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Model 907+
Getting Started Guide

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Document Revision History

Document Revision	Details of Revision	Author	Date
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Reference Documents

Document Number	Document Title and Description
907-2xxx-xx	Model 907 card configuration drawings
907-8xxx-00/-01	Model 907 installation drawings
907-0601-00	Model 907 User's Guide
907-0604-00	Model 907 Diagnostics Software Manual

1.0 Model 907 Overview

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 in the system.

Model 907 systems are built up from four main types of cards:

1) Multiplexer motherboards
2) Media converters
3) Expansion cards
4) System Modules

A typical 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.

Model 907 cards are supplied either as loose individual boards or assembled in stacks per customer requirements. Installation drawings for remote and console stacks show the overall dimensions and orientations of cards plus a list of the included 907 cards with reference to corresponding configuration drawings. The configuration drawings for each card generally are numbered in the form **907-2XXX-00** and provide the following information:

- General specifications (e.g. power, temperature, part number)
- I/O connectors and pin-outs
- Optical specifications (e.g. wavelength, Tx/Rx power)
- Data rates and analog channel bandwidth
- Diagnostic LED information
- Fuse locations and ratings
- Board dimensions and location of connectors and key parts

Stack assemblies and corresponding installation drawings are usually in the form **907-8XXX-00** for the console stack and **907-8XXX-01** for the remote stack. In the case of complex optical systems with more than two wavelengths or special requirements, an optical configuration drawing is typically supplied with the remote and console installation drawing as **907-8XXX-02**.

Several standard and custom versions of the Model 907 multiplexer are available. This guide is intended primarily for the 907+ version, although general operational principles are similar for all of the products.

2.0 907+ Multiplexer Motherboard (907+)

The 907+ multiplexer motherboard, shown below, supports four unidirectional video channels, from remote to console, and six dedicated on-board bidirectional data channels: 4 x RS-232, 2 x RS-485. (Two RS-485 channels may be used as a single RS-422 channel.) The PC/104 header allows expansion cards to be stacked on the motherboard, adding up to 48 additional serial channels or a combination of serial channels and various types of analog channels, depending on the types of cards used. Stacking expansion cards on the 907+ motherboard does not disable any of the on-board serial channels.

The 907+ uses a small form-factor pluggable (SFP) optical transceiver operating at 1200 Mbaud on both uplink and downlink. Transceiver type and optical specifications (wavelength, power, range, connector, fiber number and type) for a given 907+ card are defined by the card part number and shown in the card configuration drawings, e.g. 907-2035-00 for remote and 907-2036-00 for console. For example, P/N 907-0025-00 is a 907+ remote (907+R) with singlemode, dual fiber SFP operating at 1310 nm and providing a 24 dB optical budget. Standard optical power budgets are a minimum of 20 dB or 24 dB, with high power options available for applications with budgets of 28 dB and higher. The 907+ is recommended for singlemode operation on up to 40 km fiber links. Short multimode links (< 500 m) are possible with appropriate transceivers.

Figure 1: 907+ Multiplexer Motherboard (907+R)

Figure 2 shows the on-board input/output channel configuration of the 907+ Remote Multiplexer Motherboard (907+R) and the 907+ Console Multiplexer Motherboard (907+C).

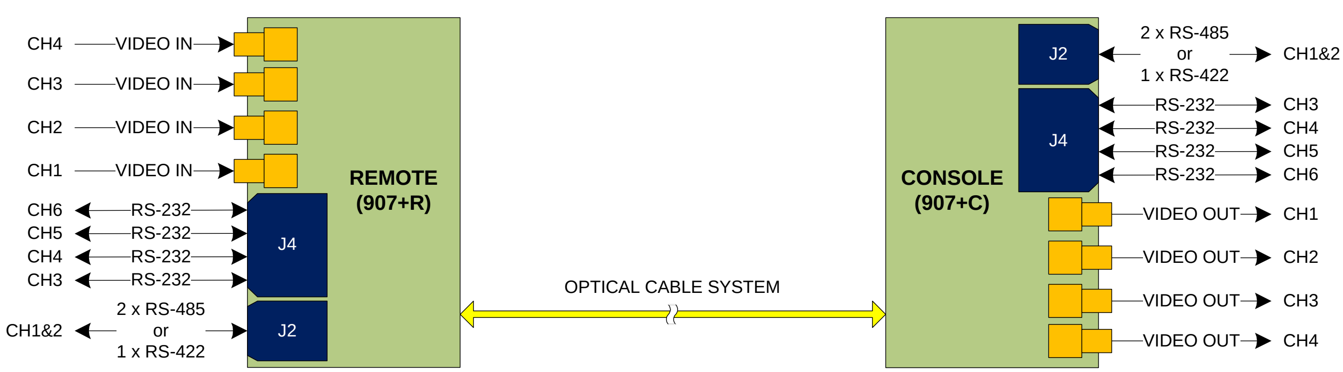

Figure 2: On-board I/O Channels for 907+ Multiplexer Motherboards

3.0 Installation and Configuration

Please review the following guidelines and recommendations prior to handling or installing a Model 907+ system. Refer to Figure 3 below for location of connectors and critical items on the cards.

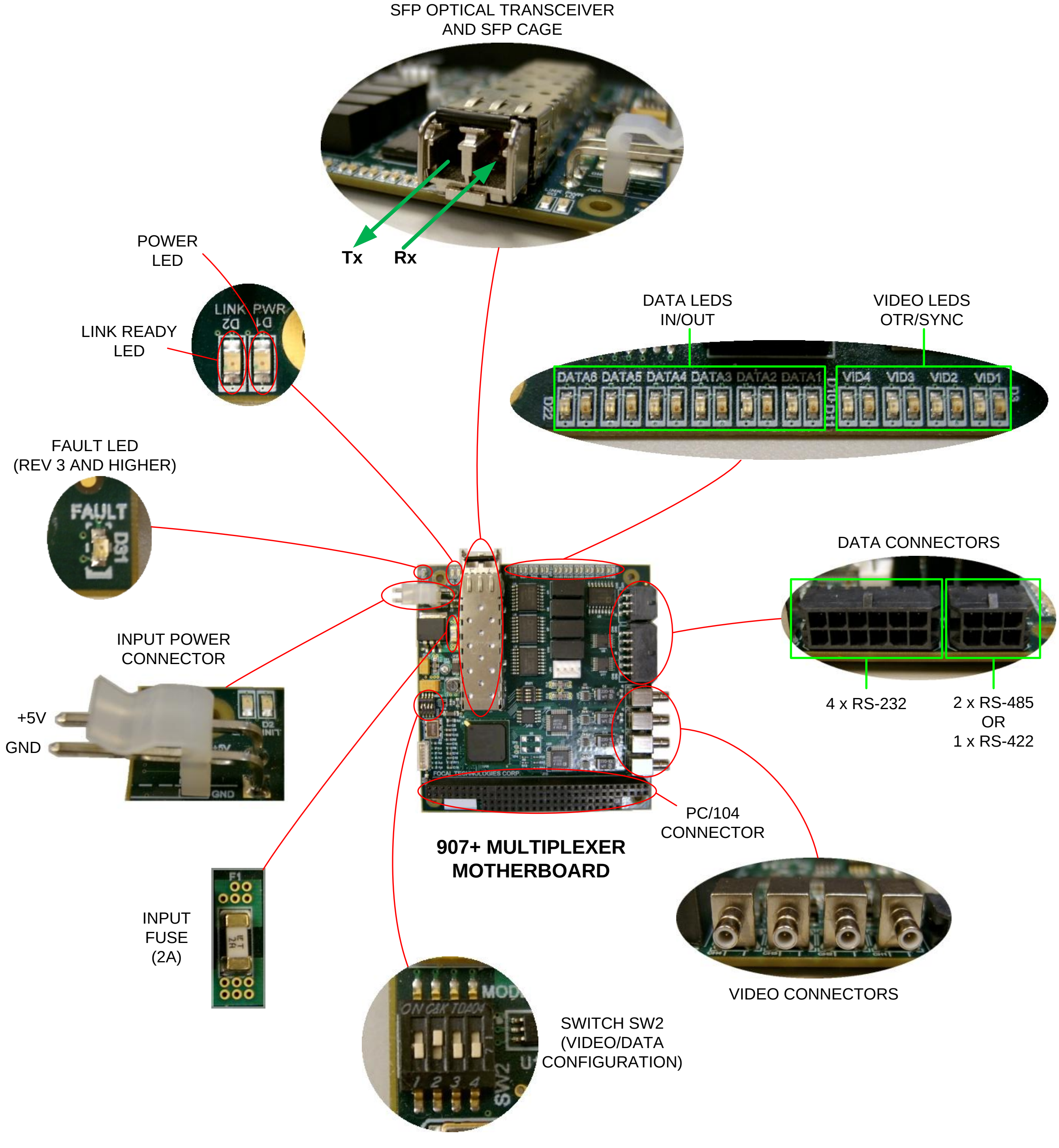

Figure 3: Model 907+ Part Locations

Optical Considerations

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

2. **Ensure fiber optic components are of the same type**
All jumpers, cables, connectors, couplers, and Fiber Optic Rotary Joints (FORJs) used in the external optical system connecting the remote to console multiplexer must use the same type of fiber. If the 907+ is singlemode, i.e. has a singlemode SFP transceiver installed, all components in the fiber link should also be singlemode, typically Corning SMF-28 (9/125 µm) or equivalent. If the 907+ is multimode, similarly the fiber link should be multimode, typically 50/125 µm graded index (GI). A single mismatched jumper in the system may cause intermittent or persistent optical link errors. Furthermore, if using multimode fiber, ensure all components are of the same core size, i.e. 50 µm or 62.5 µm. Do not rely on cable jacket or connector colors alone to determine the type of optical fiber.

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

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

Figure 4 shows an LC connector which is a small form-factor fiber optic connector that uses a 1.25 mm ferrule and incorporates a push-and-latch design similar to an RJ-45 latch. Figure 5 shows an ST fiber optic connector that uses a 2.5 mm ferrule. The ST connector is latched into place by twisting to engage a spring-loaded bayonet socket.

Figure 4: LC connector

Figure 5: ST connector

4. **Maintain good optical connections**
As shown in Figure 3, SFP optical transceivers typically have a transmit and receive optical bushing (LC type), which requires dual fiber operation. The transmit side of the remote transceiver should be connected to the receiver side of the console transceiver and vice versa, i.e. the optical connections must be crossed over. When using bidirectional or "bidi" transceivers, which have a built-in wavelength division multiplexer (WDM) to combine the uplink and downlink wavelengths on a single fiber, only a single connection is required. In some cases an external WDM is used to combine the uplink and downlink on a single fiber, and the external fiber system must be connected to the "common" port of this configuration. Typically the optical connections for systems with external couplers are described by the corresponding 8000 series optical configuration drawing for the system.

5. **Maintain proper optical power levels**
Optical receivers will experience errors if the received optical power is too low. Ensure the total optical losses of the components in the external cable system (jumpers, cable, connectors, couplers, FORJ, etc.) are less than the specified optical power budget of the 907 cards used. The 907-DIAG-E diagnostics card may be stacked on the console motherboard to provide approximate readings of transceiver transmit and receive optical powers at both remote and console. But a calibrated optical power meter should be used for any detailed measurements or trouble-shooting.

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

   More details on optical budgets are given in the Model 907 User's Guide, 907-0601-00.

Electrical Power Considerations

1. **Use a suitably rated power supply**
The 907+ requires regulated +5 VDC (±10%) at the input header. Ensure the supply voltage accounts for voltage drop across the power cabling. It is recommended to measure the voltage right at the input connector before and after the 907 card is under full load to ensure a +5 VDC input voltage is maintained under all conditions. The typical power current of a 907+ is 0.7 A, but the supply should be capable of 2 A. Dedicated, isolated power supplies, e.g. DC-DC converters, are recommended for use with the Model 907. In cases where multiple cards are stacked or otherwise share power, the supply must be capable of sourcing the total current required. Do not replace fixed (soldered) fuses, if blown, as a serious card fault is indicated.

2. **Use proper power cable and connections**
Power supply leads to the Model 907 should be AWG 20 or larger – but within the range of sizes supported by the crimp terminals – to minimize voltage drop across the powering harness from the supply 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 a star configuration, rather than daisy chained, to share the current and minimize voltage drop across the power wiring.

   Figure 3 shows the location of the power connector and fuse on the 907+ motherboard. Expansion cards stacked on the motherboard typically draw power/current through the PC/104 connector. Power access points and current draw for stacks are indicated in the corresponding 8000 series installation drawings.

Video Considerations

1. **Use cables and terminations with 75-ohm impedance**
   Ensure all video cables are 75-ohm impedance coax, e.g. RG-179 for SMB-SMB and SMB-BNC or RG-59 for BNC-BNC cables. The video inputs already have a built-in 75-ohm terminator – no additional terminators should be added, and video signals should not be split and "double terminated". RG-179 has higher loss at high frequencies than RG-59 and should not be used for long runs of cable, e.g. more than 5 m.

2. **Use standard voltage levels**
   Several subsea cameras are configured to drive long copper cables and have extremely high video output voltages, sometimes greater than 10 Vpp. Ensure that cameras are configured for standard video levels, nominally 1.2 Vpp, and do not power up in a high output configuration.

3. **Avoid ground loops**
   Video inputs and outputs are not isolated by the Model 907 to reduce signal degradation by isolators. Power for the Model 907 card should be isolated from power for other devices to "float" the video ground reference at the 907 and minimize noise pick-up from other systems, especially motors and other high current devices. In some cases, high quality, video isolation transformers should be used to isolate the video signals.

Serial Data Considerations

1. **Use proper cabling and terminators**
   RS-485 and RS-422 links should be via twisted pair cabling with controlled 120 ohm impedance. RS-232 links may use straight wiring, preferably with a shield. On high speed RS-485/422 links (> 250 kbaud), ensure 120 ohm terminators are used at the ends of the links. Multidrop RS-485/422 bus configurations should be avoided as direct connections to the Model 907, although simple configurations can be validated through bench testing. (Hubs or repeaters are recommended for multidrop applications.) Note that “open” unterminated wire harnesses connected to the Model 907 inputs may pick up sufficient noise from other cables to trigger false pulses and flashing LEDs on the unused channel.

2. **Use correct polarity, connections, and levels**
   The polarity of the RS-485 connections is important and should match the pin out on the configuration drawings. The polarity which generates the least LED on time is typically the correct one. In the case of RS-232 and RS-422, note that Rx input lines at one end of the system become Tx output lines at the other end of the system, i.e. use different pins. Voltage levels on the serial channels should be per the standards. Compatibility with special implementations, e.g. AC-coupled RS-485, should be confirmed with Focal.

3. **Use correct Autosense settings**
   The RS-485 channels can be configured with various settings for "autosense", which controls how fast the RS-485 transceiver reverts back to a receiver after driving the external lines. On most cards, the default setting is a 1 ms timeout, which is appropriate for 9600 baud links and most other data rates where the "turnaround time" of the communicating devices, e.g. sonar head and sonar controller, is greater than 1 ms. In cases where a faster turnaround time is present, the RS-485 channels can be configured with "no autosense", which actively drives the external lines on a bit by bit basis. Refer to the configuration drawings and users guide for details on autosense options.

Switch Configuration

Cards are shipped from Focal in the default configuration for your system, if ordered to an 8000 series installation drawing. Otherwise the cards are shipped with the default settings shown in the corresponding configuration drawings 907-2035-00 (907+R) and 907-2036-00 (907+C).

Switch bank SW2 on the board sets the signal format of the four video channels and of 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 RGB, Y/C (S-Video), and YPrPb formats per configuration drawings. The two on-board RS-485 channels are default configured as RS-485, but can also be configured to operate as a single RS-422 channel.

DIP switches are set to either on (1) or off (0). Circuit 1 is leftmost when reading the text on the switch. The DIP switches shown in Figure 3 are for reference only. The DIP switches settings are described by the configuration drawings 907-2035-00 (907+R) and 907-2036-00 (907+C). Switch bank SW1 is for factory settings only and should not be changed without consulting Focal.

Diagnostic LEDs

The 907+ has an array of diagnostic LEDs for monitoring electrical power, optical link status, presence of video sync signals, and serial data I/O activity. Table 1 contains a description of the on-board LEDs. Additional diagnostics information can be read via an Ethernet connection to a 907 diagnostics card (907-DIAG-E) attached to the console multiplexer or console stack. Refer to the Model 907 Diagnostics Software Manual, 907-0604-00, for more information on the Ethernet diagnostics.

A series of LEDs located on the edge of the card monitor data activity on the serial data channels. Each data channel has a pair of data LEDs, as shown in Figure 6. The left LED indicates traffic on the downlink, going from console to remote multiplexer; the right LED indicates traffic on the uplink, going from remote to console. Pin designations of Tx (transmit) and Rx (receive) on the serial connector headers are relative to the Model 907, so Tx pins are outputs trying to drive external cables and Rx pins are inputs. The serial signal coming into the Rx pin at the remote card, for example, exits the console card on the Tx pin.

The color of the LED, when on, further identifies the direction: LEDs are red for inputs and green for outputs. Depending on the data rate and level of traffic on the serial channel, the activity LEDs may be on solid, flashing, or dim. The LED is only turned on during the active ("space") state of the serial channel, not during the idle ("mark") state. For channels that have infrequent transmissions, the LED flashes may not be visible. The color and state of the activity LEDs is useful to confirm the initial wiring is correct. For example, any consistent data coming into the console multiplexer (mux) should cause a red LED to turn on at the console card and a corresponding green LED on the remote card, where it is an output.

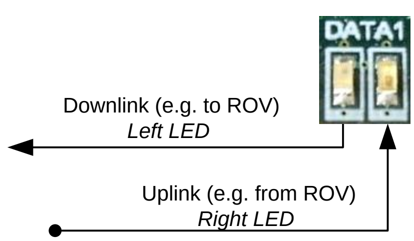

Figure 6: Example of Data LEDs

In the case of the RS-485 wiring, it's easy to get the positive and negative wires crossed. Generally if the LEDs seem to be on when they should be off or vice versa, crossed wiring is indicated. For example, a control link to a sonar from console to remote typically has infrequent transmissions, so the red LED on the console mux should normally be off. On the other hand, the sonar uplink may be nearly continuous, so the remote red LED (and console green LED) should be on during operation.

On revision 3 and higher of the multiplexer cards, an additional "Fault" LED is present near the power connector. This LED is red and held on for 0.25 seconds each time an error is detected on the optical link.

Table 1: Diagnostic LEDs Description

LED	Color	Description
Power	Green	On indicates input voltage is correct polarity and within operational range
Link Ready	Green	On indicates card is receiving a valid optical link, though errors may exist
Fault	Red	On indicates an error occurred on the optical link
Video Sync	Green	On indicates presence of a valid sync pulse, typically present on composite signals (NTSC or PAL), Y of Y/C signals, and G of RGB signals
Video OTR	Red	On indicates video input voltage is excessive, i.e. > 1.5 Vpp
Data Rx	Red	On indicates serial input data is active
Data Tx	Green	On indicates serial output data is active

Card Handling Considerations

Loose boards should be packaged, handled, and installed with precautions for Electrostatic Discharge (ESD), including wrist straps and appropriate anti-static containers. Although signal inputs are protected from ESD, general handling can inadvertently contact pins on the board that are not ESD protected.

Cards are conformally coating and therefore have some resistance to contamination and humidity. For moderate to severe contamination, e.g. from a flooded electronics case, the cards can be cleaned by soaking in distilled water and completely dried prior to reuse.

Be careful when cards are installed or removed from stacks to ensure the long PC/104 pins are not bent. A PC/104 card removing tool is highly recommended. Avoid bending the cards at all times, as this can put significant stress on the solder joints for surface mount parts.

4.0 Video and Data – Bench Test Set Up Examples

Figure 7 shows a typical set up for bench testing a 907+R remote and 907+C console multiplexer. In this example, video channel 4 and the data channel 4 (RS-232) are being tested by sending analog video and digital data signals from the remote side to the console side. Multimode optical fiber jumpers are used to match the multimode transceivers installed, and fixed attenuators are included in each fiber link to simulate cable losses and ensure receivers are not saturated.

Video signals can be tested using a video test pattern generator or a composite camera. Video input/output cabling must be 75-ohm coaxial cable, e.g. RG-179, and signal levels should be standard 1.2 Vpp. Serial channels (RS-232, RS-485) can be tested using a PC COM port or USB-serial channel interface box. Serial test data should be continuous during bench testing to ensure data activity LEDs are visible. Low activity links, such as typing in a terminal program, may not produce sufficiently regular data to make the Data LEDS visible.

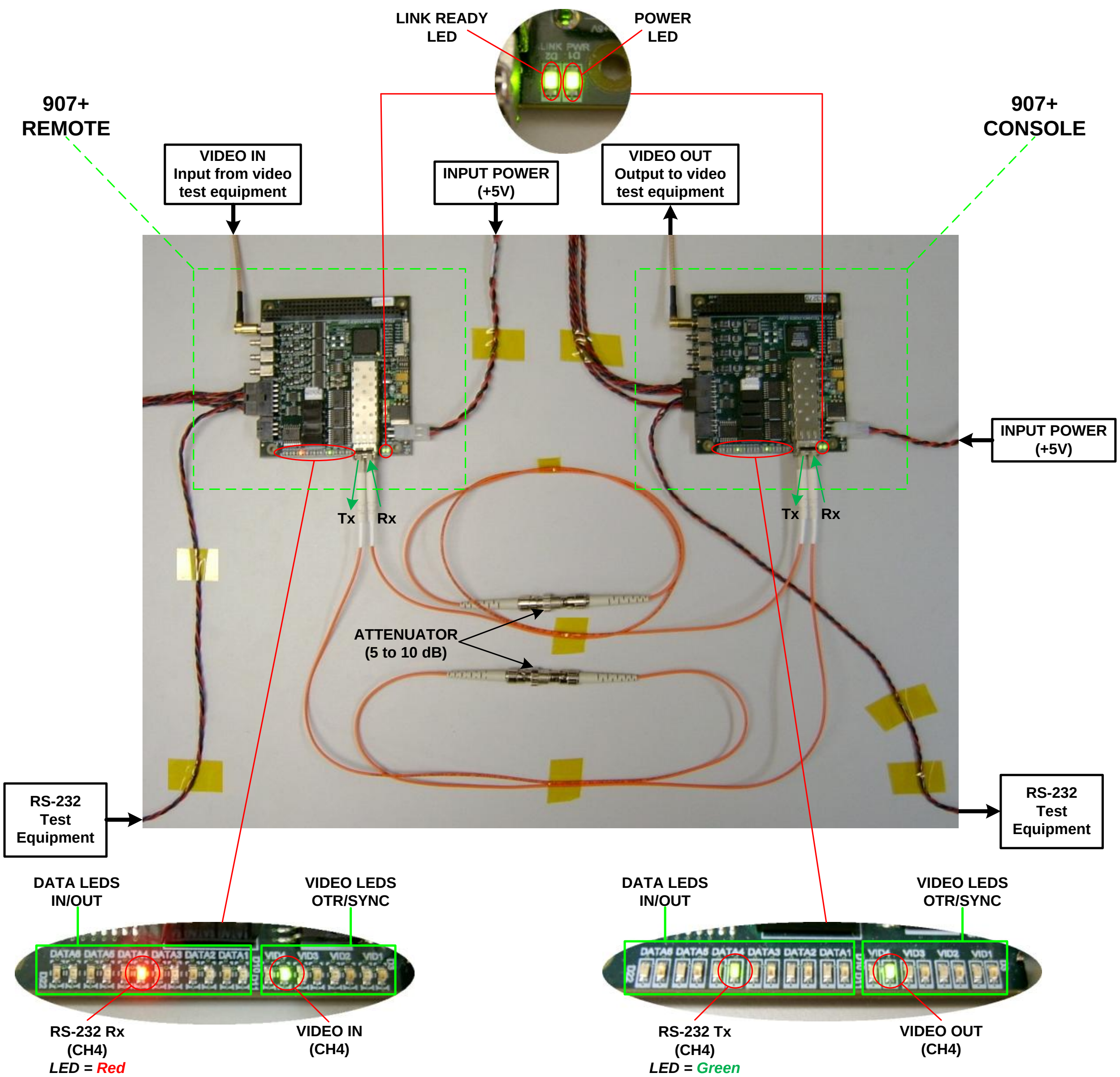

Figure 7: 907+ Multiplexer Bench Test, (Video Channel 4, Data Channel 4)

At the remote side, the green SYNC LED for video channel 4 (VID4) indicates that a proper video sync is being received from the video test equipment on video input channel 4, and since the OTR LED is off, the video signal level is not too high. The red data LED for serial channel 4 (DATA4) is on, indicating active RS-232 data is being received from the RS-232 test equipment.

At the console side, the green SYNC LED indicates that a proper video sync signal is still detected on the signal being transmitted out the channel 4 jack (SMB connector), which is the reconstructed analog signal from the optical link. As with the remote, the video OTR LED for channel 4 is out, indicating the signal is not saturated or clipping. The green data LED for serial channel 4 is on, indicating active RS-232 data is being transmitted to the external RS-232 test equipment.

On both multiplexer cards, the green Power LED indicates that the input power voltage is within an acceptable range and the green Link Ready LED indicates that the cards are receiving sufficient optical power and have a valid link. The red Fault LED is also off, which means no optical data errors are being detected.

Figure 8 shows another example using video channel 1 and data channel 4 (bidirectional RS-232) by sending analog video and digital data signals from the remote side to the console side and also sending a digital data signal from the console to the remote side. In this case the Power, Link Ready, and Fault LEDs are the same as before. The video LEDs have now switched to channel 1, and both Rx and Tx LEDs are on for serial data channel 4, as they should be when there is simultaneous bidirectional traffic.

Typically each Model 907 multiplexer card is provided with one video test cable (75 ohm SMB-BNC) and one serial data test cable of each type (tinned leads to Molex connector). Alternatively, cables can be built with the spare connectors provided. Refer to the manual and configuration drawing for part numbers. All pin wiring to the external equipment should be verified prior to testing with the multiplexer.

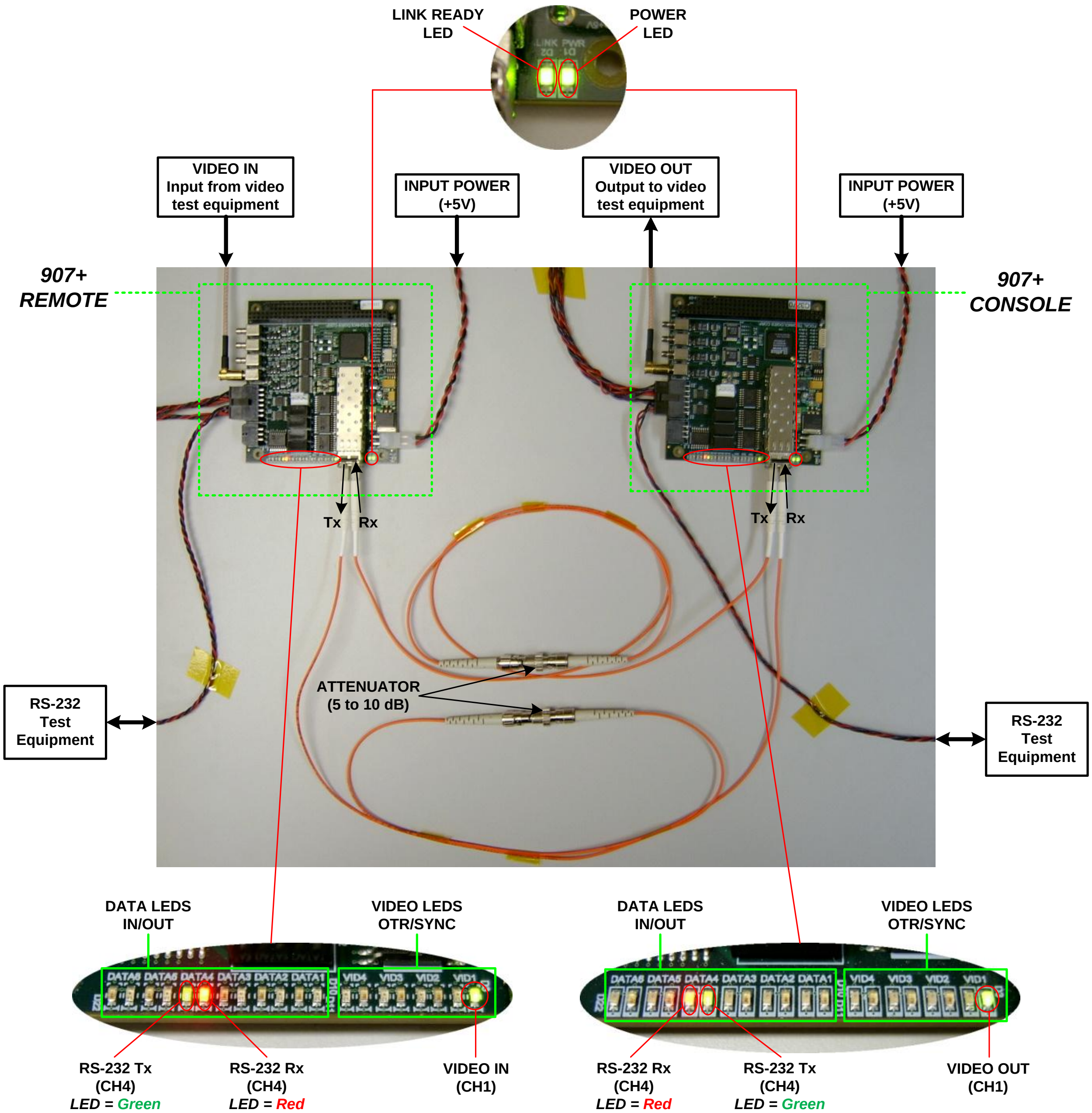

Figure 8: 907+ Multiplexer Bench Test (Video Channel 1, Data Channel 4)