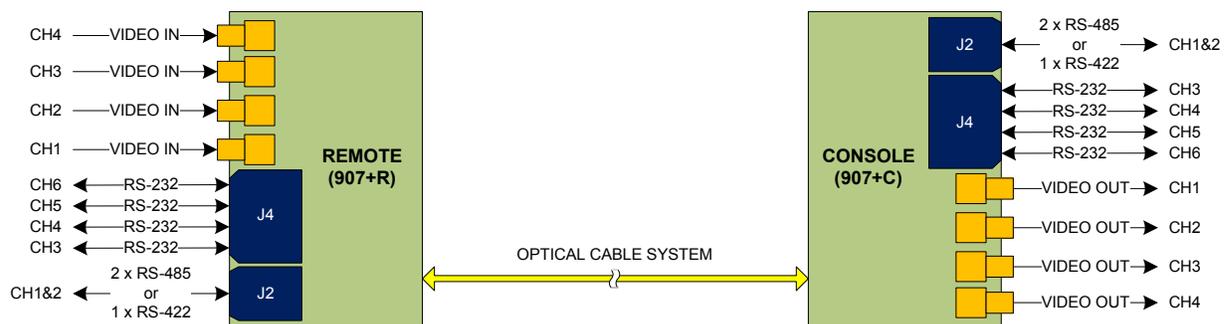
Figure 3-9: On board I/O Channels for 907+R and 907+C Multiplexer Motherboard Cards

3.3.1 Remote 907Plus Multiplexer Card (907+R)

Card P/N   907-0025-00
Config. Dwg.   907-2035-00
Diagnostics: 907-DIAG-E Compatible

Figure 3-10 shows top and side views of the 907Plus remote card. The backplane PC/104 connector allows stacking of other PC/104 form-factor cards. A standard two-pin Molex power connector is used for a +5 VDC power input, which includes a fuse and protection from reverse polarity and overvoltage. Typical current draw is 0.7 A from a +5 VDC supply.

The 907Plus has an array of diagnostic LEDs for Power, Link Ready, Optical Data Tx and Rx, Video Sync for each video channel and Data I/O Activity for each on-board data channel. The Power LED is on when the input power voltage is above 4V. The Video Sync LEDs are green when proper video sync is detected and red or orange when the input voltage is out of range, i.e. exceeds 1.5 Vpp. The optical Link Ready LED is on when the card is receiving sufficient optical power and valid frames from the console. Data LEDs are red when receiving data and green when transmitting data. Optical Rx/Tx LEDs indicate valid links to the SFP transceiver.
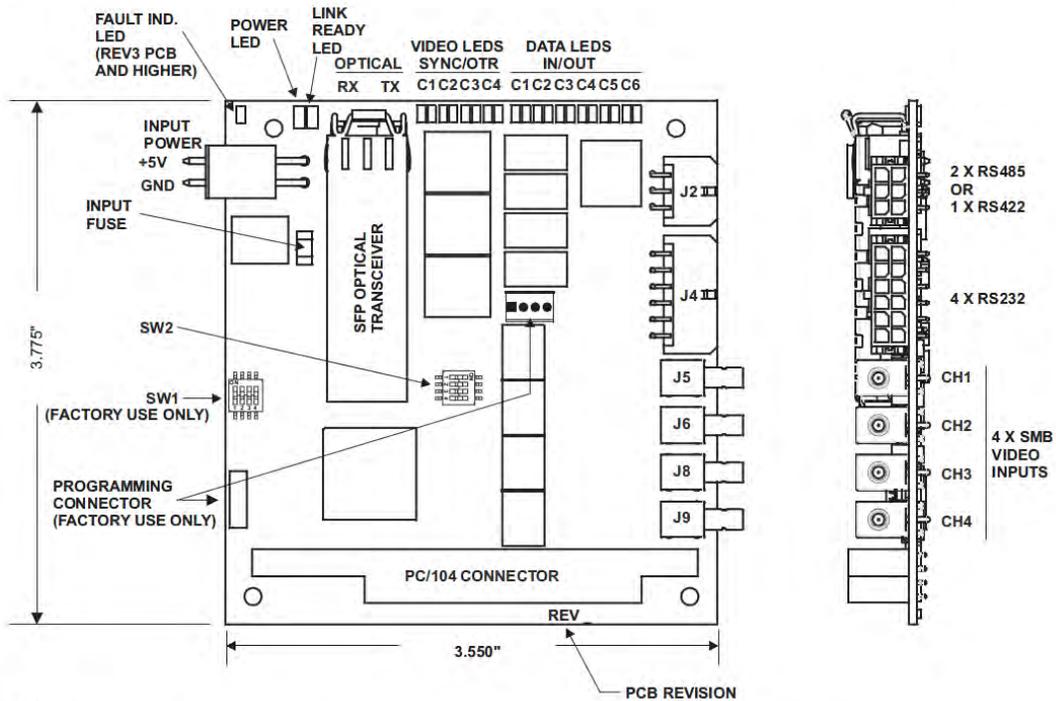
Figure 3-10: 907+R Multiplexer Card

Note: The mating video connectors and cables should be 75-ohm impedance.

3.3.2 Console 907Plus Multiplexer Card (907+C)

Card P/N   907-0026-00
Config. Dwg.   907-2036-00
Diagnostics: 907-DIAG-E Compatible

Top and side views of the 907Plus console card are shown in Figure 3-11. The 907Plus console card is nearly identical in electrical and optical design in that all LEDs, both switches, the power interface, and data faces are identical to that described for the remote 907Plus, except at the video connectors, which are outputs on the console and inputs on the remote.

A 907-DIAG-E diagnostic card may be added to the same stack as the 907+C to obtain critical system diagnostics of both the remote and console stacks through an Ethernet interface. Details of the 907- DIAG-E card are provided in the System Modules section.
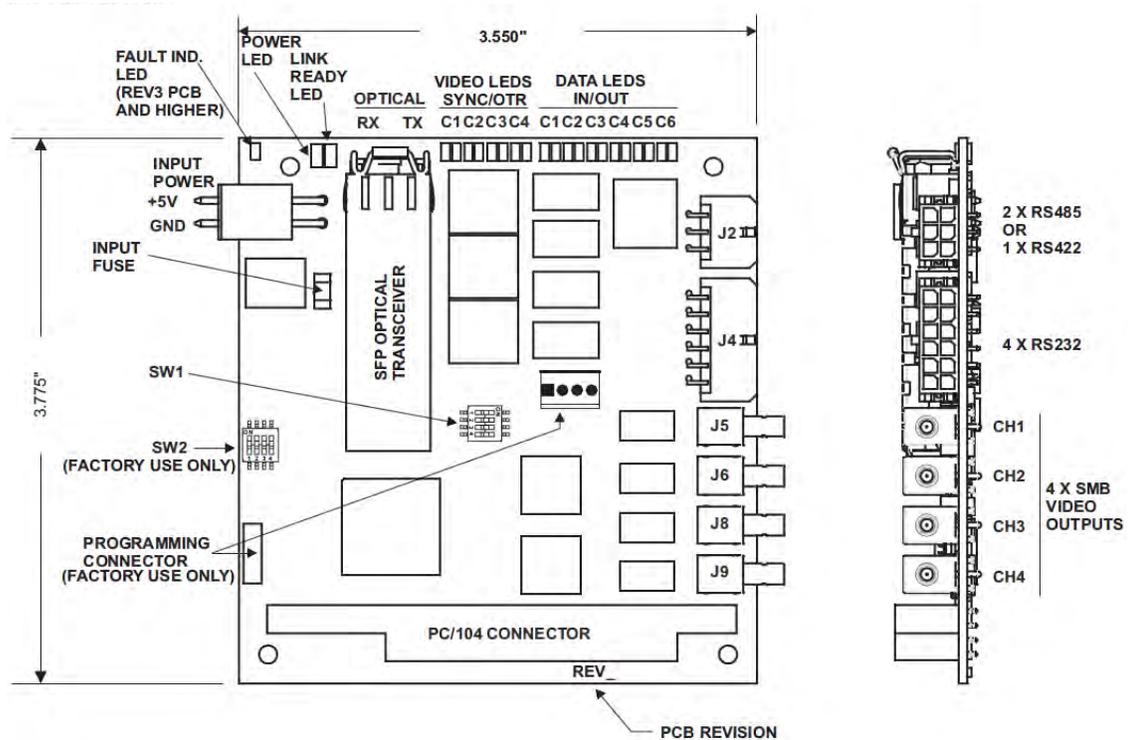
Figure 3-11: 907+C Multiplexer Card

Note: The mating video connectors and cables should be 75-ohm impedance.

3.4 907-HDM2 Multiplexer Motherboard

The 907-HDM2 multiplexer motherboards support up to two HD-SDI channels, 4 bidirectional serial data channels that are switch configured for either RS-232 or RS-485 and up to six expansion cards via the PC/104 data ports. The four on-board serial channels are always available and are not disabled by adding expansion cards. RS-422 is only available as a factory modification. This card is compatible with SMPTE-292 signals on coaxial cable, which includes 720p, 1080i and 1080p formats.

The 907-HDM2 motherboard uses a small form-factor pluggable (SFP) optical transceiver for quick and reliable configuration of optics and an array of board-edge LEDs for diagnostic purposes. The SFP transceiver used in this card supports high optical data rates of up to 3.125 Gbaud. Typically optical budgets are 20 dB or greater. In higher budget systems a minimum of 5 dB attenuation is recommended for bench testing to ensure receivers are not saturated. The 907-HDM2 is recommended for singlemode operation only. Please refer to configuration drawing 907-2052-00 for more information.

Figure 3-12 shows a 907-HDM2 multiplexer motherboard.
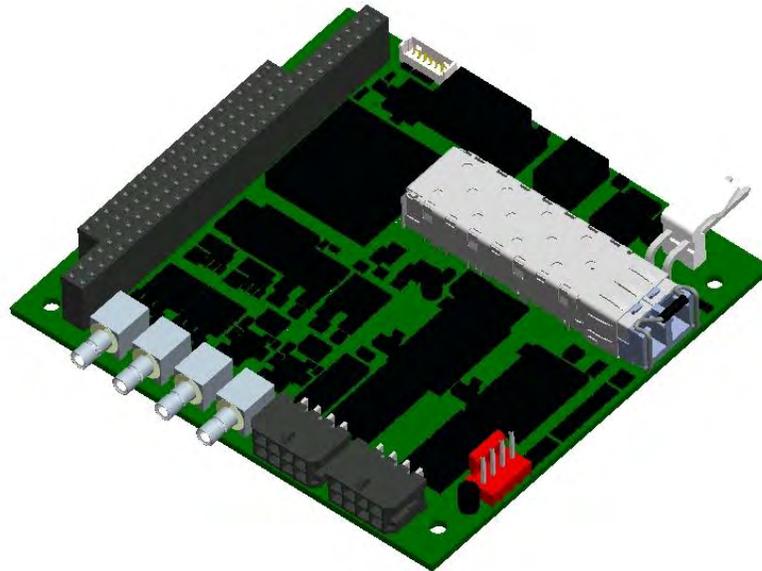
Figure 3-12: Model 907-HDM2 Multiplexer Motherboard

There are three different configurations for the 907-HDM2. They each balance the required video and data inputs with the available optical bandwidth differently as shown in Table 3-1. Native HD-SDI uses 4:2:2 pixel sampling. 4:1:1 sampling refers to full luminance sampling but reduced chrominance (color) sampling. 2:1:1 refers to reduced luminance and chrominance sampling. Ancillary data is typically used to embed audio and closed captioning data with the HD-SDI video.

Table 3-1: 907-HDM2 Configuration Options (Defaults Shaded)

	Data Options[1]	Video CH1	Video CH2	Ancillary Data	On-board Serial Data	Expansion Card Support	Optical Baudrate (Gbaud)
A	**Dual Video Channel (Optimized Sampling[2])**	4:2:2	2:1:1	No	Yes	Yes	2.5
		2:1:1	4:2:2	No			
		4:1:1	4:1:1	No			
B	**Dual Video Channel (Full Sampling)**	4:2:2	4:2:2	No	No	No	3.125
C	**Single Video Channel (Full Sampling, Switched Dual Input)**	4:2:2	Not Active	Yes	Yes	Yes	2.5
		Not Active	4:2:2	Yes			

Notes:

1 = The required card configuration option (A, B or C) must be specified at time of order.

2 = Optimized sampling options (4:2:2, 2:1:1, 4:1:1) can be changed using the 907-DIAG-E card.

Option A: 907-HDM2 Dual Video (Optimized Sampling), default option.

The default option (dual video channel with 4:2:2 and 2:1:1 pixel sampling) provides one full HD-SDI video channel on CH1 and one HD-SDI video channel with reduced luminance and chrominance samples on CH2. Channel 1 in this case is typically used for video recording or continuous monitoring; channel 2 on the other hand is typically used as a secondary channel that does not require all the color details of the video signal. The quality of the secondary channel however, is still better than a standard definition or composite video signal. This option supports up to six expansion cards and the ancillary data of the HD-SDI signal is not transmitted over the optical link. Any of the three video sampling settings on this option can be switched in real time using the 907-DIAG-E card.
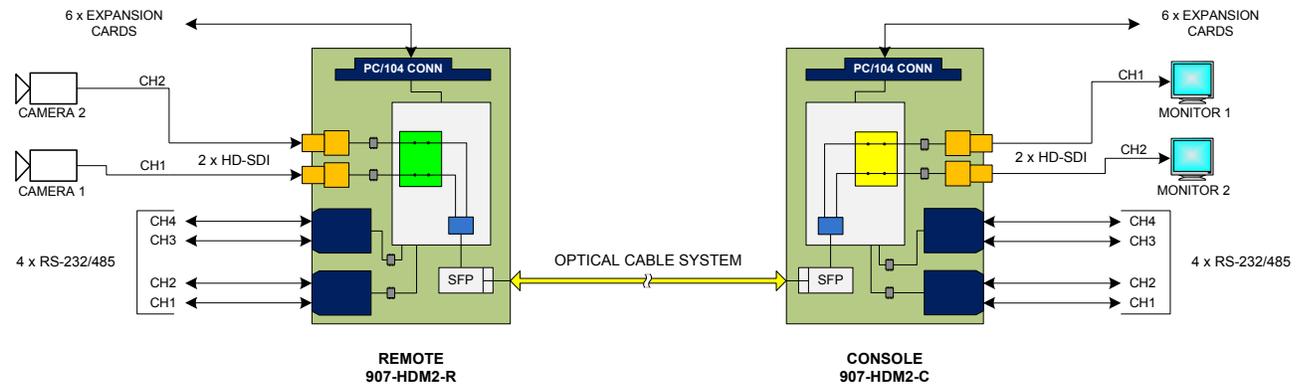
Figure 3-13: On board I/O Channels for 907-HDM2-R and 907-HDM2-C Multiplexer Motherboard Cards (Dual Video Channel – Optimized Sampling)

Option B: 907-HDM2 Dual Video (Full Sampling), factory modification option.

This option provides two full HD-SDI video channels without ancillary data embedded in the data stream and it is typically used when two full HD-SDI video signals are required for video processing. This option does not support any expansion cards or on board serial data.
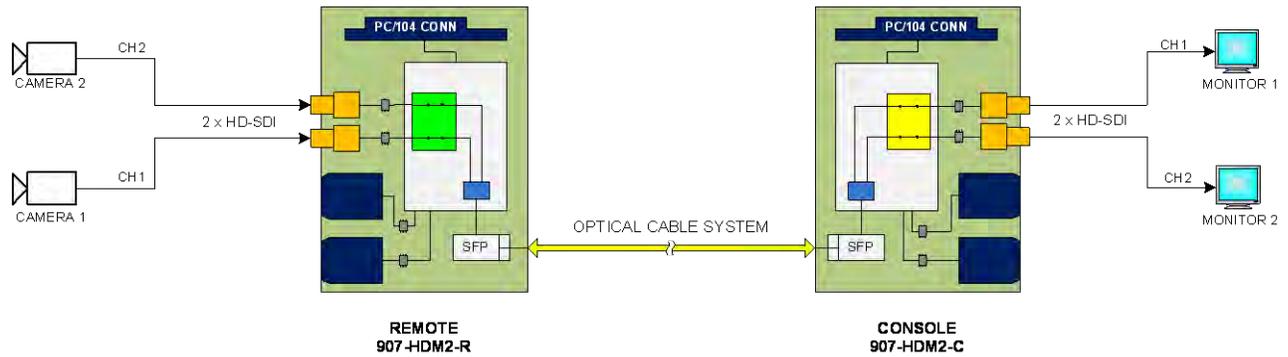
Figure 3-14: On board I/O Channels for 907-HDM2-R and 907-HDM2-C
Multiplexer Motherboard Cards (Dual Video Channel – Full Sampling)

Option C: 907-HDM2 Single Video Channel (Full Sampling, Switched Dual Input), factory modification option.

With this option two different full HD-SDI signals can be input at the remote end but only one HD-SDI signal can be transmitted over the optical link. At the console end, two outputs are provided with the same HD-SDI signal (either HD-SDI CH1 or CH2) so that the signal can be simultaneously connected to an HD-SDI recorder and monitor. The remote card defaults to HD-SDI channel 1 input but can be switched to channel 2 via the 907-DIAG-E card. This option supports up to six expansion cards and the ancillary data of the HD-SDI signal is embedded in the optical link.
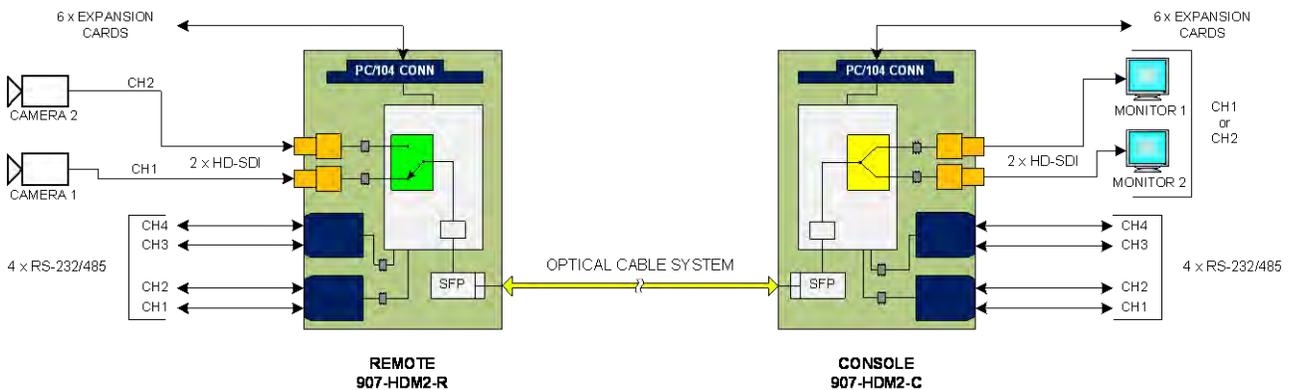
Figure 3-15: On board I/O Channels for 907-HDM2-R and 907-HDM2-C
Multiplexer Motherboard Cards (Single Video Channel – Full Sampling, Switched Dual Input)

3.4.1 Remote 907-HDM2 Multiplexer Card (907-HDM2-R)

Card P/N   907-0050-XX
Config. Dwg.   907-2052-00
Diagnostics: 907-DIAG-E Compatible

Top and side views of the 907-HDM2-R card are shown Figure 3-16. The backplane PC/104 connector allows stacking of other 907 cards. The 907-HDM2 card receives +5 VDC power through a standard two-pin Molex power connector. The power input has overvoltage and reverse polarity protection. The 907-HDM2 card can also receive power via the PC/104 connector from other cards when used in a Model 907 stack. Typical current draw is 1.5 A from a +5 VDC power supply.

At the 907-HDM2-R (remote end), the HD signal is input at 75-ohm Mini-SMB jacks J7/J8, as shown in Figure 3-16. Note that mating connectors and cables must be 75 ohm impedance. Typically, for a single camera application, J7 (channel 1) is used for the input. The input HD video signals are streamed to the output video connectors of the 907-HDM2-C.

The serial data ports (connector J2 and J6) of the 907-HDM2 multiplexer motherboard card can be configured as RS-232 or RS-485 using switch SW1 (channels are default configured as RS-232). Please refer to configuration drawing 907-2052-00 for more information.

The 907-HDM2 has an array of diagnostic LEDs for Power, No Link, Link Ready, Video, and Serial Data I/O Activity for each on-board data channel. The power LED is green when the input power voltage is within an acceptable range. When the SFP transceiver is receiving sufficient optical power, the Link Ready LED is green; otherwise, the No Link LED is red. The Video LED is green when valid HD video is being detected. Serial data activity LEDs are on when channels are in the "space" state, i.e. not idle.

Figure 3-16: 907-HDM2-R & 907-HDM2-C Multiplexer Card

The optical configuration of the card, and any other special options, are designated by the –XX suffix of the part number. Refer to the configuration drawing for more details.

3.4.2 Console 907-HDM2 Multiplexer Card (907-HDM2-C)

Card P/N   907-0051-XX
Config. Dwg.   907-2052-00
Diagnostics: 907-DIAG-E Compatible

The card views for the 907-HDM2-C multiplexer motherboard are identical to the 907-HDM2-R shown in Figure 3-16. The console card electrical and optical interfaces are all identical to the remote except that the two SMB video connectors are used instead of the two inputs. Output impedance for each video connector is 75 ohms.

At the 907-HDM2-C (console end), the HD-SDI monitor or processing equipment is attached to 75-ohm Mini-SMB jacks J9/J11, as shown in Figure 3-16. Note that mating connectors and cables must be 75-ohm impedance.

A 907-DIAG-E diagnostic card may be stacked with the 907-HDM2-C to obtain critical system diagnostics of both the remote and console stacks through an Ethernet interface. More details of the 907-DIAG-E card are provided in the System Modules section.

3.5 907-GEM Multiplexer Motherboard

The 907-GEM is an expandable Gigabit Ethernet (GbE) multiplexer motherboard that supports four completely independent and "switchless" 10/100/1000 Mbps Ethernet links and up to six expansion cards via the PC/104 backplane data ports. The four copper ports of 10/100/1000 Mbps Ethernet traffic and the backplane data from the expansion cards are transmitted over a bidirectional optical link via an on-board SFP optical transceiver.

The 907-GEM card allows the use of non-standard frames often used by multibeam sonars (e.g. Reson 7125) and other proprietary data links that require simultaneous yet dedicated point-to-point "switchless" connections over fiber. The 907-GEM also supports jumbo frames, suitable for GigE Vision applications. Because of the "switchless" design, the 907-GEM provides lower latency than standard Ethernet Switches.

The 907-GEM motherboard uses a small form-factor pluggable (SFP) optical transceiver for quick and reliable configuration of optics and an array of board-edge LEDs for diagnostic purposes. The SFP transceiver used in this card can support high optical data rates of up 3.125 Gbaud. Typically optical budgets are 20 dB or greater. In higher budget systems a minimum of 5 dB attenuation is recommended for bench testing to ensure receivers are not saturated. A wide range of optical options are available for the 907-GEM, including CWDM wavelengths for optical multiplexing with other media converters and multiplexers. Please refer to configuration drawing 907-2056-00 for more information.
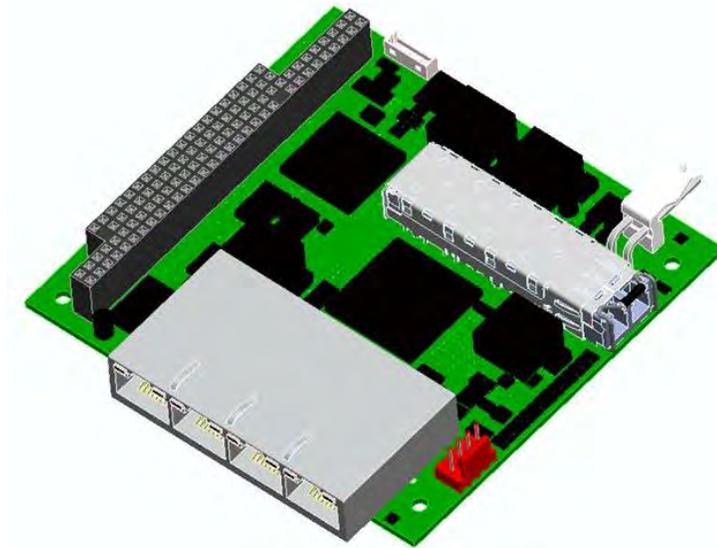
Figure 3-17: Model 907-GEM Multiplexer Motherboard

Auto-negotiation is supported at all three speeds, but can be bypassed if connecting to another device which does not support auto-negotiation. MDI/MDX crossover handling is also supported on the RJ-45 ports. Note that any packets that cause the input buffers to overflow are simply discarded, i.e. there is no flow control.

Figure 3-18 shows the I/O channels for the 907-GEM-R and 907-GEM-C multiplexer cards.
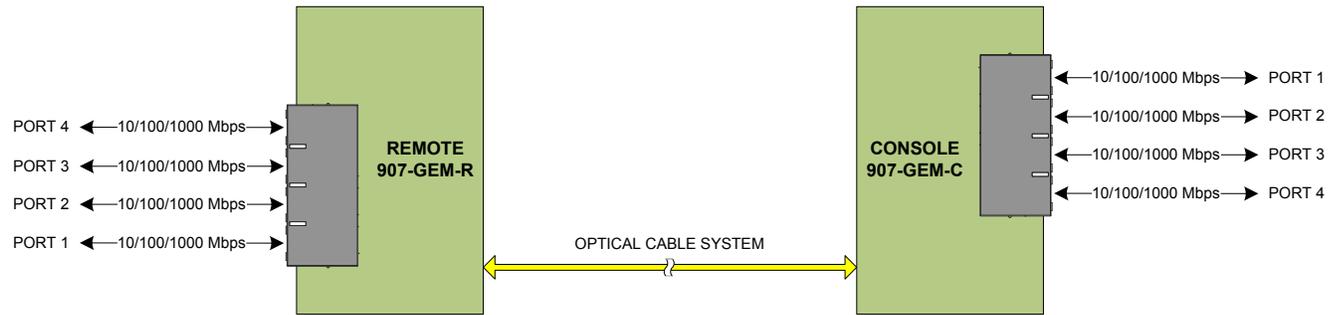
Figure 3-18: On board I/O Channels for 907-GEM-R and 907-GEM-C Multiplexer Motherboard Cards

3.5.1 Remote 907-GEM Multiplexer Card (907-GEM-R)

Card P/N   907-0060-XX
Config. Dwg.   907-2056-00
Diagnostics: 907-DIAG-E Compatible

Top and side views of the 907-GEM-R multiplexer motherboard are shown in Figure 3-19. The backplane PC/104 connector allows stacking of other 907 expansion cards. The 907-GEM card receives +5 VDC power through a standard two-pin Molex power connector. The power input has overvoltage and reverse polarity protection. The 907-GEM card can also receive power via the PC/104 connector from other cards when used in a Model 907 stack. Typical current draw is 1.5 A from a +5 VDC power supply.

The 907-GEM has an array of diagnostic LEDs for Power, Optical Link Ready, Optical Link Error, Port Errors and Port Tx/Rx Activity. The power LED is green when the input power voltage is within an acceptable range. When the SFP transceiver is receiving sufficient optical power, the Link Ready LED is green; otherwise, the Optical Link Error LED is red. The Port Error LEDs are red when the copper port is receiving packets that cause the input buffers to overflow. Port Tx Activity LEDs are green when packets are being transmitted from the 907-GEM card and Port Rx Activity LEDs are green when packets are being received into the 907-GEM card. Also, the quad RJ-45 jack of the 907-GEM card has LEDs to indicate the link status of each copper port; the orange LED indicates 10 Mbps, the yellow LED indicates 100 Mbps and the green LED indicates 1000 Mbps.
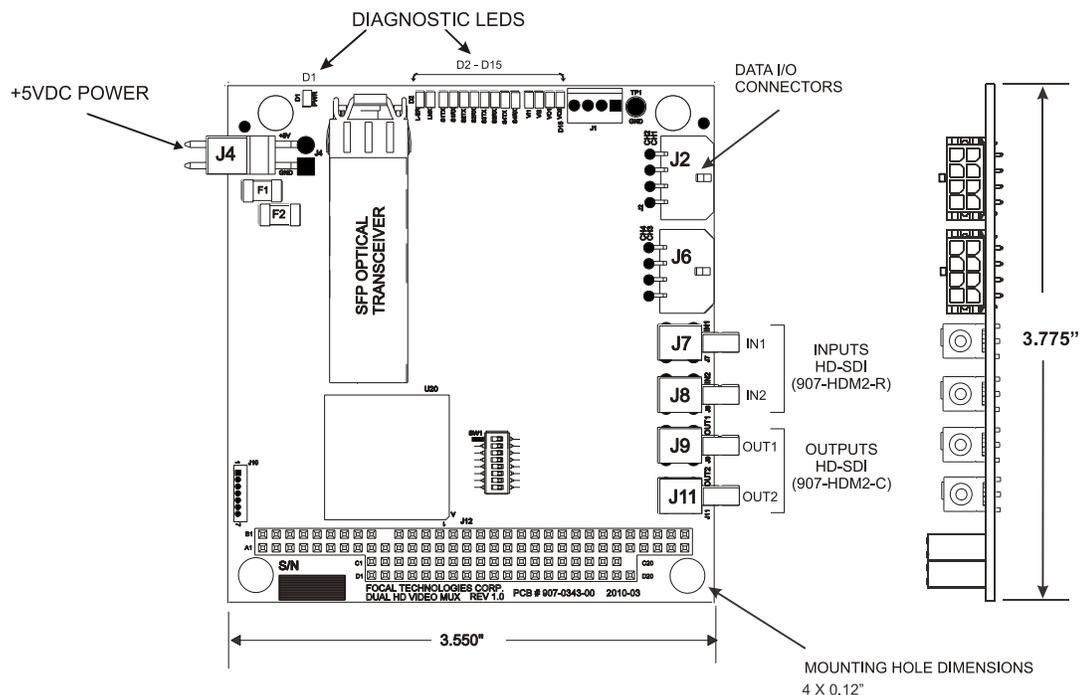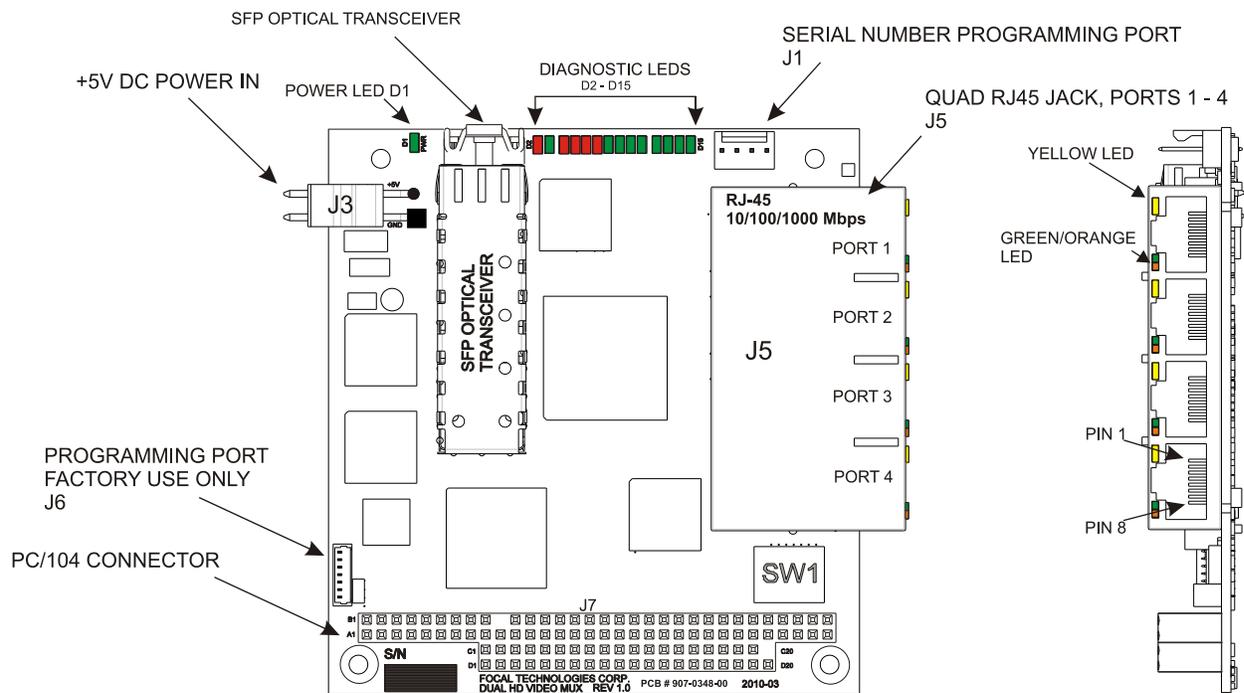

Figure 3-19: 907-GEM-R & 907-GEM-C Multiplexer Card

The optical configuration of the card, and any other special options, are designated by the –XX suffix of the card part number. Refer to the configuration drawing for more details.

3.5.2 Console 907-GEM Multiplexer Card (907-GEM-C)

Card P/N   907-0060-XX
Config. Dwg.   907-2056-00
Diagnostics: 907-DIAG-E Compatible

The card views for the 907-GEM-C multiplexer motherboard are identical to the 907-GEM-R shown in Figure 3-19. The console card‟s electrical and optical interfaces are identical to the remote, the only difference is that pin 1 of the dip switch SW1 needs to be set "ON" for remote configuration (907-GEM-R) or "OFF" for console configuration (907-GEM-C).

A 907-DIAG-E diagnostic card may be stacked with the 907-GEM-C to obtain critical system diagnostics of both the remote and console stacks through an Ethernet interface. Diagnostic-specific data accounts for less than 0.01% of the total throughput from the remote to console, and is transmitted at lower priority than user-based traffic. More details of the 907-DIAG-E card are provided in the System Modules section.

4.0 Media Converters

Model 907 media converter cards are PC/104 form-factor modules used to provide optical transmission of high-speed data signals (20-1500 Mbps), such as Ethernet, ECL/PECL for multi-beam sonar links, IEEE-1394 (widely known as "Firewire") for digital cameras and digital high-definition video (SMPTE-292). Media converters may be deployed as standalone cards using a designated fiber or as CWDM versions that are optically multiplexed with a motherboard or other media converter cards.

Standard media converter cards are available as "standalone" and "stacking" units. Standalone (nonstacking) cards have short pins on the PC/104 connector and typically use 1310/1550 nm wavelengths that operate on a dedicated fiber. Stacking units have long pins on the PC/104 connector so that they can be stacked on top of other cards, typically a 907 motherboard with expansion cards. Usually stacking units have CWDM wavelength transceivers so that their optical signals can be combined with other cards in the stack on a common fiber. Unless otherwise specified, standard media converter cards with 1310/1550 nm wavelengths are non-stacking. Media converter cards with CWDM wavelengths are available in stacking and non-stacking versions. Non-stacking cards require their own power harness whereas stacking cards draw power from attached cards, e.g. multiplexer motherboard, via the PC/104 connector.

The diagnostics data from SFPs on the media converters may be accessed by motherboards with diagnostic capability when stacked together.

Figure 4-1 shows a Quad-port Gigabit Ethernet Switch (GBES) media converter card.
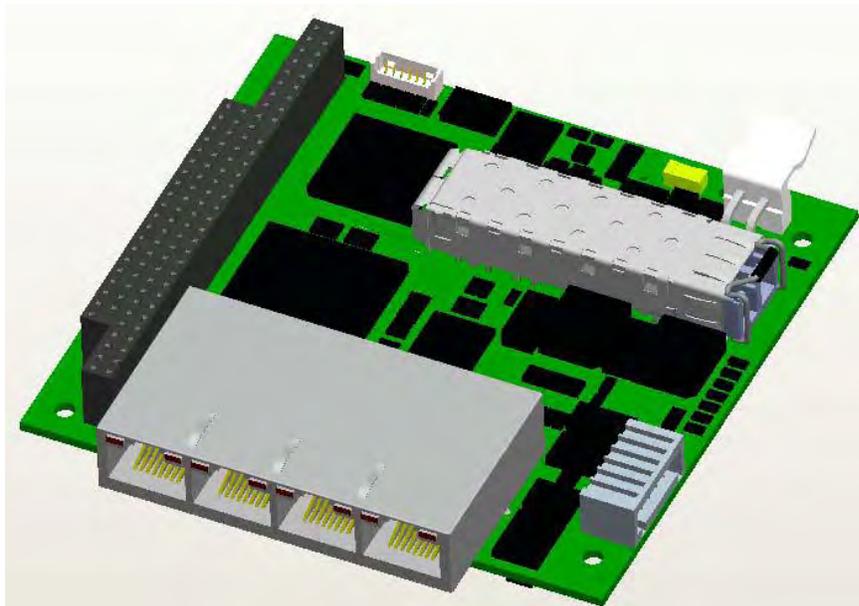
Figure 4-1: Media Converter Card (907-GBES)

4.1   907-MC (10/100 Mbps Ethernet)

Card P/N   907-0014-XX
Config. Dwg.   907-2007-XX
Diagnostics: LEDs Only

Note: This card is not recommended for new designs. Refer to 907-GBE or 907-GBES cards.

The 907-MC Ethernet media converter card supports single channel 10Base-T and 100Base-Tx, both full and half-duplex links, with link-speed auto-detection. An example of one configuration is illustrated in Figure 4-2. The fiber link is limited to a length of 2 km when half-duplex mode is used, as per IEEE 802.3 standards. If the 907-MC card is configured to use full-duplex mode, the fiber link length is limited only by the optical budget. The external fiber optic bushing is typically ST/PC, but FC/PC versions are available.

The 907-MC 10/100 Ethernet media converter is powered from +5 VDC (±5%) with a maximum current draw of 0.7 A via Molex connector labeled J2. The board is fitted with circuitry to support an optional DC-DC converter for input voltages ranging from 10 to 28 VDC. When stacked on a motherboard, the card is typically powered via the PC/104 backplane. The card has a 1 A time delay, soldered fuse for each of the connector-powered and backplane-powered configurations.

The 907-MC Ethernet media converter is outfitted with diagnostic status LEDs that indicate both the copper (Ethernet) and optical speeds. Power and Ethernet Rx/Tx indicator LEDs are also provided. Multiple configurations and PCB assemblies are available for this card. For more details on the different configurations of the 907-MC media converter card, refer to the configuration drawings 907-2007-00, 907-2007-01, and 907-2007-02.
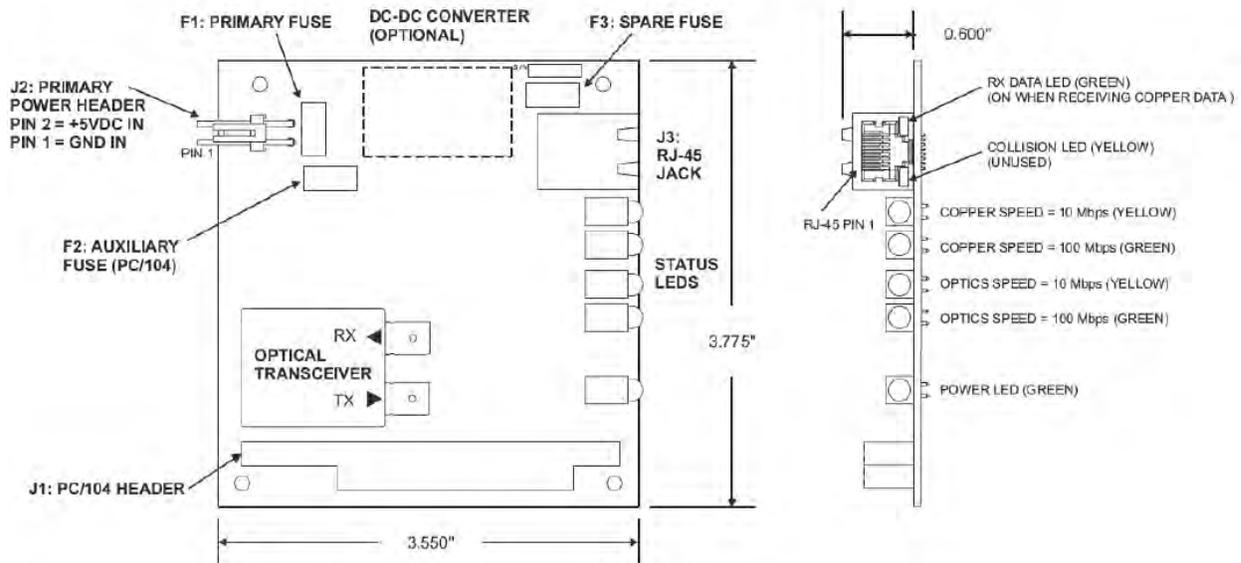
Figure 4-2: 907-MC (10/100 Ethernet) Card without WDM

The 907-MC is available in pressure tolerant versions with a 3000 psi rating.

4.2   907-1394 (Firewire)

Card P/N   907-0018-00 (Obsolete)
Config. Dwg.   907-2013-XX
Diagnostics: LEDs Only

Note: This card is now obsolete and can no longer be ordered.

The 907-1394 media converter card supports multiplexing and de-multiplexing of up to two IEEE-1394-type data streams. This card supports devices capable of transfer modes S100 (100 Mbps), S200 (200 Mbps), or S400 (400 Mbps).

External 5 VDC (±10%) power is required via Molex connector labeled J1. The board itself draws up to 0.6 A of current. When stacked on a motherboard, the card can also be powered via the PC/104 backplane. The 907-1394 media converter can also be configured (configuration includes populating the optional DC-DC converter) to acquire power from devices connected to the IEEE-1394 bus. The input voltage must be between 10 and 28 VDC, and the connected devices must meet the IEEE-1394 specification. Alternately, the board can provide power to external devices, supplying up to 500 mA per port. The card uses a 3 A time delay fuse for the input power (includes budget for sourced power to external devices), and another 1 A fuse for board circuitry. Appropriate replacement fuse part-numbers are provided in the Appendix A.

As shown in Figure 4-3, the 907-1394 card has LEDs for Power, Board Reset, Cable-Link, and Optical Signal Detect. The Power LED is on when the board is powered, the Board Reset LED is on momentarily during power up and continuously for an under-voltage input. The Cable-Link LED is on when any link has been established on either the IEEE-1394 or optical interfaces. The Optical Signal Detect LED is on while sufficient optical power is detected at the optical receiver, but does not necessarily indicate valid frame data.
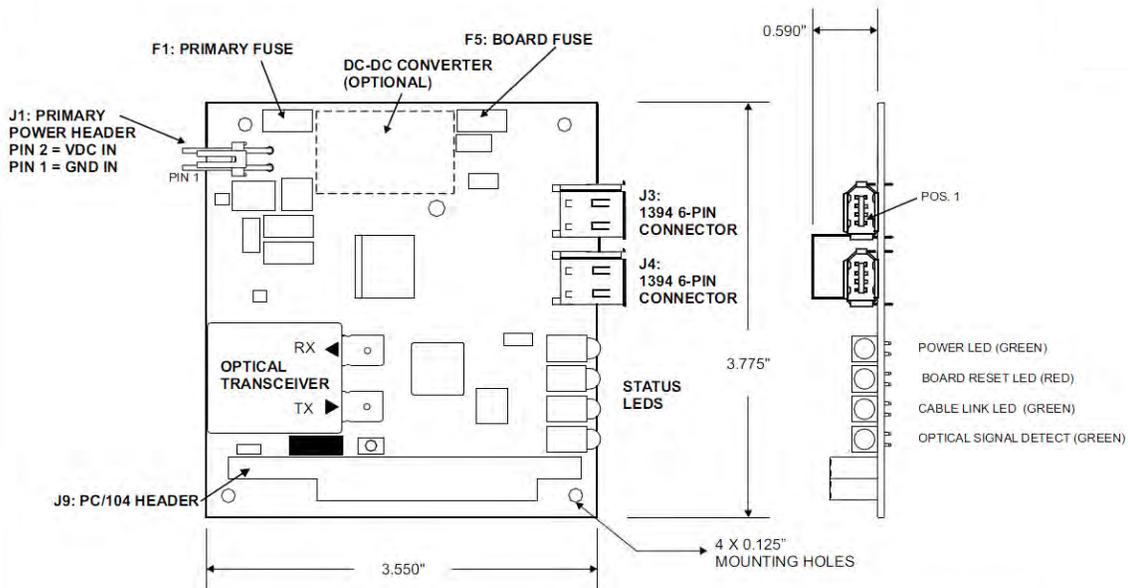
Figure 4-3: 907-1394 Media Converter Card

The 907-1394 card can be assembled to support various optical configurations including 1310 nm or 1550 nm bidirectional transceivers using two fibers, or 1330/1550 nm transceivers coupled with a WDM to multiplex all of the data onto a single fiber. The access fiber bushing near the middle of the card is typically an ST/PC connector, but FC/PC is also available.

4.3 907-ECL (Sonar)

Card P/N   907-0019-XX
Config. Dwg.   907-2012-02
Diagnostics: 907-DIAG-E Compatible (SFP only)

The 907-ECL (Emitter Coupled Logic) is a single card that supports multiple high speed data formats typically used by sonars. The card can be configured to support ECL and PECL (Positive Emitter Coupled Logic) formats when SW1A and SW1B are OFF and SW2A is ON. In this configuration, the cards provide one channel of single-ended or differential ECL/PECL throughput. The ECL/PECL signals must be between 30-155 Mbaud and have been suitably encoded for optical transmission with DC balance and sufficient density of transmissions, such as that provided by 8B10B encoding.

For subsea applications, 907-ECL cards are typically connected to a sonar head at the remote end and the sonar processing unit at the console end. Supported sonar devices include the Reson 81XX Series, and the Kongsberg EM2000 and EM3000.

The ECL/PECL inputs and outputs are AC-coupled, 75 ohms. Cards may be modified to support 50 ohm systems directly or external impedance matching pads may be used to convert 75 ohms to 50 ohms.

The 907-ECL card can be ordered as a standalone card (built with short PC/104 connector pins and a short optical jumper from the SFP transceiver to the optical ST/PC bushing) or as a CWDM stacking version, for integration with a 907 multiplexer or other devices. Stacking versions have long PC/104 connector pins and a built-in CWDM installed on the optical bushing, as shown in Figure 4-4.

The 907-ECL cards are available in pressure tolerant versions with a 6000 psi rating.
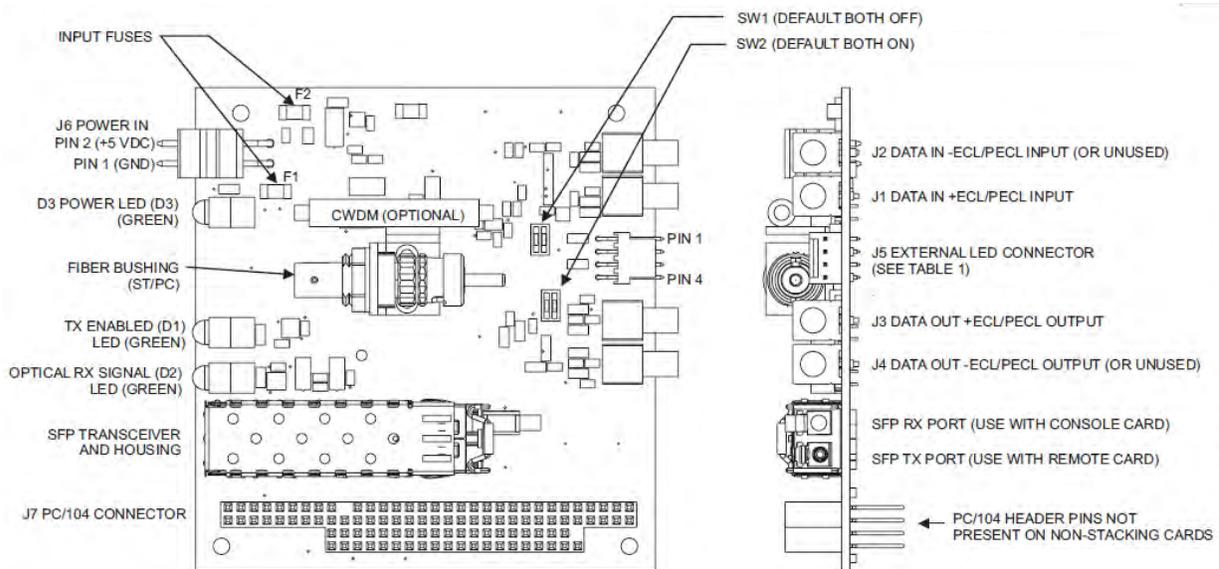
Figure 4-4: 907-ECL Media Converter Card

4.4 907-HDV (HD-SDI)

Card P/N   907-0022-XX
Config. Dwg.   907-2012-00
Diagnostics: 907-DIAG-E Compatible (SFP only)

The 907-HDV (HD-SDI) media converter card is based on the same printed circuit board assembly as the 907-ECL, but using an SFP transceiver with a higher data rate to support the 1.5 Gbaud signals. At the remote (subsea) end, the camera signal is input at SMB jack J1, as shown in Figure 4-5. At the console end, the HD-SDI monitor or processing equipment is attached to jack J3.

Because of the high bandwidth of the HD-SDI signal, any external cabling and connectorization must adhere to RF practices. For example, 75-ohm cabling and connectors should be used throughout the entire link. Any connectors or cables with the wrong impedance, for example with straight wired pins, will cause reflections and signal degradation. Shielded coaxial cables and connections are recommended throughout the wiring chain.

For HD-SDI operation, both SW1 switches should be ON and both SW2 switches should be OFF.
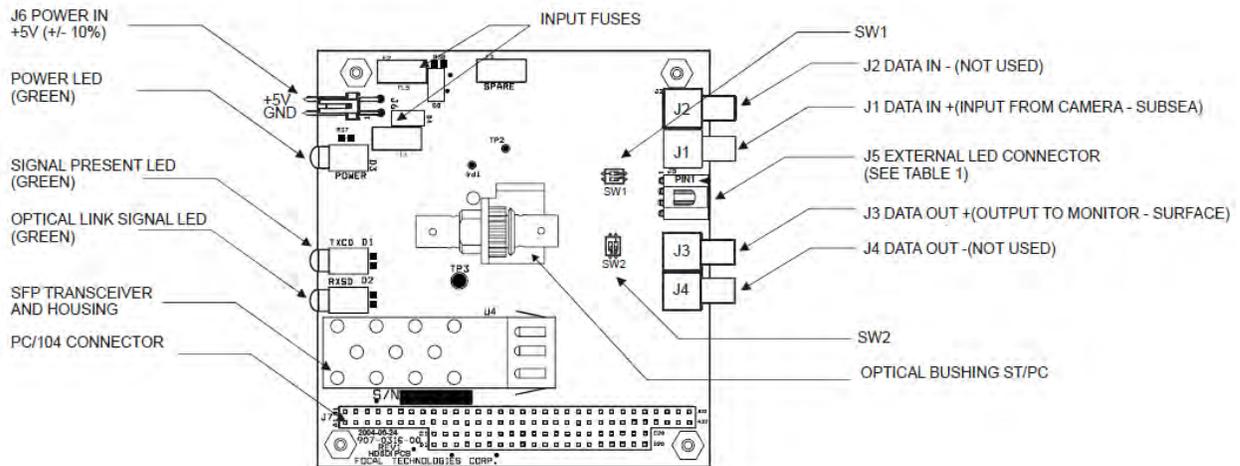
Figure 4-5: 907-HDV (HD-SDI) Media Converter card

4.5   907-GBE (Gigabit Ethernet)

Card P/N   907-0021-XX
Config. Dwg.   907-2023-00
Diagnostics: LEDs Only

The 907-GBE (Gigabit Ethernet) media converter shown in Figure 4-6 is used to convert a single channel of 10/100/1000 Mbps Ethernet data into optical format at the remote end and vice-versa at the console end. Regardless of the input data rate, the optical link always runs at 1000 Mbps (1250 Mbaud). This "switchless" media converter supports jumbo frames and non-standard frames often used by multibeam sonars (e.g. Reson 7125) and other proprietary data links.

Auto-negotiation is supported, but can be bypassed if connecting to another device which does not support auto-negotiation. MDI/MDX crossover handling is also supported on the RJ-45 port. The physical layer interface also minimizes latency.

The 907-GBE cards are available in pressure tolerant versions with a 6000 psi rating.
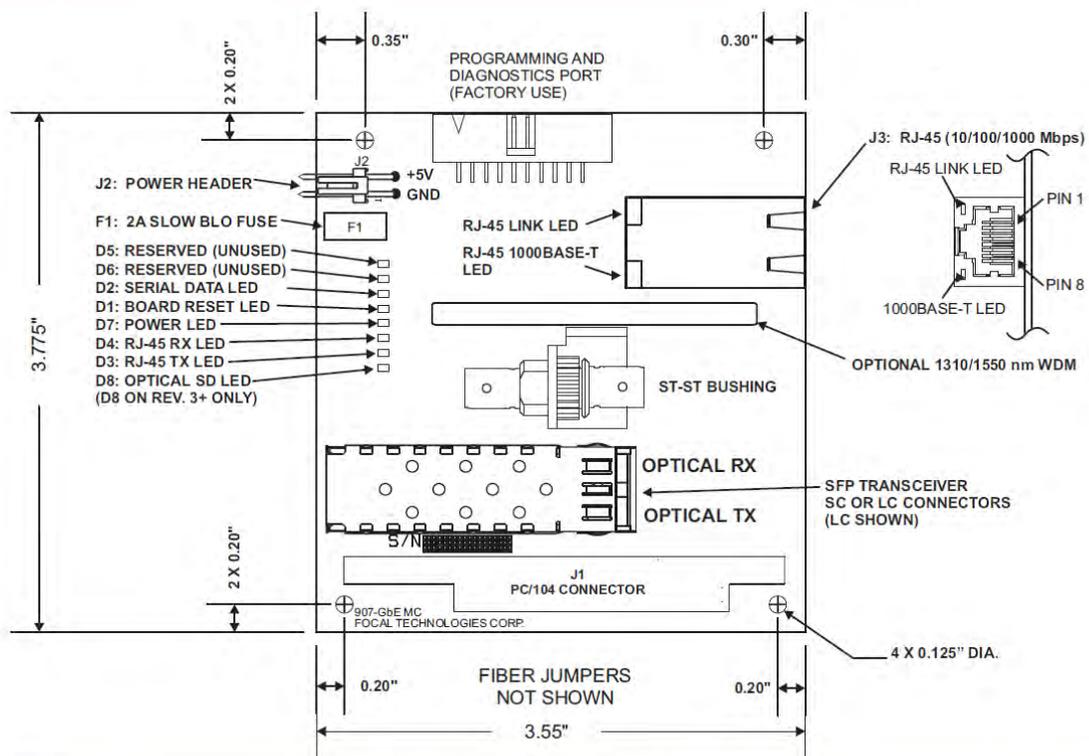
Figure 4-6: 907-GBE Media Converter Card

4.6   907-GBE2 (Dual Gigabit Ethernet)

Card P/N   907-0030-XX
Config. Dwg.   907-2040-00
Diagnostics: 907-DIAG-E Compatible

The 907-GBE2, shown in Figure 4-7, is a Dual Gigabit Ethernet Media Converter and is used to convert two channels of 1000 Mbps Ethernet data into optical format at the remote end and vice-versa at the console end. The optical data rates can be 2.5 Gbaud, 1.25 Gbaud or 625 Mbaud, and these rates can be selected using switch SW1. The 907-GBE2 can be used as a standalone card or optically integrated into a 907 system stack via CWDM modules.

The 907-GBE2 provides two independent 10/100/1000 Mbps* Ethernet ports sharing a single optical transceiver. The optical transceiver when operating at 2.5 Gbaud, a full 1 Gbps is available to each RJ-45 port. In the default 1.25 Gbaud mode, 1 Gbps of optical data capacity is shared between the two ports. The 625 Mbaud mode is typically used for multimode cables and provides 500 Mbps of optical data capacity shared between the two ports. Note that any packets that cause the input buffers to overflow are simply discarded, i.e. there is no flow control.

This media converter card can be used for multi-beam sonar devices running "dual head" configurations, or for any application that requires simultaneous yet dedicated point-to-point "switchless" connections over fiber. The physical layer interface also minimizes latency.

The 907-GBE2 has on-board SFP diagnostics, which are transmitted over the optical link with the user-Ethernet traffic to the 907-GBE2 console card. A 907-DIAG-E diagnostics card stacked on the console card can read diagnostic information from the 907-GBE2 remote and console cards. Diagnostic-specific data accounts for less than 0.1% of the total throughput from the remote to console, and are transmitted at a lower priority than user-based traffic. The 907-GBE2 may also be configured as a diagnostic master to read diagnostics from other cards in the stack, as per the 907-GBES. Details of the 907-DIAG-E card and the CWDM modules are provided in the System Modules section.

The 907-GBE2 cards are available in pressure tolerant versions with a 6000 psi rating.
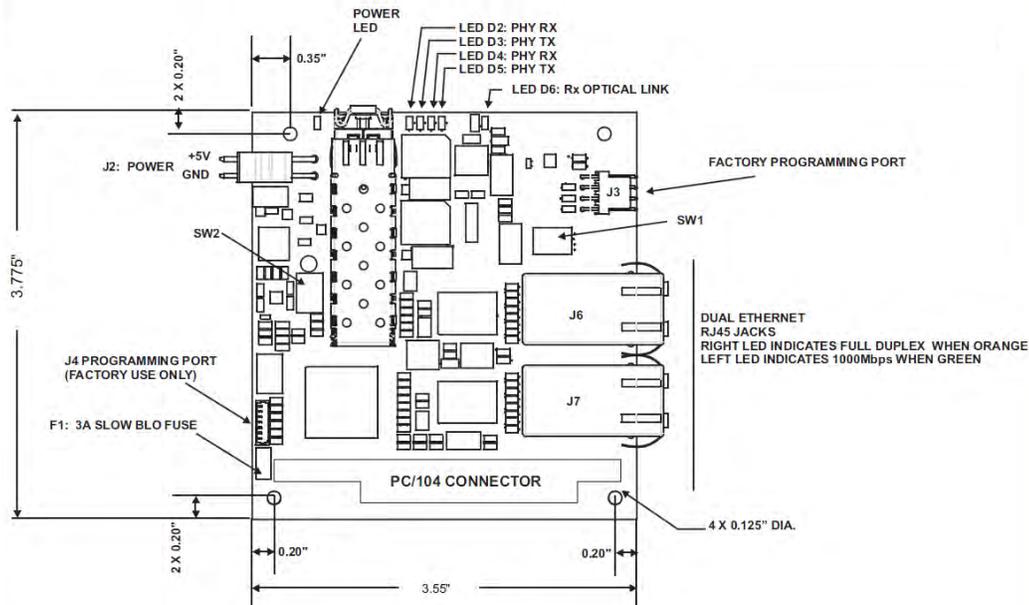
Figure 4-7: 907-GBE2, Dual Gigabit Ethernet Media Converter Card

*Cards with serial number lower than 10019957 support only 1000 Mbps on the RJ-45 ports unless they have been reprogrammed with firmware version A1 or higher.

4.7 907-GBES (Quad Gigabit Ethernet Switch)

Card P/N   907-0027-XX
Config. Dwg.   907-2037-00
Diagnostics: 907-DIAG-E Compatible

The Quad-port Gigabit Ethernet Switch (GBES) media converter card, shown in Figure 4-8, is used to transmit up to four copper ports of 10/100/1000 Mbps Ethernet traffic over a bidirectional optical link via an on-board SFP optical transceiver. Packet traffic on the optical link is shared among the four copper ports via an Ethernet Switch, and the maximum aggregate throughput of the 907-GBES is 1 Gbps in each uplink and downlink direction. Standard flow control procedures are used by the switch to throttle back incoming packets when buffers are full. Although the switch provides advanced management of the Ethernet traffic, it does introduce latency, typically in the hundreds of microseconds.

The 907-GBES has on-board SFP diagnostics, which are transmitted over the optical link with the user-Ethernet traffic to the 907-GBES console card. A 907-DIAG-E diagnostics card stacked on the console card can read diagnostic information from the 907-GBES remote and console cards. Diagnostic-specific data accounts for less than 0.1% of the total Gigabit throughput from the remote to console, and are transmitted at a lower priority than user-based traffic.

Like the 907 motherboards, the 907-GBES can be configured as a diagnostic master to read the diagnostic information from other diagnostic-capable cards in the stack. As with the on-board SFP diagnostics, diagnostic data collected from cards in the remote stack can be packaged and transmitted by the 907-GBES remote card over the optical link.
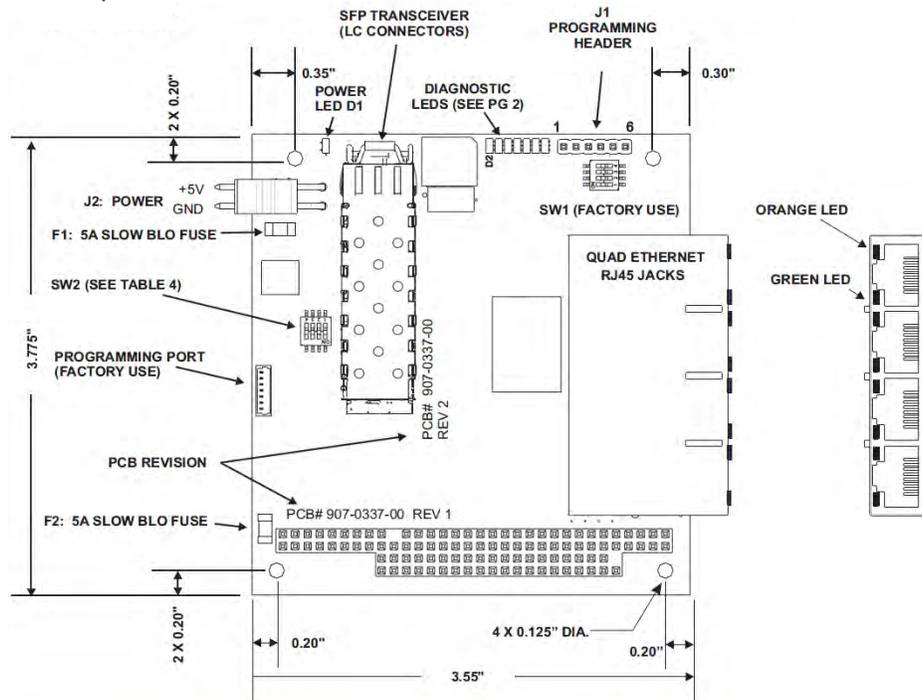
Figure 4-8: 907-GBES Media Converter Card

The 907-GBES card can supply +5 VDC power to other stacked cards or receive +5 V power from other cards in the stack. In this way, the 907-GBES card behaves like a 907 motherboard or a 907 media converter. Each 907-GBES is fuse limited to 5.0 A for on-board current draw plus total current draw from the stacked cards.

The 907-GBES cards are available in pressure tolerant versions with a 6000 psi rating.

5.0 Expansion Cards

Expansion cards are used to increase the number of serial data channels or to add different analog or digital format capabilities to a multiplexer system. Expansion cards require a motherboard to provide power and the optical link between the remote and console cards. Using an asynchronous over-sampling of serial data lines, expansion cards can time division multiplex many low speed serial channels onto one high-speed serial channel. Expansion cards send and receive their time division multiplexed data over the optical link via the data port lines on the backplane PC/104 connector of a 907 motherboard.

Switch settings on each expansion card select which of the six backplane data port lines are used. The standard 907 motherboard has six on-board data channels which are also connected to the six data port lines. When one of the six data ports is assigned to a stacked expansion card, the corresponding onboard I/O circuits on the motherboard are disabled to avoid a conflict. For example, if a 907-485 expansion card is assigned to data port 5, then the channel 5 RS-485/422 channel on the 907 card itself is disabled while the expansion card overrides it. Furthermore, the RS-232 channels (1-4) on the standard 907 card run on dual transceivers, so disabling one channel always disables a second channel, i.e. channels 1/2 or channels 3/4. Removal of an expansion card automatically re-enables the motherboard channel(s).

The 907V motherboard has no on-board data channels but still has six data port lines available on the PC/104 connector. So adding expansion cards does not disable anything on the 907V motherboard. Similarly, the 907Plus motherboard has six dedicated data channels locally plus six independent data port lines via the PC/104 backplane data channels. This provides a total of twelve simultaneous data ports with no disabling of channels required on the motherboard. The 907-HDM2 and 907-GEM multiplexer cards also support expansion cards with six independent data port lines as with the 907Plus.

Four to six expansion cards may be stacked on a 907 motherboard, limited by the availability of data channels on the motherboard and the collective current draw of all cards in the stack through the motherboard.

Caution: Some expansion cards allow access to only a subset of data port lines. Ensure configuration drawings are checked for data port options prior to setting up a system. All expansion cards attached to a single motherboard must be switch configured to access different data port lines or data will be corrupted. The corresponding expansion cards at the other end of the system must be configured to match the same parts. For example, if one remote stack includes a 907-EIBS expansion card on port 1 and a 907-232 expansion card on data port 2, the console stack must also be configured with a 907-EIBS on data port 1 and 907-232 on data port 2.

5.1   907-EIBS (10 Mbps Ethernet Switch Card)

Card P/N   907-0222-00
Config. Dwg.   907-2019-00
Diagnostics: LEDs Only

The three-port, 10 Mbps Ethernet expansion card is shown below in Figure 5-1. All three RJ-45 jacks support 10/100 Mbps Ethernet linking and are connected to a switching hub chip. A fourth Ethernet port from the hub chip is used to transmit and receive data through one of the six backplane data ports on the Model 907 motherboard. Local traffic between on-board RJ-45 ports is supported and is not transmitted through the optical link.

The remote to console throughput is limited to 10 Mbps, so any aggregate traffic beyond this will cause the Ethernet switch to generate flow control packets. If multiple, separate Ethernet links are required, for example as dedicated links for two different sensors, multiple 907-EIBS expansion cards may be stacked together. Each RJ-45 jack has built-in magnetics for galvanic isolation.

Figure 5-1: 907-EIBS Ethernet Expansion Card

Configure switch SW1 to set the backplane data port used by the 907-EIBS card. All ports (1-6) are available. The default setting is data port #1.

5.2 907-232 (8-Channel RS-232 Card)

Card P/N   907-0212-00
Config. Dwg. 907-2008-00
Diagnostics: LEDs Only

The 8-channel RS-232 expansion card is shown below in Figure 5-2. All eight RS-232 channels are combined on a single high speed serial stream (8:1), which is transported over a single data port channel on the motherboard.
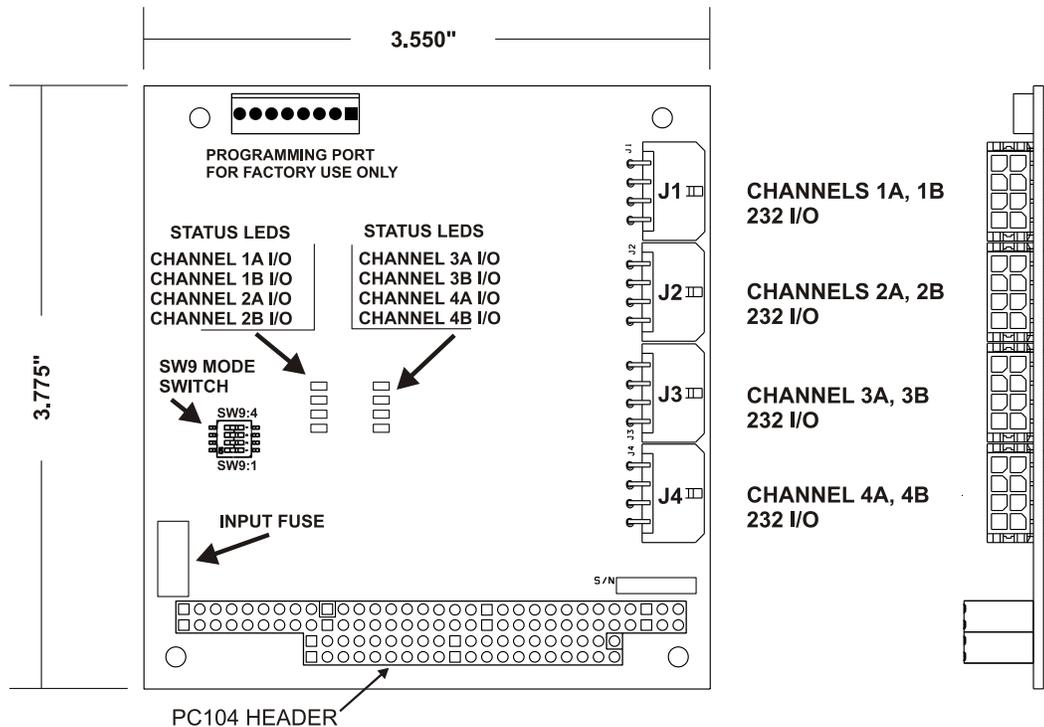
Figure 5-2: 907-232, RS-232 Expansion Card

Configure switch SW9 to set the backplane data port used by the 907-232 card. Ports 3~6 are available. The default setting is data port #3.

5.3   907-485 (8-Channel RS-485/422 Card)

Card P/N   907-0217-00
Config. Dwg.   907-2015-00
Diagnostics: LEDs Only

The 8-channel RS-485/422 expansion card is shown below in Figure 5-3. This card is default switch configured to multiplex up to eight data channels onto a single backplane data port (8:1). The 8:1 configuration uses only one backplane data channel from the motherboard but provides the lowest data rate (maximum 250 Kbaud) per each of the eight channels. Alternatively, 4:4 and 2 x 4:1 options are configurable, at maximum input channel data rates of 2.5 Mbaud and 400 Kbaud respectively. The 4:4 configuration allows for the highest data rates but requires four backplane data ports from the motherboard. Refer to configuration drawing 907-2015-00 for switch settings.

To maintain signal integrity at the high data rates, external cables should be shielded twisted pairs with 120-ohm impedance.
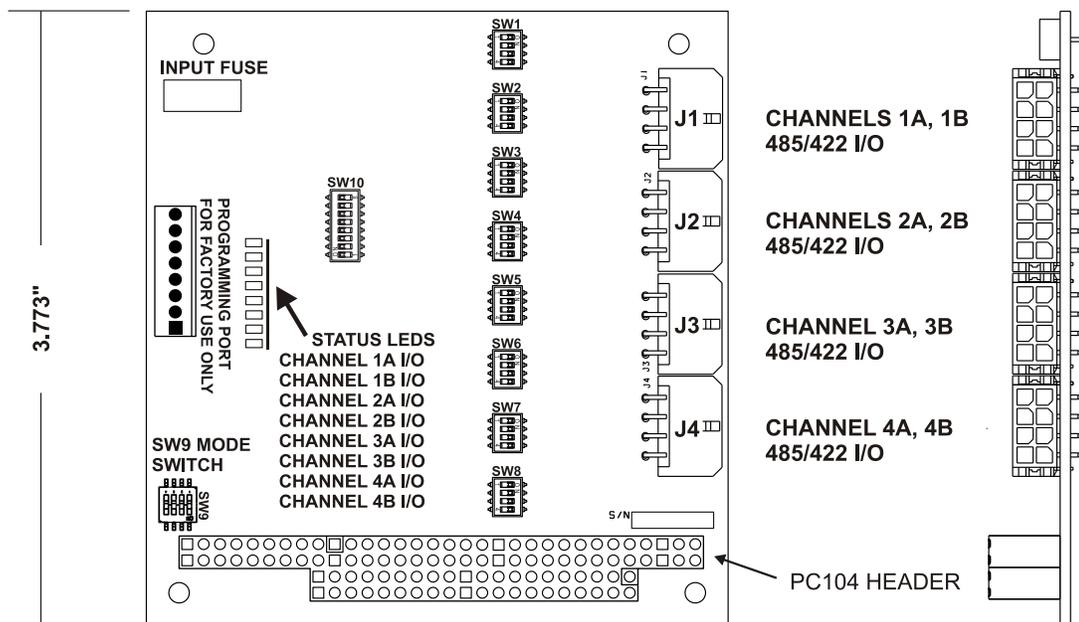
Figure 5-3: 907-485, RS-485/422 Expansion Card

Configure switch SW9 to set the backplane data port used by the 907-485 card. All ports (1~6) are available. The default setting is data port #1.

5.4   907-SER (8-Channel Serial Data Card)

Card P/N   907-0242-00 (RS-232/485), 907-0242-01 (RS-422)
Config. Dwg.   907-2047-00
Diagnostics: 907-DIAG-E Compatible

The 8-Channel RS/232/485/422 serial data expansion card (907-SER) is shown in Figure 5-4. This card is switch configured to multiplex eight data channels onto a single backplane data port (8:1). The 8:1 configuration uses one backplane data channel from the motherboard and supports a maximum baud rate of 250 Kbaud on each of the eight channels. Alternatively, 4:4 and 4:1 options are configurable, at maximum input channel data rates of 2.5 Mbaud and 400 Kbaud respectively. The 4:4 configuration requires four backplane data ports from the motherboard.

A 907-DIAG-E diagnostic card may be added to the same stack as the console 907 motherboard to obtain critical system diagnostics of both the remote and console stacks through an Ethernet interface. Details of the 907- DIAG-E card are provided in the System Modules section 6.0.

Switch SW1 is used to configure the 907-SER card for either remote or console use, although this is only needed for diagnostics purposes when used with a 907-DIAG-E card. Refer to configuration drawing for switch settings.
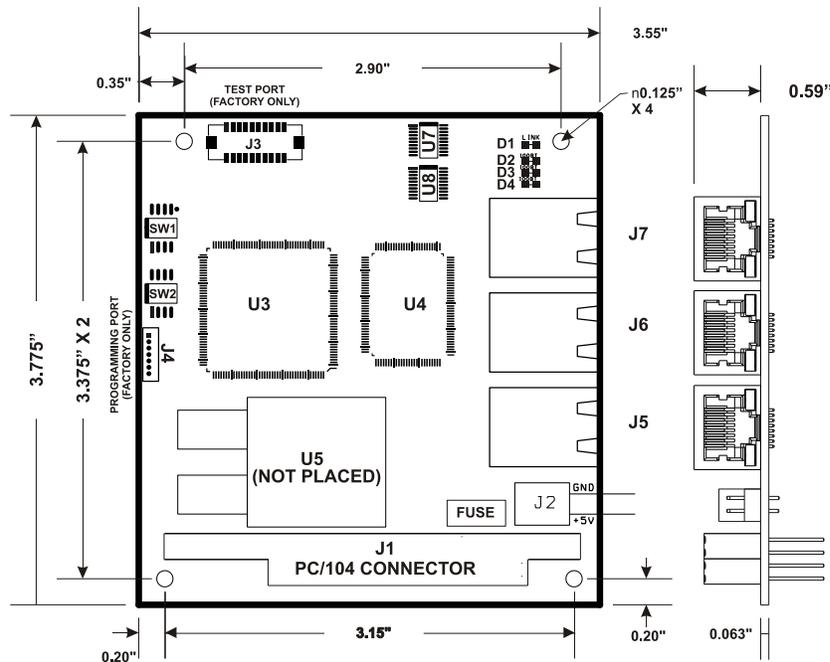

Figure 5-4: 907-SER, Serial Data Expansion Card

Configure switch SW2 to set the backplane data port used by the 907-SER card. All ports (1~6) are available. The default setting is data port #1.

The 907-SER card is compatible with 907-232 and 907-485 cards, although the pin outs on the data I/O connectors are different in RS-232 mode, so any existing RS-232 harnessing must be rewired. The 907-SER card supports only RS-232 and RS-485 signals when the card part number used is 907-0242-00 or only RS-422 signals when the card part number used is 907-0242-01. In some cases, two RS-485 channels can be used as equivalent to one RS-422 channel.

When the card part number used is 907-0242-00, switch SW3 and SW4 are used to configure each channel individually as either RS-232 or RS-485. When the card part number used is 907-0242-01, switch SW3 and SW4 must be set in the ON position (default).

Additionally, a 907-SER pair (remote and console) can be used to convert from RS-232 to RS-485/422 and vice versa. Cable assembly rewiring may be required depending on the card configuration. Please contact Focal for more details about this feature.

5.5 907-ADC (8-Channel 8/12 bit ADC Card)

Card P/N   907-0218-00
Config. Dwg.   907-2016-00
Diagnostics: None

The 907-ADC expansion card shown in Figure 5-5 is an analog-to-digital converter card. It takes up to eight channels of differential analog inputs, and digitizes the signals (maximum of 1 VDC differential voltage) with 8 bits of amplitude resolution at a sampling rate of 160 kHz (maximum of 50 kHz signal bandwidth). All channels are sampled simultaneously to minimize channel-to-channel skew. Switch SW1 is used to configure which inputs are active, i.e. the inputs can be configured such that all 8 channels are active (8 x 8-bit) or channels 1 through 6 are active (6 x 12-bit). The card may be factory configured for 12-bit resolution.
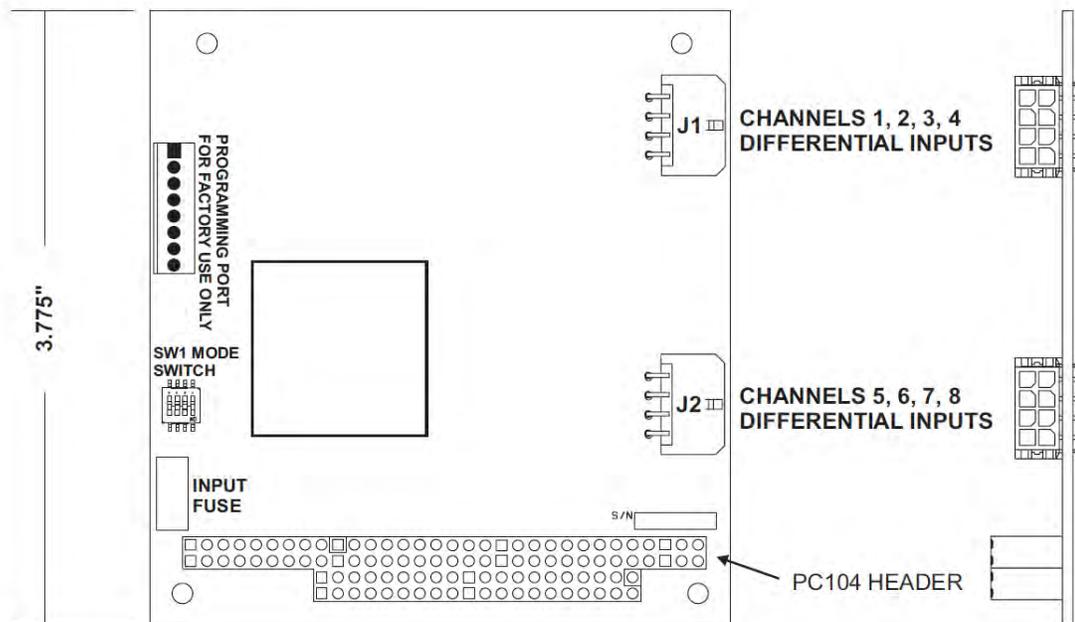
Figure 5-5: 907-ADC Expansion Card

Switch SW1 is also used to set the backplane data port used by the 907-ADC card. Ports 1, 3 or 5 are available. The default setting is data port #1.

5.6 907-DAC (8-Channel DAC Card)

Card P/N   907-0219-00
Config. Dwg.   907-2017-00
Diagnostics: None

The 907-DAC expansion card shown in Figure 5-6 is a digital-to-analog converter card used in conjunction with the 907-ADC. The 907-DAC takes 8-bit digitized data streams (12-bit support can be provided through factory configuration) and converts the samples into analog waveforms. Switch SW1 is used to select the number of active channels, i.e. the inputs can be configured such that all 8 channels are active (8 x 8-bit) or channels 1 through 6 are active (6 x 12-bit). The card provides a maximum of 1 VDC differential output voltage, with a typical common mode voltage of 2.5 VDC, and handles signals from DC up to a maximum of 50 kHz bandwidth.
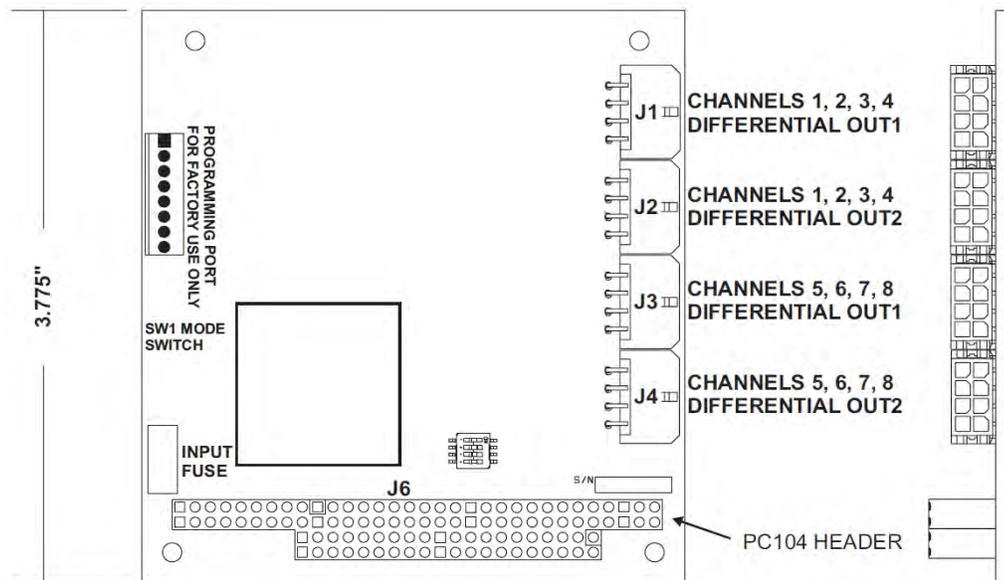
Figure 5-6: 907-DAC Expansion Card

Dual outputs are provided by connectors J1 - J4 so that channels may be monitored live while also connected to controllers or logging equipment.

Switch SW1 is also used to set the backplane data port used by the 907-DAC card. Ports 1, 3 or 5 are available. The default setting is data port #1.

5.7   907-AUDIO (4-Channel, 24-bit Audio Card)

Card P/N   907-0228-00
Config. Dwg.   907-2030-00
Diagnostics: LEDs Only

The 907-AUDIO expansion card is shown in Figure 5-7. The 907-AUDIO expansion card provides four simultaneous channels of variable gain microphone inputs (J2-J5) and four channels of 2 W outputs for speakers (J6-J9). The card supports 24-bit digital conversion of 20 to 20,000 Hz balanced and unbalanced input signals with a dynamic range of 60 dB, and provides switch-selectable linear gains of 0.5, 1, 5, 10, and 100. An optional 12 VDC bias is available on each microphone input. All of the outputs are differential. If an output is connected to a single ended input externally, or a speaker with a ground connection, the signal must be transformer coupled. The 907 audio transformer board (907-AUDIO-T) allows for easy integration of transformers into a 907 stack.
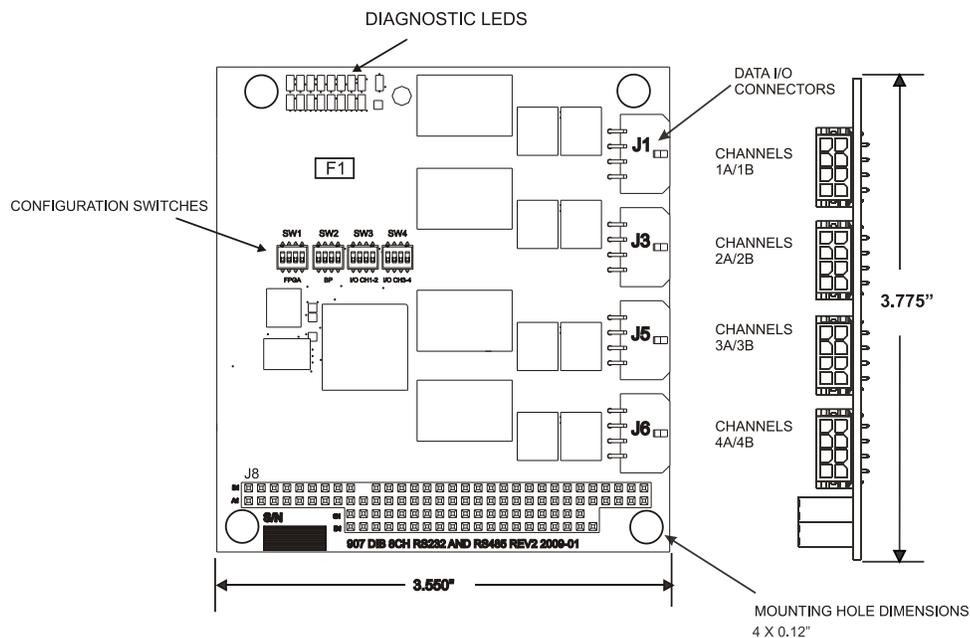

Figure 5-7: 907-AUDIO Expansion Card

Configure switch SW13 to set the backplane data port used by the 907-AUDIO card. All ports (1~6) are available. The default setting is data port #1.

5.8   907-AUDIO-T (4- Channel Audio Transformer Card)

Card P/N   907-0230-00
Config. Dwg.   907-2032-00
Diagnostics: None

The 4-channel 907-AUDIO-T expansion card allows for easy integration of audio transformers into a Model 907 multiplexer stack. It consists of an array of transformers and an array of resistors, as shown in Figure 5-8. The 1:1, 600-ohm impedance transformers can be used to isolate grounds between audio components, or to provide a single ended speaker output from the differential output of the 907-AUDIO expansion card. The transformers can also be looped back through the on-board resistors in order to attenuate the signal. Note that for the input connectors J9 to J16, pin 1 is input (+) and pin 2 is input (-) and for output connectors J1 to J8, pin 1 is output (-) and pin 2 is output (+).

WAGO 2-PIN HEADER

PIN 1: INPUT + / OUTPUT -
PIN 2: INPUT - / OUTPUT +

PIN 2   PIN 1
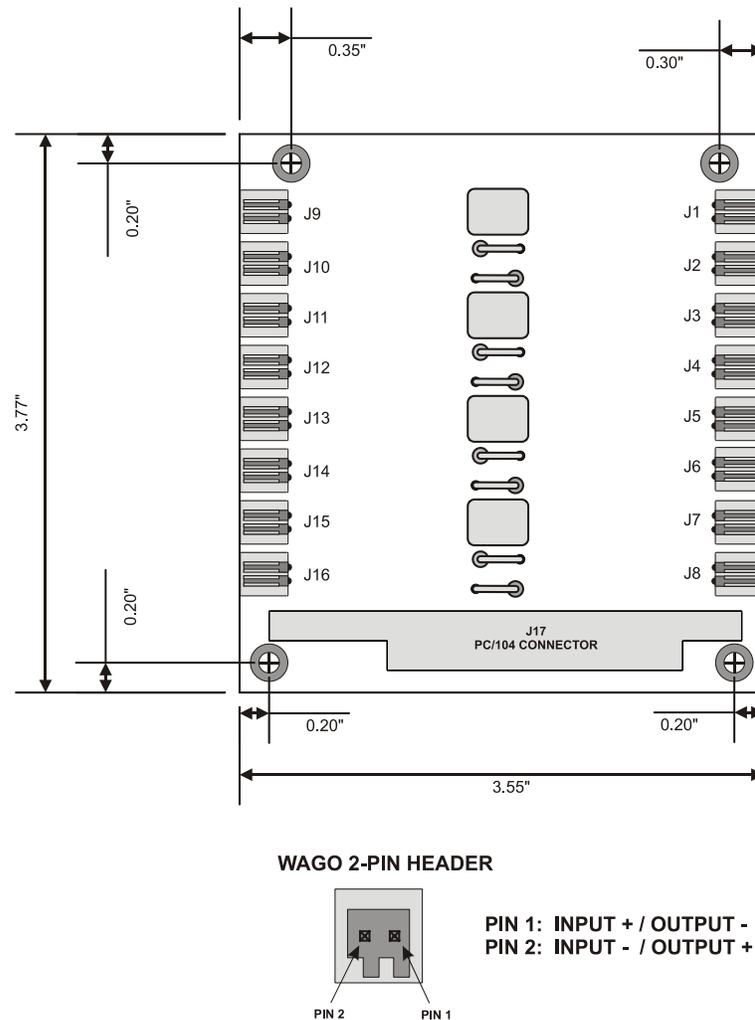
Figure 5-8: 907-AUDIO-T Expansion Card

5.9 907-TTL (8-Channel TTL Card)

Card P/N   902-0212-00
Config. Dwg.   907-2008-01
Diagnostics: LEDs Only

The 907-TTL shown in Figure 5-9 is an 8-Channel Transistor-Transistor Logic (TTL) multiplexer card based on the 907-232 expansion card. By means of switch configuration, eight TTL channels are multiplexed into a single stream (8:1), which is transported over a single backplane data port on the motherboard. Alternatively, 4:4 and 4:1 multiplexing options are available.
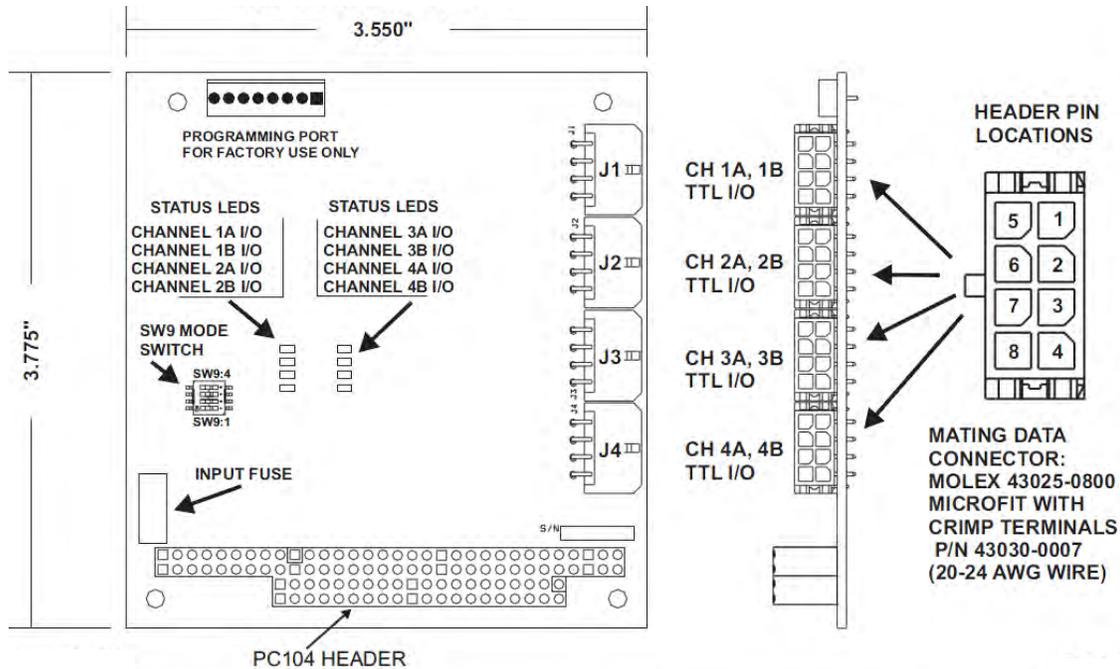
Figure 5-9: 907-TTL Expansion Card

The 907-TTL expansion cards have 5 V TVS diodes and 100-ohm inline resistors for protection. Similarly, outputs have 5 V TVS diodes and 22-ohm inline resistors. Maximum input and output signal ranges are from -0.5 V to +5.5 V.

Configure switch SW9 to set the backplane data port used by the 907-TTL card. Ports 3~6 are available. The default setting is data port #3.

5.10 907-CIB (4-Channel Control Interface Card)

Card P/N   907-0231-00
Config. Dwg.   907-2027-00
Diagnostics: LEDs Only

The 907-CIB shown in Figure 5-10 is a 4-channel control interface (on/off control) expansion card. This card provides four bidirectional control links.

The opto-isolated inputs for each channel are controlled by either a 0-24 V digital signal (Type 1) or external switches (Type 2), as set on an individual channel basis by switches SW1-SW8. The outputs are solid state relays with a maximum current rating of 200 mA each. The board multiplexes all of the inputs onto any one of the six available backplane data ports.
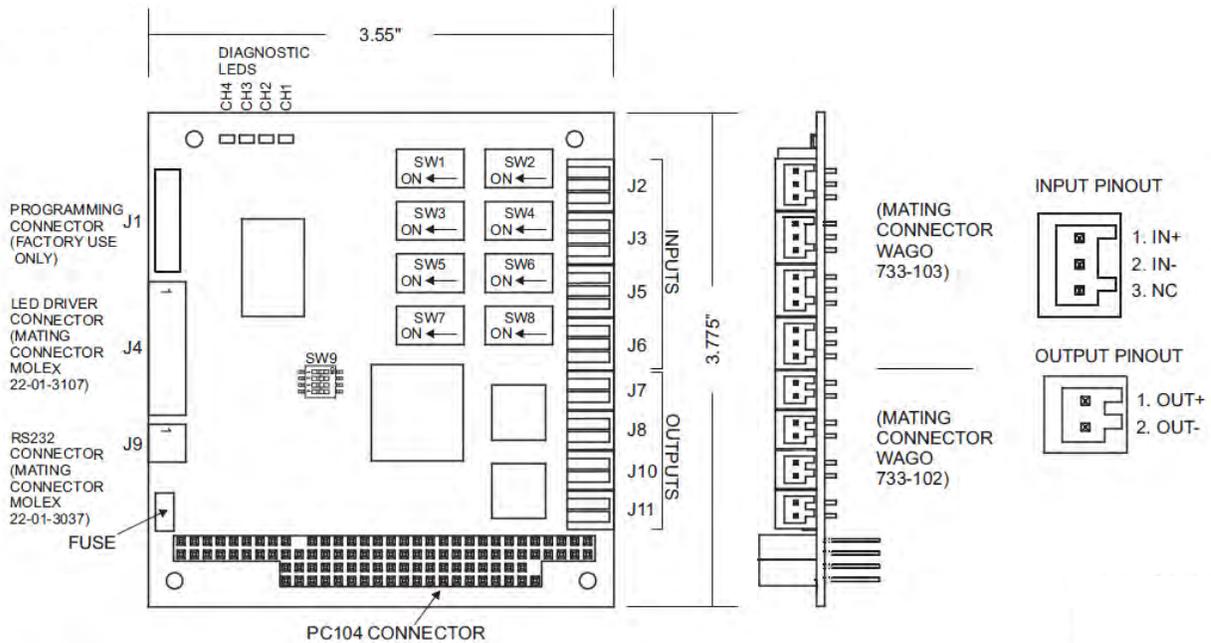
Figure 5-10: 907-CIB Control Channel Expansion Card
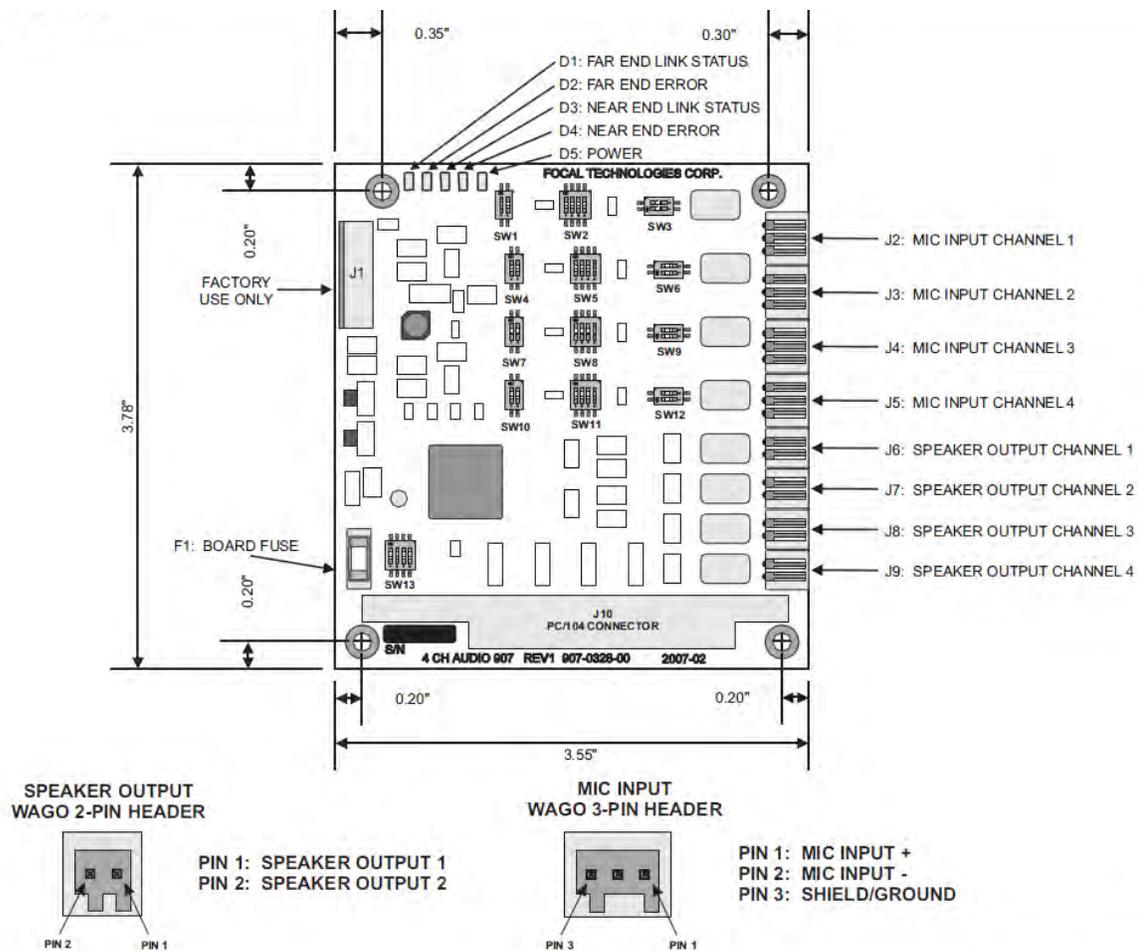
Configure switch SW9 to set the backplane data port used by the 907-CIB card. All ports (1~6) are available.

The 907-CIB may also be configured to transmit the multiplexed channel status over an RS-232 port via connector J9, allowing the 907-CIB cards to operate over a spare RS-232 channel or independent copper link.

5.11 907-420 (6-Channel 4-20 mA Card)

Card P/N   907-0218-01
Config. Dwg.   907-2024-00
Diagnostics: None

The 907-420 expansion card shown in Figure 5-11 is used to multiplex up to six channels of 4-20 mA inputs. The 4-20 mA input signal is a current-based signaling scheme where 4 mA represents zero percent signal and 20 mA represents the one hundred percent signal. The input current levels are converted to voltages and an ADC is used to digitize the signal. The card is factory configured for 12-bit digitization of the 4-20 mA signals at a sample rate of 30 Hz.

The multiplexed channels from this card are not available on the PC/104 backplane connector but are instead provided at two RS-232 channels on connector J2. The RS-232 serial stream must therefore be connected to an available RS-232 input/output connector on another 907 card. Alternatively, the 907-420 may be installed on a Eurocard adaptor for use in a Model 903 system, in which case the RS-232 output must be harnessed to an available RS-232 channel at the front panel.
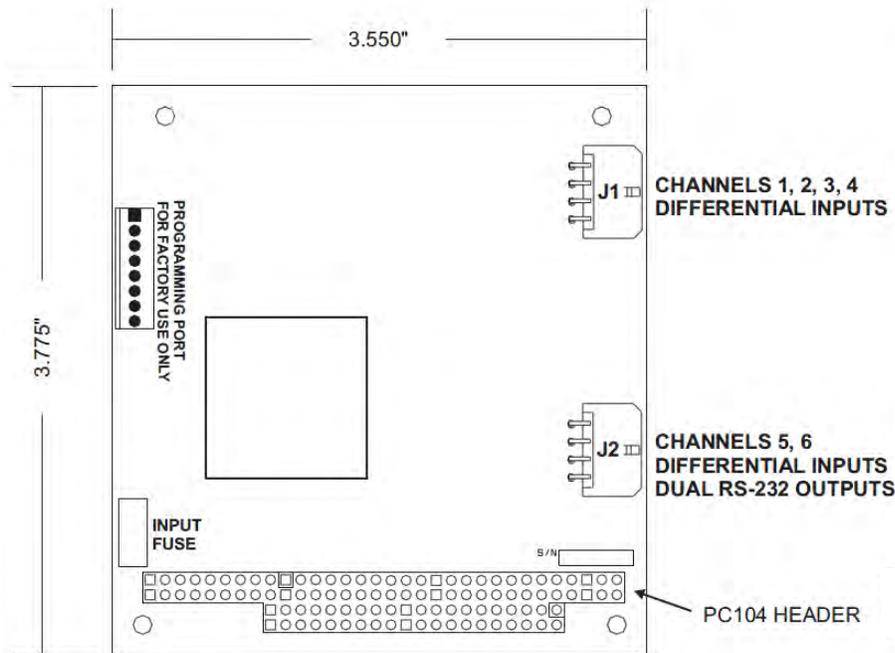
Figure 5-11: 907-420 Expansion Card

For output, the card supports two output RS-232 channels which contain the digital representation of the six input channels of multiplexed input data streams. Details of the RS-232 format are provided in the configuration drawing.

5.12 907-USB (Universal Serial Bus Card)

Card P/N   907-0224-00 (Obsolete)
Config. Dwg.   907-2022-00
Diagnostics: None

Note: This card is now obsolete and can no longer be ordered.

The 907-USB expansion card is a special card used to convert USB signals to Ethernet, and vice-versa. This card is not outfitted with any optical transceivers, and must be used in conjunction with an Ethernet converter card (e.g. 907-GBES, 907-GBE, 907-MC, 907-EIBS) for USB communications over an optical link.

The card supports USB 1.0, 1.1, and 2.0 standards, and the Ethernet port supports 10Base-T or 100Base-T Ethernet data rates. The 907-USB expansion card supports asynchronous data formats, such as those provided by still cameras and other USB storage devices, but not isochronous formats (synchronized but containing start and stop bits) typically required by web-cameras and other data streaming devices. Any proposed configuration should be verified with bench testing.

The 907-USB expansion card, shown in Figure 5-12, is typically installed in the remote stack with a short RJ-45 jumper running from the Ethernet port shown to a free Ethernet port on another card. At the console, the Ethernet connection is connected to the Network Interface Card (NIC) of a computer running an application that automatically redirects USB traffic on the computer to the Ethernet link.
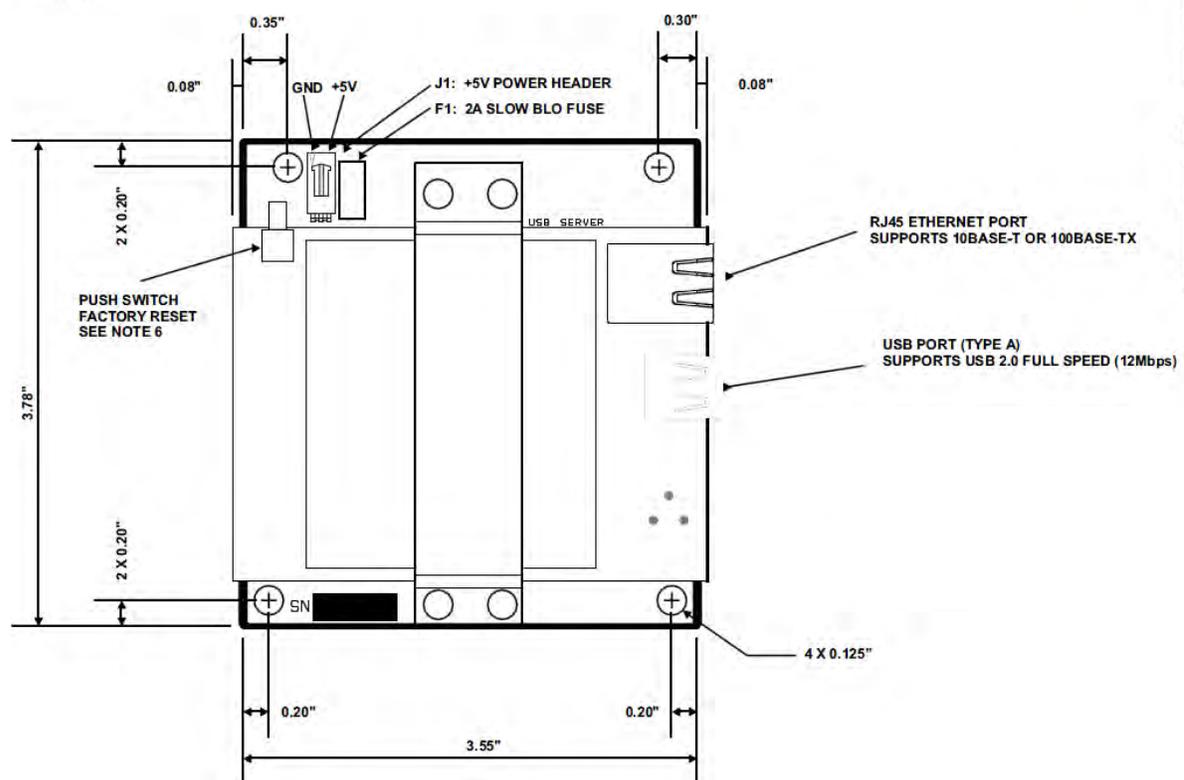
Figure 5-12: 907-USB Expansion Card

This card does not use any of the backplane data port links.

5.13 907-AIB (Dual-Socket AIB Adaptor)

Card P/N   907-0204-00
Config. Dwg.   907-2004-00
Diagnostics: LEDs Only

The 907-AIB expansion card allows standard AIB (Adaptable Interface Board) plug-in modules from the Model 903 systems to be employed in Model 907 stacks. Note that to accommodate the length of the plug-in cards, the sides of the 907-AIB extend 0.28'" outside the normal PC/104 form factor as shown in Figure 5-13.
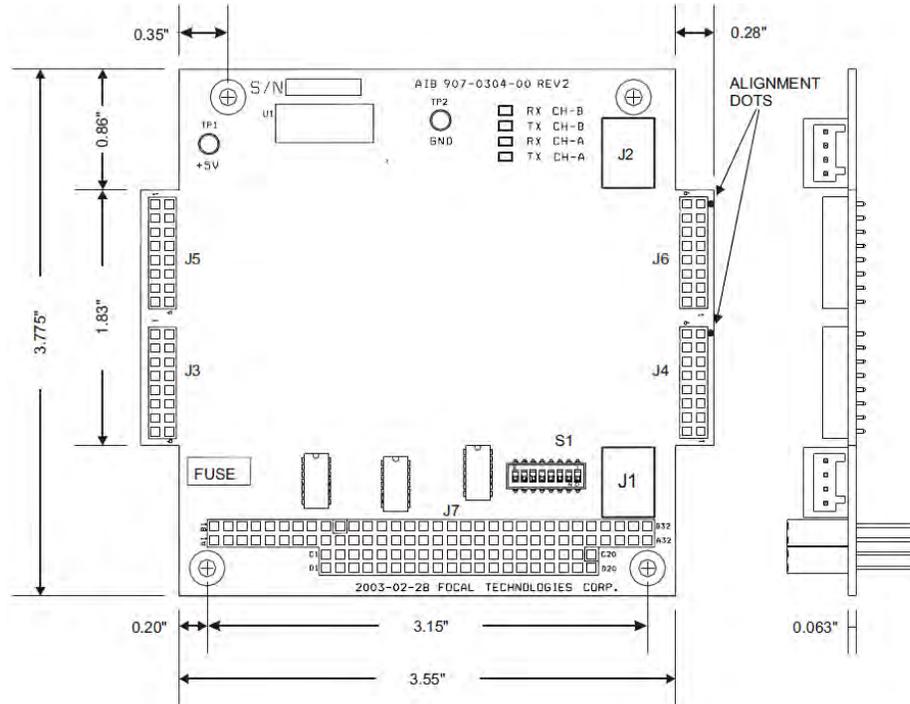
Figure 5-13: 907-AIB, Adaptable Interface Board Adaptor

The 907-AIB expansion card provides two generic data channels. Two pairs of socket interfaces are populated with AIB plug-in modules, which are accessed externally via WAGO connectors J1 and J2. A variety of plug-in modules are available for use with the 907-AIB expansion card. The AIB plug-in modules include analog interfaces for hydrophones and sonar (MS900) in addition to digital interfaces, such as RS-232, RS-485/422/TTL, Tritech sonar ARCNET and CANBUS.

When installing the AIB plug-in modules into the 907-AIB expansion card, ensure the connector marked by the white alignment dot on the module PCB is mated with the corresponding header marked with a white dot on the 907-AIB expansion card. When removing the modules, carefully extract the plug-in board by pulling both connectors straight out to minimize flexing of the PCB. Uninstalled AIB modules should be handled like integrated circuits: observe ESD handling precautions and store in static dissipating bags or conductive foam.

The 907-AIB expansion card is powered from the 907 motherboard through the backplane. Actual current draw depends on the plug-in modules installed. Switch S1 is used to configure which backplane data ports are used for data transfer through the motherboard, per configuration drawing 907-2004-00. Defaults are data port 1 for J3/J4 and data port 2 for J5/J6.

Refer to document 700-0271-00 for details on all of the available AIB Plug-In modules.

6.0   System Modules

System modules include various adaptors, optical multiplexing cards, optical redundancy cards, power interface boards, and other types of subassemblies used to build up 907 stacks or special configurations. Many cards are custom built for unique applications. The most commonly used system modules are shown in the following sections. Please contact Focal for custom requirements.

6.1   907-EURO (Eurocard Adaptor)

Card P/N   907-0221-00
Config. Dwg.   907-2018-00

The 907-EURO Eurocard adaptor shown in Figure 6-1 is used to add a Model 907 card to a Model 903 system. The 907 Card is typically soldered to J2 via the PC/104 backplane connector and further held in place with four standoffs. The pins are soldered if 907 expansion cards are used and no pins are soldered if 907 multiplexer motherboards or media converters are used. Soldered combinations are assembled by the factory only.

Switch S1 is used to enable and disable the use of the Model 903 backplane for data I/O to the 907 card. When data I/O is disabled, the Model 903 backplane is only used to supply +5 V power and ground, which supports the use of 907 motherboards and media converters. When data I/O is enabled, the Model 903 backplane provides power and access to 903 backplane data lines, which supports the use of most 907 expansion cards in a data slot on a Model 903 chassis.
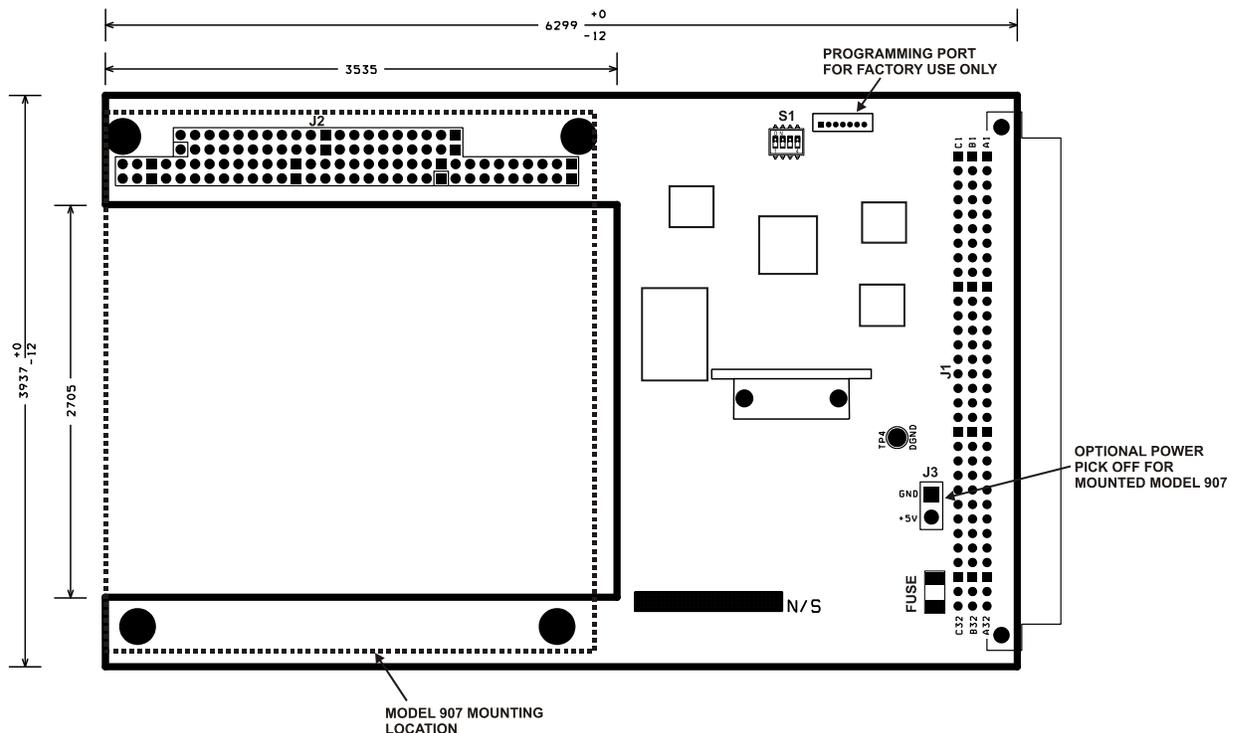
Figure 6-1: 907-EURO Eurocard Adaptor

The 907 Eurocard adaptor PCBA can be configured with either a 4HP- or 8HP-wide front panel for a 3U Eurocard rack. Figure 6-2 shows a 907-EURO Eurocard adaptor card assembly.
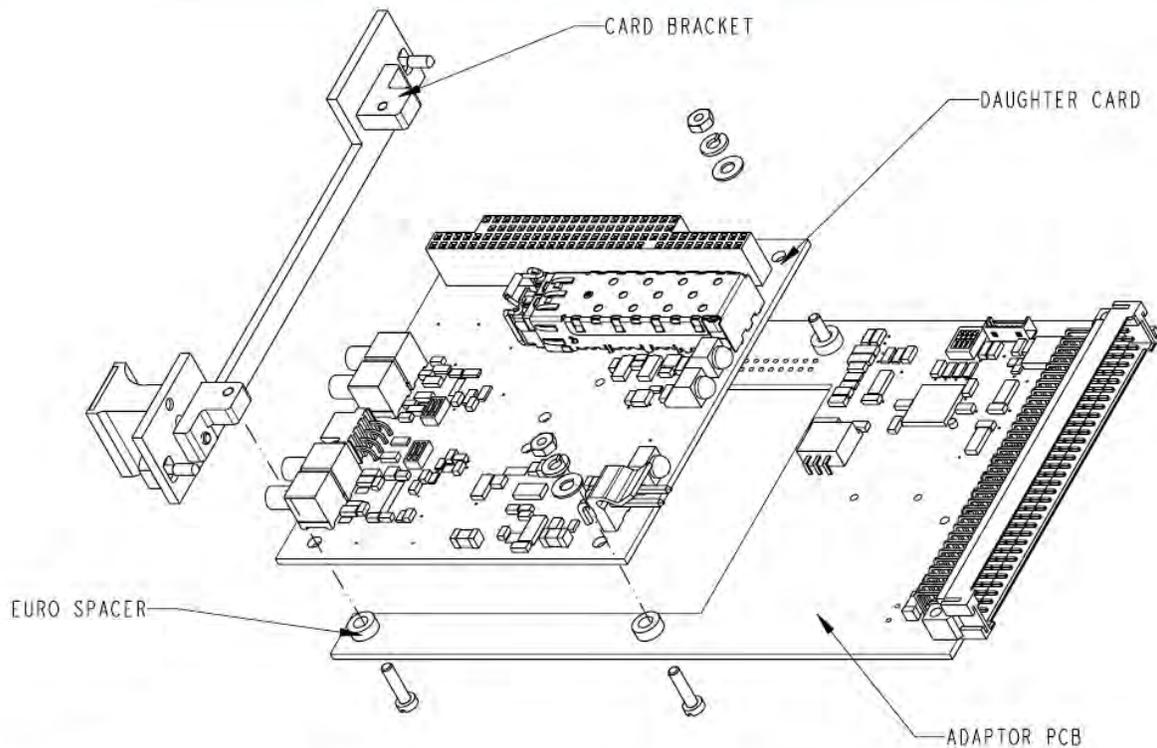
Figure 6-2: 907-EURO Eurocard Adaptor Card Assembly

Final assemblies are normally ordered as Model 903 cards. For example, P/N 903-5053-00, includes a 907-EURO Eurocard adaptor and a 907-485 (8-channel RS-485/422) expansion card. Another example is P/N 903-5056-00, which includes a 907-EURO Eurocard adaptor and a 907-232 (8-channel RS-232) expansion card.

Not all combinations of 907 cards and Eurocard adaptor are recommended, particularly if Model 903 cards already exist with the same functions. For instance, it is recommended to use a Model 903-AIB-4 instead of a 907-AIB for plug-ins or to use a EIB-10/100 instead of a 907-EIBS.

Typically the 907 Eurocard adaptors must be ordered as part of a higher level assembly from the factory and are not field installable.

6.2   907-PC104 (907 to Standard PC/104 Adaptor)

Card P/N   907-0205-00
Config. Dwg.   907-2010-00

Model 907 cards use a proprietary PC/104-connector pin designation for backplane communication and power. If a system requires the Model 907 stack to be directly connected to a standard PC/104 stack, the 907-PC/104 Adaptor board must be used to prevent damage. This card provides isolation between the PC/104 backplane and the Focal 907 stack. Only the +5 V pins and the GND pins are connected through the PC/104 connector. Figure 6-3 shows the 907-PC104 adaptor board.
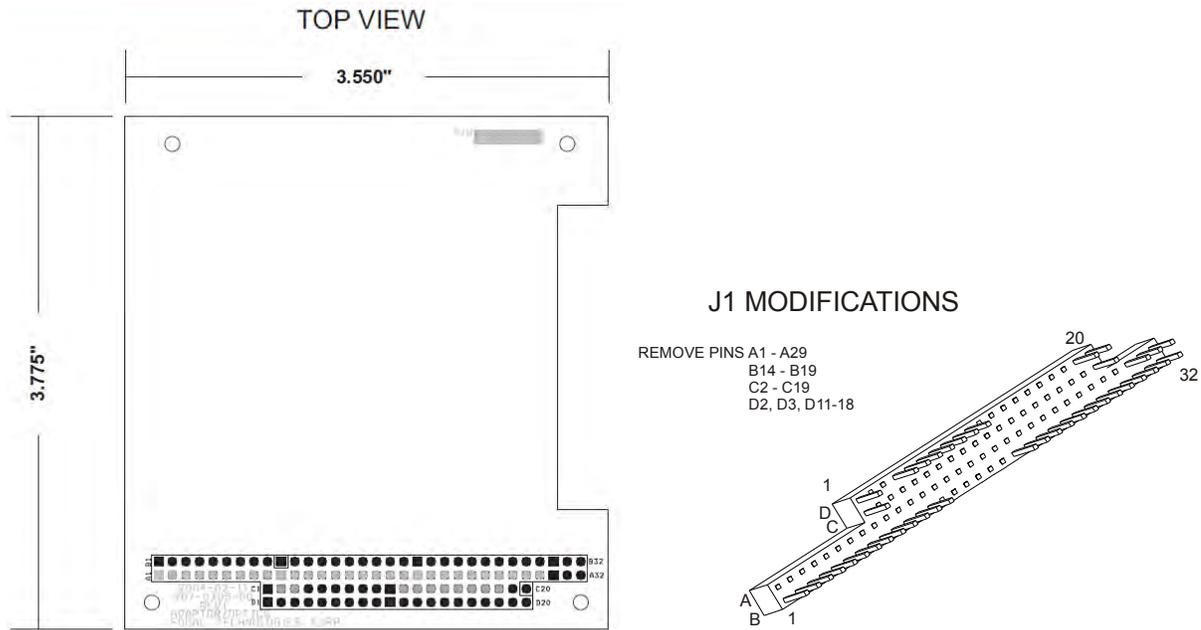
Figure 6-3: 907-PC104, 907 to Standard PC/104 Adaptor

Recommended practice, however, is to power the Model 907 card stack separately from any standard PC/104 stack.

6.3   907-DC-24 (Isolated DC-DC Power Card)

Card P/N   907-0233-00
Config. Dwg.   907-2029-00

The power supply card, shown below in Figure 6-4, is based on a 40 W DC-DC converter module used to distribute power to several Model 907 cards or substacks. Power input to the DC-DC converter via a 2-pin WAGO connector can range from 18 to 30 VDC (24 VDC nominal). Reverse protection and a 3 A replaceable fuse are included in the power input circuit. Wire gauge for the input power harness should be 20-22 AWG and wire gauge for the output power harness should be 18-20 AWG.

Four separate +5 VDC outputs are accessible from the 2-pin Molex connectors. Outputs are fused on the cards to which they are connected (all 907 cards have on-board fuses). Maximum output current on any single output connector should not exceed 4 A. The aggregate current output of the DC-DC converter should not exceed 8 A. Typically the 907-DC-24 is mounted on the bottom of a stack or installed separately but near the 907 stack.
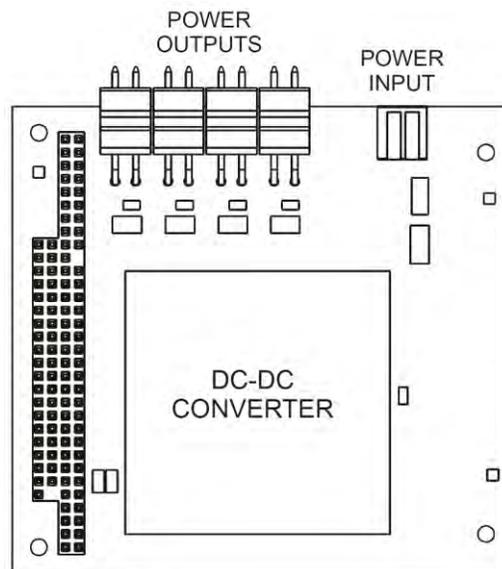
Figure 6-4: 907-DC-24 Power Distribution Card

The +5V and 0V pins on each power output connector are connected to the same +5V and 0V output pins on the DC-DC converter. These output pins on the DC-DC converter are isolated from the primary +24V nominal input.

6.4   907-CWDM (CWDM Optics Card)

Card P/N   907-0015-00 (SMF), 907-0015-02 (MMF)
Config. Dwg.   907-2009-00

The 907-CWDM optics card shown in Figure 6-5 is a two-channel CWDM optical add/drop multiplexer (OADM). The 907-CWDM is able to add or drop individual 1471 nm and 1491 nm CWDM wavelengths to an existing 1310/1550 nm (wider band) WDM signal by daisy chaining to the existing fiber link.

The 907-CWDM optics card delivers cost savings by upgrading an existing 907 multiplexer system operating at 1310/1550 nm wavelengths. For example, with a 907-CWDM optics card, a 907Plus multiplexer motherboard using a bidirectional transceiver operating at 1310/1550 nm wavelengths can be upgraded by adding a 907-GBE Gigabit Ethernet media converter card that uses a transceiver operating at 1471/1491nm wavelengths.

To daisy chain the 907-CWDM optics card, the bypass port ST1B should be connected to a 1310/1550 nm 907 card and the common port ST2B should be connected to the external cable system per the configuration drawing.
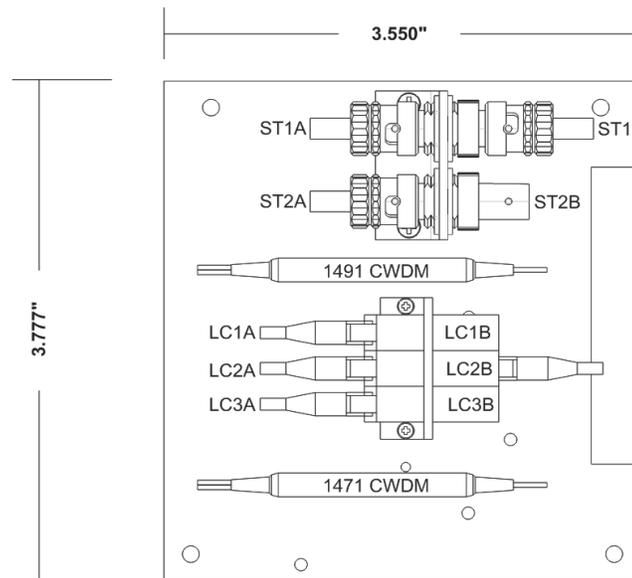
Figure 6-5: 907-CWDM Optics Card
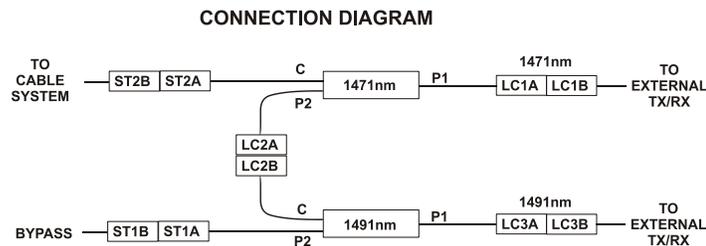
The standard 1471 nm and 1491 nm CWDM wavelengths used on the 907-CWDM optics card can be changed to other CWDM wavelengths upon request, but only the 1471/1491 nm version can be daisy chained with existing 1310/1550 nm systems.

6.5   907-CWDM-4 (4-Channel CWDM Optics Card)

Card P/N   907-0015-31 (SMF), 907-0015-34 (MMF)
Config. Dwg.   907-2031-08

Several versions of 4-Channel CWDM optics cards (907-CWDM-4) are available for the Model 907. Variations include multimode and singlemode options, different ranges of wavelengths, different physical layouts and connector types, and options for bypass/express ports to daisy chain CWDMs.

A typical 907-CWDM-4 optics card, shown in Figure 6-6, is used to optically multiplex four standard CWDM channels with 20 nm spacing from P1, P2, P3, and P4, into a single common optical fiber (COM) for connection to the external fiber system, typically at an ST/PC bushing. The same card is used to de-multiplex signals from a single fiber into four optical channels.

A 907-CWDM-4 card with P/N 907-0015-31 for example, multiplexes singlemode CWDM channels 1471, 1491, 1511 and 1531. In addition, an express channel (EXP), when available, can be used to bypass all wavelengths from 1551 to 1611 nm.

Pressure tolerant versions of the 907-CWDM-4 cards are also available.
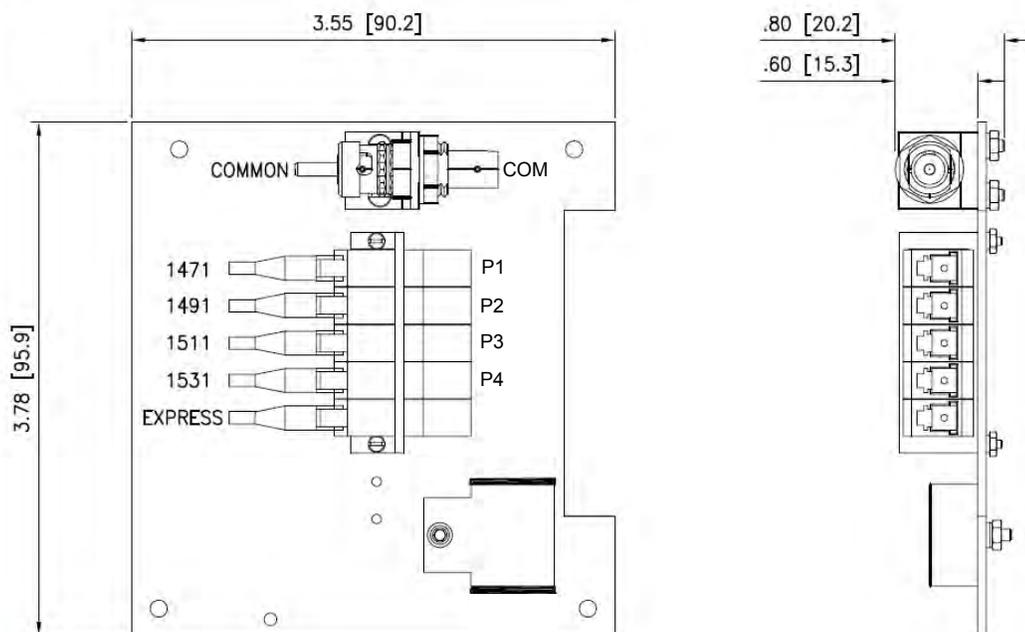
Figure 6-6: 907-CWDM-4, 4-Channel CWDM Optics Card

Optical insertion loss is typically less than 2.5 dB per 907-CWDM-4 card. Optical link analysis must account for CWDM cards at both ends of the system.

6.6   907-CWDM-8 (8-Channel CWDM Optics Card)

Card P/N   907-0015-20
Config. Dwg.   907-2031-04

Several versions of 8-Channel CWDM optics cards (907-CWDM-8) are available for the Model 907. Variations include multimode and singlemode options, different ranges of wavelengths, different physical layouts and connector types, and options for bypass/express ports to daisy chain CWDMs.

A typical 907-CWDM-8 optics card, shown in Figure 6-7, is used to optically multiplex eight standard CWDM channels with 20 nm spacing, into a single common optical fiber (COM) for connection to the external fiber system. The same card is used to de-multiplex signals from a single fiber into eight optical channels. A 907-CWDM-8 card with part number 907-0015-20, for example, multiplexes CWDM channels 1471, 1491, 1511, 1531, 1551, 1571, 1591, and 1611. In addition, the express or bypass channel (EXP or BYPASS), when available, can be used to pass all wavelengths from 1261 to 1451 nm.

Pressure tolerant versions of the 907-CWDM-8 cards are also available.
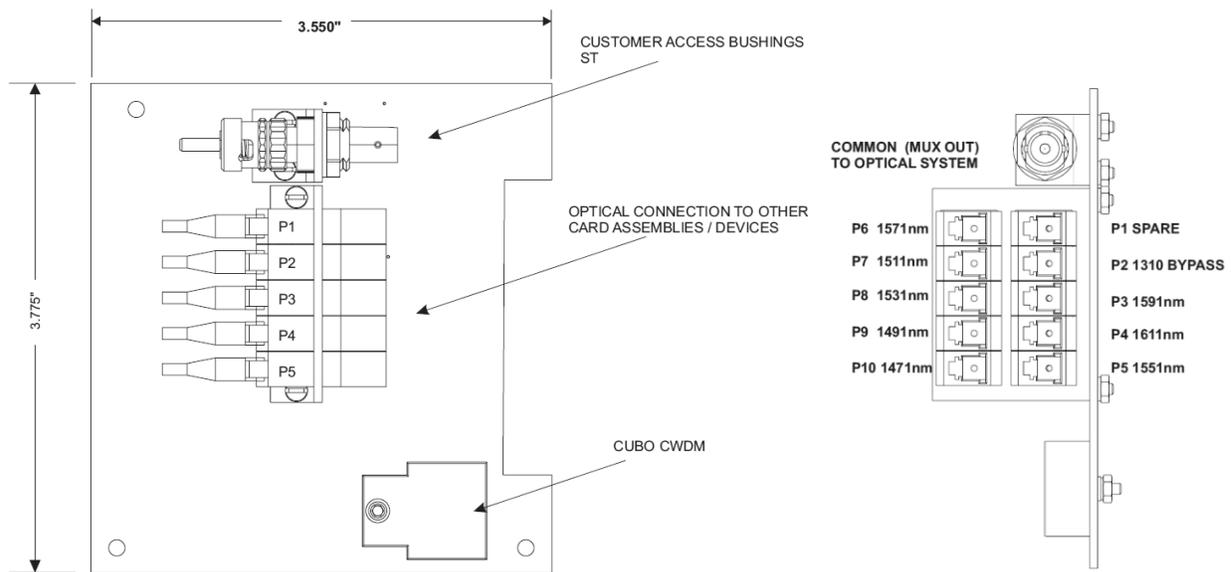
Figure 6-7: 907-CWDM-8, 8-Channel CWDM Optics Card

The center wavelengths of band 1 (red band) are 1471 / 1491 / 1511 / 1531 / 1551 / 1571 / 1591 / 1611 nm and the center wavelengths of the band 2 (blue band) are 1271 / 1291 / 1311 / 1331 / 1351 / 1371 / 1391 / 1411 / 1431 / 1451 nm.

Optical insertion loss is typically less than 3 dB per 907-CWDM-8 card. Optical link analysis must account for CWDM cards at both ends of the system.

6.7   907-FOS (1x2 SMF/MMF Fiber Optic Switch Card)

Card P/N   907-0015-06 (SMF), 907-0015-50 (MMF)
Config. Dwg.   907-2031-00

The 907-FOS card shown in Figure 6-8 is an optical switch card that can be manually or electrically switched to choose one of two optical fiber inputs in redundant systems. Variations of this card include multimode and singlemode options. The optical signal from either input F2 or input F3 is switched to a common output fiber, F1, via toggle switch S1 or via a TTL-compatible signal at J2 connector. Typically the two input fibers are connected through an umbilical and tether to a remote card with a splitter (907-SPLIT) or two separate remote cards for optimal redundancy subsea.

When switch S1 is set to position 1, the switch is forced to the F2 input; when the switch S1 is set to position 2 or 3, the fiber switch is forced to the F3 input, but will be overridden by a digital signal at the J2 connector, per the configuration drawing.

External LEDs can be directly driven via pins 1 and 2 of connector J2, corresponding to F3 and F2 respectively. These pins are pulled low (0V) when the LEDs are on and can be directly connected to the cathode of external LEDs, where the anodes are connected to +5V. On board resistors limit the sink current to 12mA when on. Refer to the configuration drawing. LEDs D1 and D3 are ON when the F2 path is selected, and D2 and D4 are ON when the F3 path is selected.

The 907-FOS card can be powered with +5 VDC via the PC/104 backplane or via connector J2 (pin 4 = +5V and pin 6 = GND). The card draws 70 to 90 mA, depending on the switch state – switch position 1 draws the higher current.
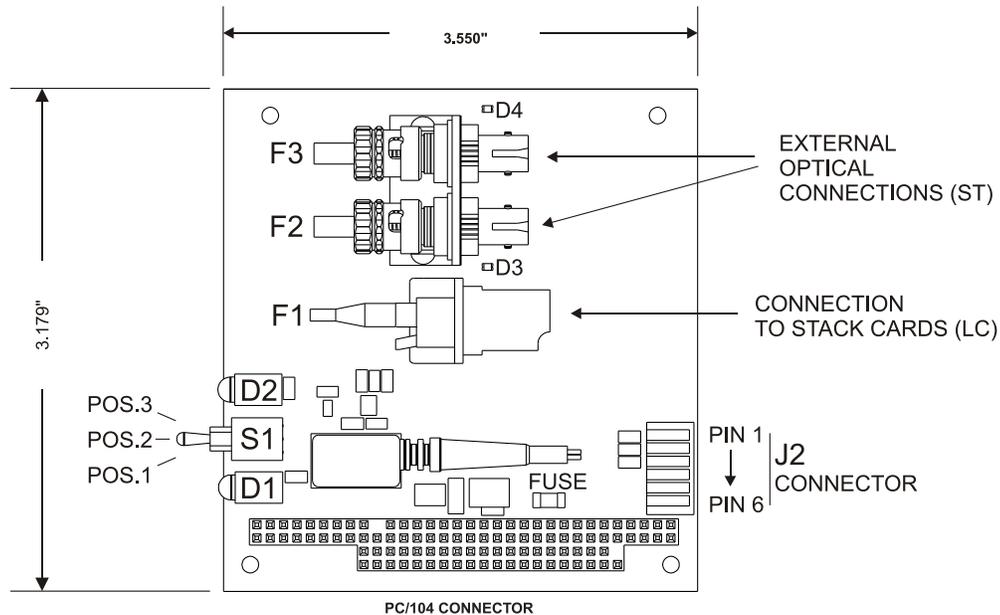
Figure 6-8: 907-FOS, 1x2 Fiber Optic Switch Card

Optical insertion loss is typically less than 1.0 dB per 907-FOS card.

6.8   907-SPLIT (1x2 Optical Splitter Card)

Card P/N   907-0015-05 (SMF), 907-0015-09 (MMF)
Config. Dwg.   907-2031-01

The 907-SPLIT 1x2 optical splitter card, shown in Figure 6-9, is used to split an optical signal for redundant operation. Typically installed at the remote (subsea) end of a 907 system, this card splits the optical power from a multiplexer or media converter card equally into two fiber outputs at F1 and F2. Typical loss through the splitter is less than 4 dB, with a 1 dB level of power uniformity between the two output fibers. Usually a fiber optic switch is included at the console to select which fiber is active. Alternatively, fibers can be manually selected and reconnected to the console card.

The 907-SPLIT card is also available in pressure tolerant versions.
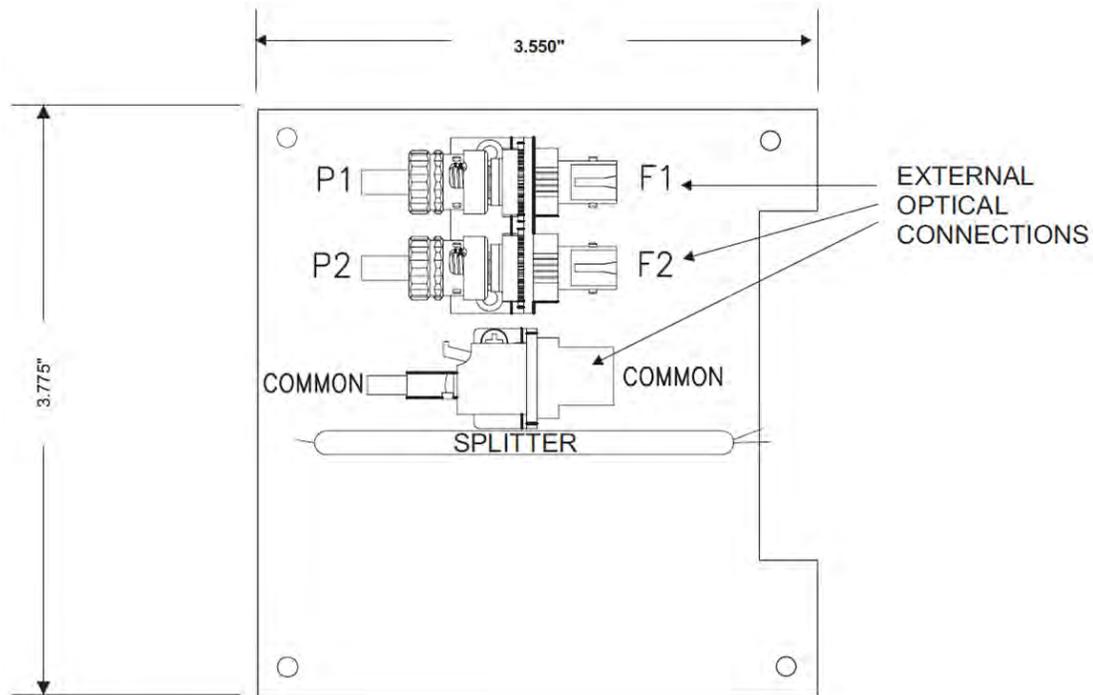
Figure 6-9: 907-SPLIT, 1x2 Optical Splitter Card

Caution: Splitters can only be used at one end of the system, as recombining signals at the far end with another splitter will corrupt the data due to differences in the fiber delays and possibly interference of the laser signal.

6.9   907-DIAG (Diagnostics Card, LED Driver)

Card P/N   907-0234-XX
Config. Dwg.   907-2033-XX

The 907-DIAG diagnostics interface card is shown below in Figure 6-10. This card monitors the data traffic on the six data ports as well as the video sync lines and optical link line. Ten 6-pin WAGO headers are provided for harnesses to external status LEDs.
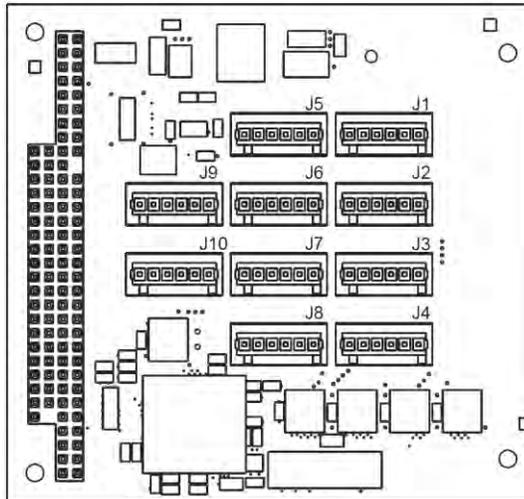
Figure 6-10: 907-DIAG LED Diagnostics Interface Card

Configuration of the WAGO connectors is determined by the installed firmware on the 907-DIAG card and is specific to the stack configuration. Any changes to the stack may require a change to the diagnostics card firmware for the LED diagnostics to remain valid. Refer to the configuration drawing for pin designations.

The installed firmware for the 907-DIAG card is reflected in the –XX part number suffix. Typically these cards are custom programmed for specific console rack configurations, for example to drive front panel LEDs. Most of the LED signals are also available on the 907 cards themselves.

6.10 907-DIAG-E (Diagnostics Card, Ethernet)

Card P/N   907-0238-00
Config. Dwg.   907-2039-00
Diagnostics: 907-DIAG-E Compatible

The 907-DIAG-E diagnostics card provides real-time diagnostic information from 907 motherboards and media converters that are 907-DIAG-E compatible. SFP diagnostics from the remote and console motherboards and media converters, such as Rx and Tx power, Tx bias current, temperature, voltage, vendor information, and wavelength, are retrieved via the 907-DIAG-E card. The diagnostic card also reads card-specific status information, stack backplane-voltages, and additional diagnostic data collected by the motherboard or media converter from other cards through the backplane. Figure 6-11 shows the top view of the 907 diagnostic card.
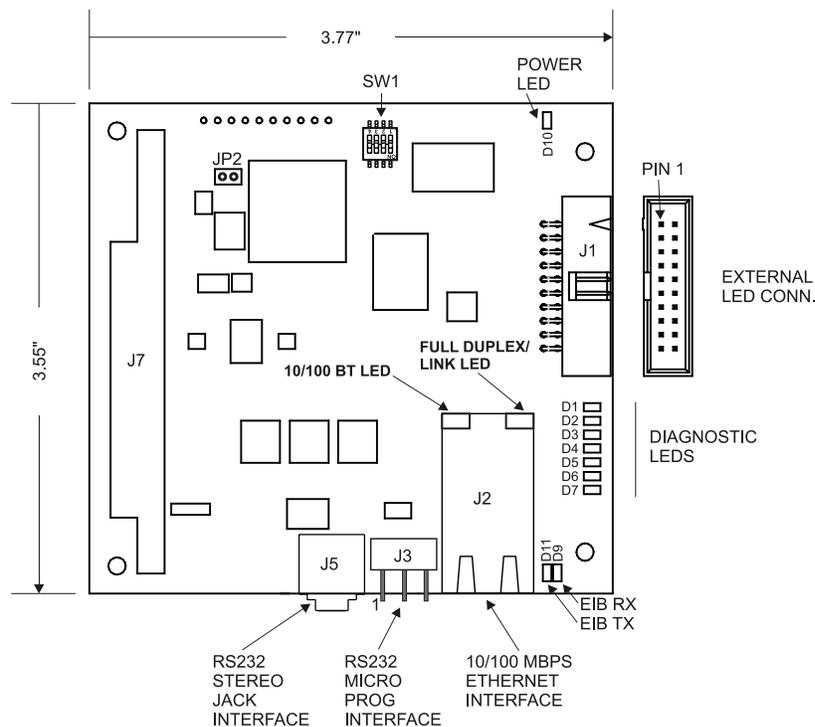
Figure 6-11: 907-DIAG-E Diagnostics Card

To retrieve diagnostic information, a single diagnostics card is mounted on the console stack. The diagnostic card provides a convenient Ethernet interface to read diagnostic data from the system. Diagnostic information is retrieved using a proprietary command-set through either an Ethernet port (J2) or an RS-232 interface (J5) on the 907-DIAG-E.

Remote and console diagnostic read-requests received on these interfaces trigger the diagnostic card to fetch the appropriate data from the console stack memory registers using an I2C interface over the PC/104 backplane (J7). Diagnostic information from cards in the remote stack are repeatedly transmitted from the remote stack to dedicated registers in the console stack and are read by the diagnostics card in the same manner as console diagnostic data.

In addition to providing a full protocol description for user-implementation of a software interface to the 907-DIAG-E system, Focal Technologies has created a .NET library and a sample Graphical User Interface for displaying system diagnostics on a Windows-based PC. Refer to the Diagnostic Protocol Manual, 700-0739-00, and the Diagnostic Software Manual, 907-0604-00, for more details on the card capabilities, interfaces, protocol description, and available software development tools.

The following table shows a list of the Model 907 cards that are compatible with the 907-DIAG-E card.

Table 6-1: 907 Cards Compatible with 907-DIAG-E

Card	Description
907V	907V Multiplexer Motherboard
907+	907Plus Multiplexer Motherboard
907-HDM2	907-HDM2 Multiplexer Motherboard
907-GEM	907-GEM Multiplexer Motherboard
907-ECL*	Sonar (Media Converter)
907-HDV*	HD-SDI (Media Converter)
907-GBE*	Gigabit Ethernet (Media Converter)
907-GBE2	Dual Gigabit Ethernet (Media Converter)
907-GBES	Quad Gigabit Ethernet Switch (Media Converter)
907-SER	8-Channel RS-232/RS-422/RS-485 (Expansion Card)

* SFP diagnostics only.

7.0   Fiber Optic System

Model 907 cards are configured to form video and data multiplexing systems with specific requirements, including optical link length, data throughput, system redundancy and cost. Wavelength division multiplexers (WDM) or coarse wavelength division multiplexers (CWDM) are often used to increase system capacity over a single optical fiber. Optical splitters and switches are used to increase the reliability of the system by providing fiber redundancy. Choice of optical transmitter power and wavelength, receiver sensitivity, fiber type (singlemode versus multimode), and fiber optic rotary joint (FORJ) selection are critical to ensuring the optical system meets all performance criteria.

Figure 7-1 illustrates block diagrams for some example optical configurations. These arrangements are by no means exhaustive. Diagram A illustrates a dual-fiber optical configuration passing through a two-pass FORJ. Diagram B illustrates an example of a 1310/1550 nm transceiver pair multiplexed onto a single optical fiber and sent through a single-pass FORJ. Diagram C illustrates multiple transceivers (say from two separate cards, for example a motherboard and media converter) optically multiplexed using a CWDM device onto a single fiber, and Diagram D illustrates a single transceiver pair using WDM multiplexing, but with an in-line 1x2 switch for a redundant backup link.
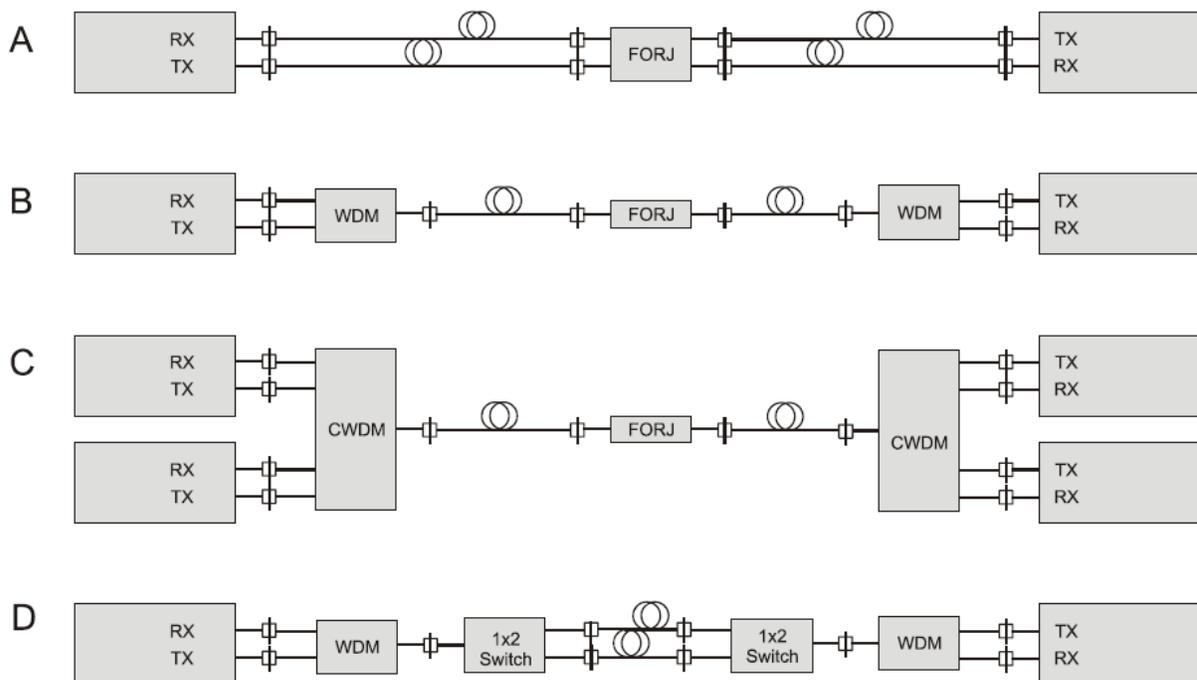
Figure 7-1: Example Optical Configurations

7.1   Safety

All lasers used in the Model 907 system are Class I laser devices per IEC-60825 unless otherwise specified in installation or configuration drawing. No special control measures or warning labels are required, although any needless exposure of the eye should be avoided as a matter of good practice, and fibers should never be viewed with magnifying instruments, e.g. fiber scopes, while optical power is present.

7.2   System Design

One important component of the optical system design is to prepare a detailed flux (optical power) budget. This calculation is a good indicator of the expected performance of the optical system and is useful when selecting components and finalizing the optical design. Optical power losses in decibels (dB) for each component are summed. This total system loss is subtracted from the difference between the transmitter launch power and the receiver"s sensitivity, as measured at the access bushings in the stacks, i.e. internal WDMs and couplers are taken into account. Any remaining power is the optical power margin. Some margin should be allocated for temperature and aging effects, typically 4-6 dB. Minimum flux budgets for 907-based systems range from 16 dB to 26 dB available to the external cables, connectors, FORJs, etc.

For long cables, an additional 1-2 dB should be allowed for additional signal degradation due to pulse dispersion. Component return loss (optical back reflection) is also considered when lasers are used in high bit-rate systems, as optical back reflection can cause degradation in transceiver performance or introduce optical crosstalk. To ensure optimum performance, the back reflection of the optical system should be less than -25 dB.

An example flux budget calculation for a dual-fiber, 1310/1550 nm based system is provided in Table 7-1.

Table 7-1: 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**	
Data Rate	1200 Mbaud	1200 Mbaud	
Direction	ROV to Surface	Surface to ROV	
Wavelength	1310 nm	1550 nm	
SFP Transmit Power (Min)	-5.0	-5.0	dBm
System Loss			
Connector	-0.3	-0.3	dB
Cable (for 10 km length)	-4.0	-3.0	dB
Connector	-0.3	-0.3	dB
FORJ	-4.0	-4.0	dB
Connector	-0.3	-0.3	dB
Total Losses	**-8.9**	**-7.9**	**dB**
Received Power	-13.9	-12.9	dBm
Dispersion Penalty	-1.0	-1.0	dB
Required Sensitivity	**-14.9**	**-13.9**	**dBm**
Rx Sensitivity for 1E-12 BER	**-28.0**	**-28.0**	**dBm**
Available Margin	**13.1**	**14.1**	**dB**

Caution: Model 907 transceivers with high sensitivity receivers can be saturated, and therefore non-operational, when too much power is received. All testing and operation of the 907 multiplexer system should be conducted with a minimum 5 dB of attenuation to ensure optimum performance.

8.0   Installation and Operation

8.1   Mounting

Model 907 cards use the standard PC/104 form factor of 3.55 × 3.775 inches (90 × 96 mm). The cards are outfitted with a PC/104 keyed connector to provide backplane connectivity between multiple cards assembled in a vertical stack. Note that this connector, as used by the Model 907 system, has a proprietary pin-out that is not compatible with commercial PC/104 cards. Adaptor Card 907-PC104 (See Section 6.2) must be used if directly connecting Focal cards to a standard PC/104 stack.

Cards stack one on top of the other, supported by standoffs fitted into mounting holes on the corners of the card, and electrically connected via the PC/104 connector, as shown below in Figure 8-1. Model 907 motherboard cards have short-pin (female only) PC/104 connectors, and are typically mounted on the bottom of the stack, whereas Model 907 expansion cards have both female and male PC/104 connector interfaces that allow them to be stacked on top of the motherboard and each other. The standoff height between cards is typically 0.625"; however, the 907-GBE card is an exception. Between this card and the card stacked just above it, 0.75" standoffs are required. For information on other exceptions refer to the installation drawing.
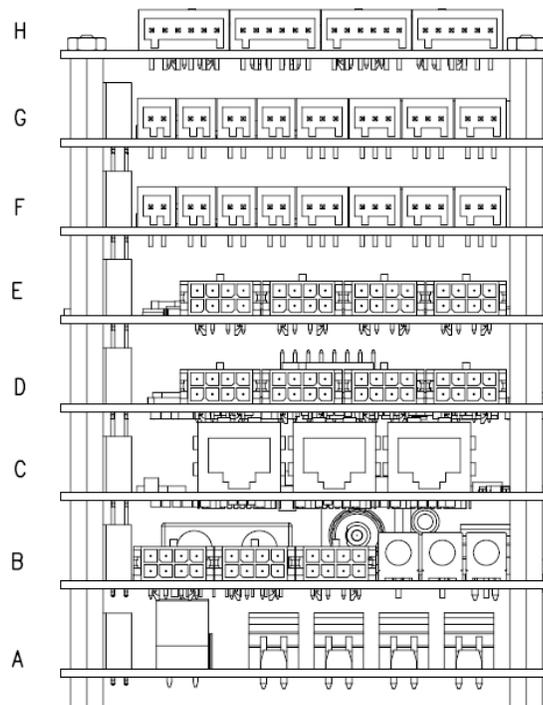
Figure 8-1: Example Model 907 Remote Stack View

Some stack configurations require fiber pigtails to optically connect one card to another. When mounting, disassembling, or reassembling the cards, ensure that no fibers are subjected to bends in excess of those held by the natural routing of the fibers. The minimum bend radius of the fibers should generally be no less than 25 mm, though single partial bends may be less than this – as low as 15 mm – without damaging the fiber. Allowable long term values for bend radius are dependent on the fiber type and environment. Avoid even temporary bends with a radius less than 15 mm, which may affect the long-term reliability of the fiber.

The system installer must account for fiber loops and connectors protruding from the edges of the PC/104 form-factor when considering the internal dimensions of any enclosure surrounding the stack. Space must also be allowed for mating cables/connectors for video and data signals. Installation drawings typically show recommended "keep out" areas to allow for optical and copper cabling.

8.2   Power

Most Model 907 cards are powered in one of two ways: through a dedicated on-board power connector or via the PC/104 backplane from another card in the stack. Refer to the configuration drawings for the cards in your stack for options. In general, cards are powered as follows: Model 907 motherboards obtain power through a 2 pin Molex power connector (Ground and +5 VDC), and are capable of providing power to other cards in the stack through the backplane PC/104 interface; Model 907 expansion cards acquire power from 907 motherboards through the backplane; and Model 907 media converter cards typically access power via the 2 pin Molex connector when used as standalone cards, or via the PC/104 connector when stacked with long pins.

All Model 907 cards require a regulated +5 VDC. The tolerance varies from card to card, but is typically ±5% to ±10%. Current draw varies from card to card, and the total current draw for a stack (if drawn from the motherboard) must be calculated to ensure it does not exceed the fuse rating of the motherboard.

Power inputs are typically fused with time delay thermal fuses. The user can find replacement fuse values and part numbers in Appendix A and on the card specific configuration drawings (907-2xxx-xx series).

Power and ground leads should be 18-20 AWG and kept short to minimize voltage drop across the powering harness from the source to the card. Installers should also ensure that if multiple cards are powered from the same supply, all the power and ground leads are connected in parallel to share the current and minimize the voltage drop across the wiring. If regulated +5V power supplies are not available, the 907-DC-24 PSU card can be added to generate multiple +5V supplies from 18-30 VDC.

Note: In order to account for the start-up current required to power up the Model 907 cards, it is recommended to use a 5V, 3A regulated power supply when using a standalone 907 card or a 5V, 6A regulated power supply when using a Model 907 stack. Appendix C shows the power current (after start-up) of the Model 907 cards.

8.3   Bench Test

Basic Link Operation

Basic operation of the uplink and downlink can be verified in a bench test simply by connecting fiber jumpers between the optical access bushings. The number of jumpers and the optical attenuation required depends on the optical configuration of the system under test. In some optical configurations, it may be required to use 5 or 10 dB optical attenuators placed between the fiber bushings on the remote modem and the bushings on the console modem to ensure the optical receivers are not saturated. Complete a flux budget calculation for your system, referring to the data sheet for the installed transceivers to determine whether optical attenuation is required or not.

After power is applied to the motherboards, the power LEDs should be on. An unlit Link LED usually indicates insufficient received optical power, typically due to excessive loss in the fiber link. Excessive loss may be caused by poor fiber connections (contaminated bushings, damaged fiber, damaged ferrules) or excessive fiber bends. It is good practice to carefully clean all fiber connections prior to mating them for testing.

If the basic optical link is present, there should be good video and data continuity through the multiplexer system. A video signal is an excellent test for the system, since even relatively low rates of link errors are easily visible on a monitor as black lines or speckles.

<u>Optical Power Budget Test</u>

1. To verify the remote-to-console flux budget (uplink), measure the transmit power of the remote modem by connecting the optical output directly to a calibrated optical power meter using a short, low-loss, singlemode test jumper. (Use 50 µm core multimode jumpers if it's a multimode system.)
2. Remove the test jumper and install a variable optical attenuator (VOAT) between the remote and console modems.
3. 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. A stable video signal without any streaking or "snow" is another good reference point.
4. Measure the optical power at the console modem 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 optical power budget. A spool of fiber used with the VOAT can also be used to simulate losses due to dispersion over long cable lengths.
5. Repeat steps 1-4 with connections reversed to verify the console-to-remote optical budget (downlink).

8.4   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.

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, ensure the fiber optic connectors are kept clean. Use a suitable solvent, such as reagent grade isopropyl alcohol, and a lint free tissue paper, such as Kimwipes® EX-L, to carefully wipe any dirt off the face and barrel of the ceramic ferrules prior to making a connection.

Always replace dust caps on the Model 907 fiber optic bushings when removing connectors. If bushings are left open, they should be cleared of dust with compressed air prior to reconnection. Fiber jumpers and pigtails should be periodically inspected for damage, such as nicks in the jackets or excessive bends.

8.5   Model 907 Board Handling

The Model 907 system can include several densely populated Printed Circuit Board Assemblies (PCBAs). Although these boards are all conformally coated, care must be taken while handling the boards to ensure the PCBAs are kept clean and free from electrostatic discharge (ESD) conditions.

General Handling

Care must always be taken during the handling of PCBAs to ensure product integrity. The following guidelines should be observed while working with PCBAs:
- Always handle boards by the edges and do not touch any connector pins
- Handle boards at an ESD safe workstation with a clean surface
- Never lay PCB assemblies on top of one another
- 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 exceed the recommended minimum fiber bend radius, even momentarily

Appendices

Appendix A – Fuses

Card Type	Card	Qty.	Fuse P/N	Current Rating	Comments
907 Multiplexer Motherboards	907	1	0452002	2.0 A	Replaceable SMT fuse for +5 VDC from power connector (F1)
	907+	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from power connector (F1)
	907V	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from power connector (F1)
	907-HDM2	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from power connector (F1)
	907-GEM	1	0452003	3.0 A	Soldered SMT fuse for +5 VDC from power connector (F1)
907 Media Converters	907-MC	1	0452001	1.0 A	Soldered SMT fuse for +5 VDC from power connector (F1)
	907-1394	1	0452001	1.0 A	Soldered SMT fuse for +5 VDC Board Voltage (F5)
			0452003	3.0 A	Soldered SMT fuse for +5 VDC from power connector (F1)
	907-ECL	2	0452001	1.0 A	Soldered SMT fuse for +5 VDC (F1-backplane, F2- power header)
	907-HDV	2	0452001	1.0 A	Soldered SMT fuse for +5 VDC (F1-backplane, F2- power header)
	907-GBE	1	0452001	1.0 A	Soldered SMT fuse for +5 VDC from power connector (F1)
	907-GBE2	1	0452003	3.0 A	Soldered SMT fuse for +5 VDC feed to backplane (F1)
			0452005	5.0 A	Soldered SMT fuse for +5 VDC from power connector (F2)
	907-GBES	1	0452005	5.0 A	Soldered SMT fuse for +5 VDC feed to backplane (F2)
			0452005	5.0 A	Soldered SMT fuse for +5 VDC from power connector (F1)
907 Expansion Cards	907-EIBS	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from backplane (F1)
	907-232	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from backplane (F1)
	907-485	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from backplane (F1)
	907-SER	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from power connector (F1)
	907-ADC	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from backplane (F1)
	907-DAC	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from backplane (F1)
	907-AUDIO	1	0452005	5.0 A	Spare fuse in holder for +5 VDC from backplane (F1)
	907-TLL	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from backplane (F1)
	907-CIB	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from backplane (F1)
	907-420	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from backplane (F1)
	907-USB	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from power connector (F1)
	907-AIB	1	0452001	1.0 A	Soldered SMT fuse for +5 VDC (F1)
907 System Modules	907-EURO	1	0452003	3.0 A	Soldered SMT fuse for +5 VDC from backplane (F1)
	907-DC-24	1	0452003	3.0 A	Soldered SMT fuse for +24 VDC (F1)
	907-FOS	1	0452001	1.0 A	Soldered SMT fuse for +5 VDC from backplane (F1)
	907-DIAG	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from backplane (F1)
	907-DIAG-E	1	0452002	2.0 A	Soldered SMT fuse for +5 VDC from backplane or USB (F1)

NOTES:
1. SMT = Surface Mount Technology
2. 0452 type devices are time delay fuses manufactured by Littelfuse.

Appendix B – Model 907 Cards

Card Type	Card	Description	Config. Dwg.
907 Multiplexer Motherboards	907	Standard 907 Multiplexer Motherboard	907-2001-00
	907V	907V Multiplexer Motherboard	907-2026-00
	907+	907Plus Multiplexer Motherboard	907-2035-00 (907+ R) 907-2036-00 (907+ C)
	907-HDM2	907-HDM2 Multiplexer Motherboard	907-2052-00
	907-GEM	907-GEM Multiplexer Motherboard	907-2056-00
907 Media Converters	907-MC	10/100 Mbps Ethernet	907-2007-XX
	907-1394	Firewire	907-2013-XX
	907-ECL	Sonar	907-2012-02
	907-HDV	HD-SDI	907-2012-00
	907-GBE	Gigabit Ethernet	907-2023-00
	907-GBE2	Dual Gigabit Ethernet	907-2040-00
	907-GBES	Quad Gigabit Ethernet Switch	907-2037-00
907 Expansion Cards	907-EIBS	10 Mbps Ethernet Switch Card	907-2019-00
	907-232	8-Channel RS-232 Card	907-2008-00
	907-485	8-Channel RS-422/485 Card	907-2015-00
	907-SER	8-Channel RS-232/RS-422/RS-485 Card	907-2047-00
	907-ADC	8-Channel 8/12 bit ADC Card	907-2016-00
	907-DAC	8-Channel DAC Card	907-2017-00
	907-AUDIO	4-Channel, 24-bit Audio Card	907-2030-00
	907-AUDIO-T	4- Channel Audio Transformer Card	907-2032-00
	907-TTL	8-Channel TTL Card	907-2008-01
	907-CIB	4-Channel Control Interface Card	907-2027-00
	907-420	6-Channel 4-20 mA Card	907-2024-00
	907-USB	Universal Serial Bus Card	907-2022-00
	907-AIB	Dual-Socket AIB Adaptor	907-2004-00
907 System Modules	907-EURO	Eurocard Adaptor	907-2018-00
	907-PC104	907 to Standard PC/104 Adaptor	907-2010-00
	907-DC-24	Isolated DC-DC Power Card	907-2029-00
	907-CWDM	CWDM Optics Card	907-2009-00
	907-CWDM-4	4-Channel CWDM Optics Card	907-2031-08
	907-CWDM-8	8-Channel CWDM Optics Card	907-2031-04
	907-FOS	1x2 SMF/MMF Fiber Optic Switch Card	907-2031-00
	907-SPLIT	1x2 Optical Splitter Card	907-2031-01
	907-DIAG	Diagnostics Card, LED Driver	907-2033-XX
	907-DIAG-E	Diagnostics Card, Ethernet	907-2039-00

Appendix C – Model 907 Power Current

CARD TYPE	CARD ID	DESCRIPTION	CARD P/N	CONFIG. DWG.	POWER VOLTAGE (V) TYP	POWER CURRENT (AMPS)			POWER CONSUMPTION (WATTS)		
						MIN	TYP	MAX	MIN	TYP	MAX
907 Multiplexer Motherboards	907	Standard 907 Multiplexer Motherboard	907-0001-02	907-2001-00	5	-	0.70	1.00	-	3.50	5.00
	907V	907V Multiplexer Motherboard - Remote	907-0023-00	907-2026-00	5	-	0.70	1.00	-	3.50	5.00
	907V	907V Multiplexer Motherboard - Console	907-0024-00	907-2026-00	5	-	0.70	1.00	-	3.50	5.00
	907+	907Plus Remote Multiplexer Motherboard	907-0025-00	907-2035-00	5	-	0.70	1.00	-	3.50	5.00
	907+	907Plus Console Multiplexer Motherboard	907-0026-00	907-2036-00	5	-	0.70	1.00	-	3.50	5.00
	907-HDM2	907-HDM2 Multiplexer Motherboard	907-0050-13	907-2052-00	5	-	1.30	2.00	-	6.50	10.00
	907-GEM	907-GEM Gigabit Ethernet Multiplexer Motherboard	907-0060-13	907-2056-00	5	0.50	1.30	1.60	2.50	6.50	8.00
907 Media Converters	907-MC	10/100 Mbps Ethernet	907-0014-47	907-2007-00	5	-	0.35	0.70	-	1.75	3.50
	907-MC	10/100 Mbps Ethernet	907-0014-00	907-2007-01	5	-	0.35	0.70	-	1.75	3.50
	907-MC	10/100 Mbps Ethernet	907-0014-13	907-2007-02	5	-	0.35	0.70	-	1.75	3.50
	907-ECL	Sonar	907-0019-17	907-2012-02	5	-	0.50	0.70	-	2.50	3.50
	907-HDV	HD-SDI	907-0022-00	907-2012-00	5	-	0.50	0.70	-	2.50	3.50
	907-GBE	Gigabit Ethernet	907-0021-00	907-2023-00	5	-	0.80	1.60	-	4.00	8.00
	907-GBE2	Dual Gigabit Ethernet	907-0030-00	907-2040-00	5	0.30	1.00	1.50	1.50	5.00	7.50
	907-GBES	Quad Gigabit Ethernet Switch	907-0027-00	907-2037-00	5	-	1.00	2.00	-	5.00	10.00
907 Expansion Cards	907-EIBS	10 Mbps Ethernet Switch Card	907-0222-00	907-2019-00	5	-	0.40	0.80	-	2.00	4.00
	907-232	8-Channel RS-232 Card	907-0212-00	907-2008-00	5	-	-	0.80	-	-	4.00
	907-485	8-Channel RS-422/485 Card	907-0217-00	907-2015-00	5	0.50	-	1.00	2.50	-	5.00
	907-SER	8-Channel RS-232/ RS-422/RS-485 Card	907-0242-00	907-2047-00	5	0.42	0.75	1.50	2.10	3.75	7.50
	907-ADC	8-Channel 8/12 bit ADC Card	907-0218-00	907-2016-00	5	0.10	0.20	0.40	0.50	1.00	2.00
	907-DAC	8-Channel DAC Card	907-0219-00	907-2017-00	5	-	0.20	0.50	-	1.00	2.50
	907-AUDIO	4-Channel, 24-bit Audio Card	907-0228-00	907-2030-00	5	-	0.30	3.00	-	1.50	15.00
	907-TTL	8-Channel TTL Card	907-0212-01	907-2008-01	5	-	-	0.80	-	-	4.00
	907-CIB	4-Channel Control Interface Card	907-0231-00	907-2027-00	5	-	0.32	0.40	-	1.60	2.00
	907-420	6-Channel 4-20 mA Card	907-0218-01	907-2024-00	5	0.12	0.20	0.40	0.60	1.00	2.00
	907-USB	Universal Serial Bus Card	907-0224-24	907-2022-00	5	-	0.20	0.60	-	1.00	3.00
	907-AIB	Dual-Socket AIB Adaptor	907-0204-00	907-2004-00	5	0.03		0.10	0.15	-	0.50
907 System Modules	907-EURO	Eurocard Adaptor	907-0221-00	907-2018-00	5	-	0.03	0.10	-	0.15	0.50
	907-DC-24	Isolated DC-DC Power Card	907-0233-00	907-2029-00	24	0.10	-	0.22	2.40	-	5.28
	907-FOS	1x2 SMF/MMF Fiber Optic Switch Card	907-0015-XX	907-2031-00	5	0.02	0.07	0.09	0.12	0.35	0.45
	907-DIAG	Diagnostics Card, LED Driver	907-0234-XX	907-2033-XX	5	0.07	-	0.30	0.35	-	1.50
	907-DIAG-E	Diagnostics Card, Ethernet	907-0238-00	907-2039-00	5	-	0.30	0.50	-	1.50	2.50

All measurements at T$_A$ = +25 °C

Focal Technologies Corp.