High Speed Analog Fiber Link

Model ECH-10V

Palomar Scientific Instruments, 2009

Overview

The high speed analog fiber link (AFL) provides a dual channel optically isolated lossless long run solution for transmition of high bandwidth signals using digital transmission techniques. These links were originally developed for fusion energy experiments on the DIII-D Tokamak in San Diego, CA. The standard ALFs are specified for a dual +/- 10 Volt input signals with a -3dB small signal bandwidth of 10MHz and designed in a “eurocard” form factor for mounting in standard 3U card-cages. We have recently packaged them as standalone units in aluminum enclosures. The links can be ordered with different options regarding input and output signal locations, as well as power connections. In addition, a digital (TTL compatible) signal line can be provided as an option.

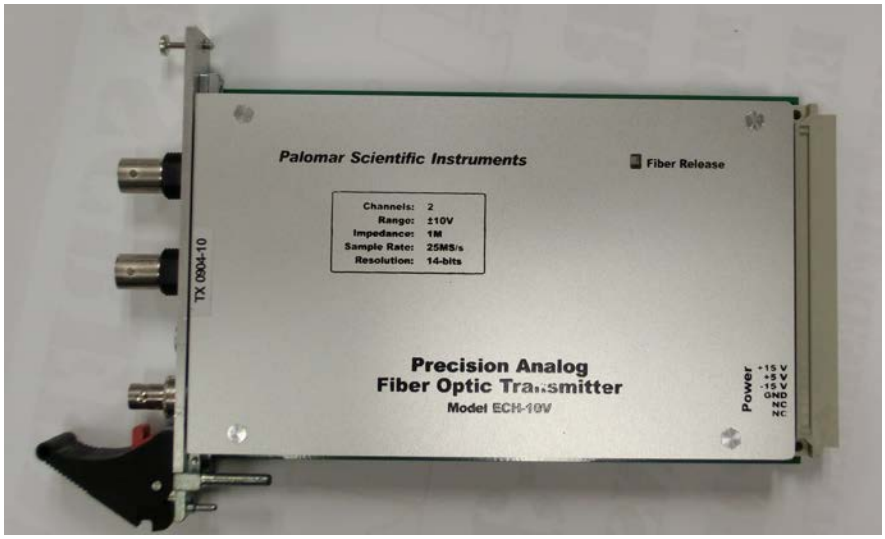

Figure 1a Transmitter Module, 3U Card Cage Format

Figure 2b Receiver Module, Standalone Format

Implementation

The AFLs consist of four main functional blocks, the analog front end, analog-digital conversion, serial encoding/decoding, and transmition/reception. A diagram depicting these major blocks is shown in Figure 3. The analog to digital and digital to analog conversion is accomplished at a rate of 25MSamples/second per channel with a resolution of 14bits.

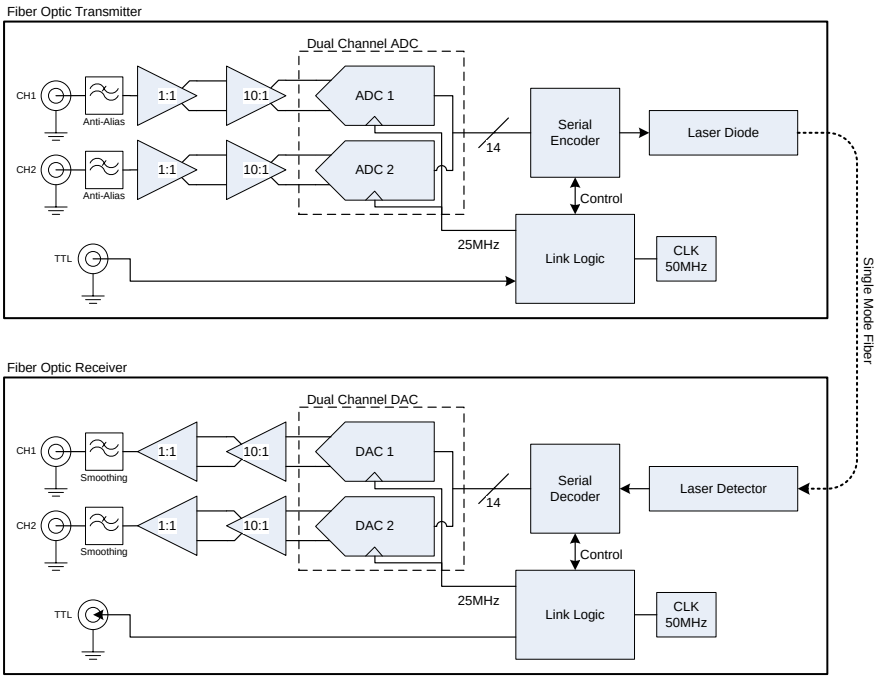

Figure 3, AFL Block Diagram

Specifications

The following section provides information on the performance and options provided by the Analog Fiber Links.

Analog Performance

The AFL provide a means to transmit analog signals by means of fiber optic cabling. The standard ALFs are designed for bipolar ±10Volt input signals, and provide a flat frequency response for large signals with a bandwidth of up to 7MHz. The large signal (±10Volt input) frequency response of the system is shown in Figure 2. The small signal bandwidth (±1V) exceeds 10 MHz.

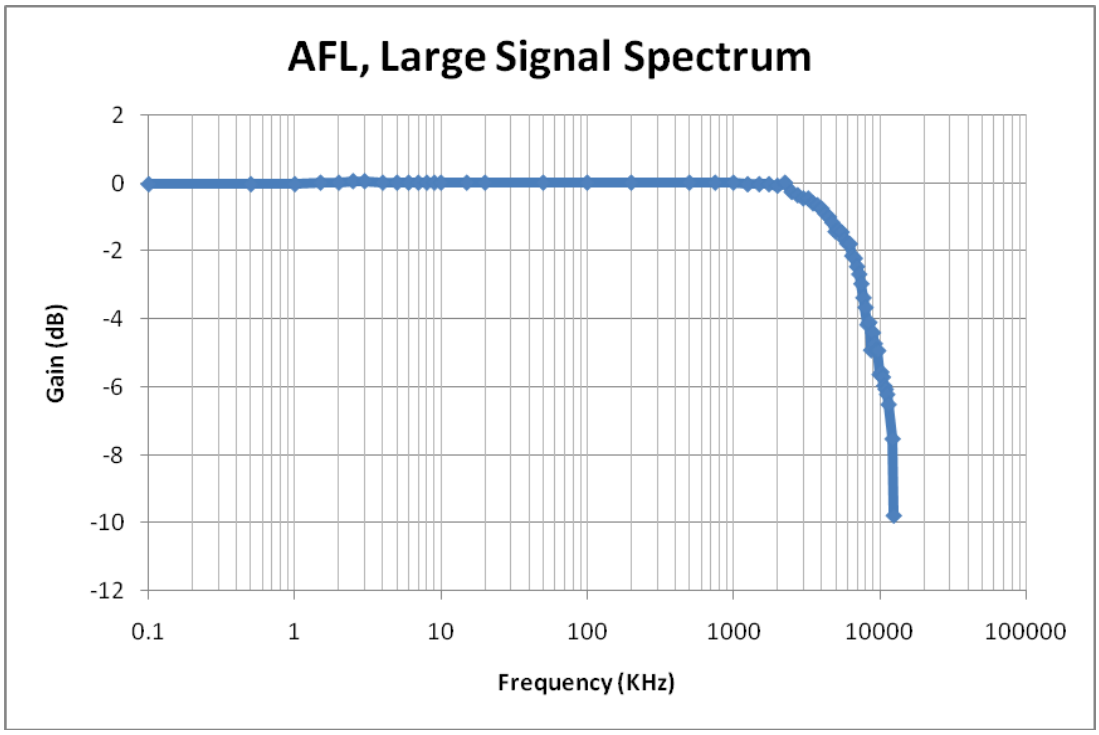

Figure 4, AFL Frequency Response

To handle the large voltage (±10V) signals, the input impedance of the transmitter is set to 1MΩ internally. If the unit is to be used for smaller signals with high bandwidths over coaxial cable, the links should be properly terminated with suitable terminators (ie 50-Ω). Optionally, internal termination can achieved by soldering a jumper on the board.

The low-Z output impedance of each receiver channel is set to 50-Ω to drive loads and can drive 50-Ω and capacitive loads up with at least 100 mA.

We have recently implemented a ±2.5V version for UCSD's Langmuir Probe Diagnostic on the DIII-D Tokamak.

Fiber Type

A single simplex fiber optic cable is required for operation of the AFL (the AFL multiplexes both analog channels onto the one fiber). Each unit uses a small-form-factor (SFF) GBIC laser transceiver module often utilized in giga-bit ethernet applications, and utilizes either 850 nm or 1300 nm lasers. The 850 nm version allows use of standard 62.5/125 multimode (MM) fiber or laser-optimized 50/125 MM fiber for increased range (550 m versus 275m). The 1300 nm version requires 9/125 µm single-mode (SM) fiber but has a range of up to 3km). The standard build for the AFL utilizes the 850 nm GBIC transceiver, and is equipped with an external ST type fiber port for easy termination. Optionally, the LC-type port of the laser transceiver can be accessed internally.

Auto-Synchronization

The links are uni-directional, therefore the transmitter has no way to determine the status of the receiver. A unique feature of the AFL receiver is the ability to self-synchronize to a transmitter. If the receiver loses signal due to fiber disconnection or power loss the receiver immediately initiates an auto-synchronization process. This process takes several milli-seconds to complete once the signal has been restored to the receiver. The Transmitter does not have to be reset to re-establish the link.

Packaging

The fiber optic links can be built as standalone units or as in a 3U Eurocard form factor with either IEEE style handles, or standard VME handles. The links utilize standard BNC connections for the analog inputs and outputs, and a single pin LEMO connector for the optional digital signal. In addition to the BNC connections an option to have the analog signals routed to the optional 96 pin DIN VME style connector is possible. Figure 1, shows the front and side panels of the eurocard AFL receiver.

Power Requirements

The 3U AFLs require a triple voltage power supply: bipolar +/- 15V analog supplies and a +5V digital supply, with common return. The requirements for each supply are listed in Table 1. Both the transmitters and the receivers have the same power requirements.

Voltage (Volts)	Current (mA)
+5	500
+15	100
-15	100

Table 1a, Power Requirements for 3U Card Cage Version

Power to the AFL is provided via either the standard 6pin connector or the optional 96pin DIN connector. See Table 2 for the pin-out of the standard power connector and Table 3 for the DIN connector's pin-out.

The table-top models utilize a standard 5-9VDC power supply commonly used in routers and other low-voltage electronic equipment. Power is provided via a standard 2.5mm DC connector.

Status Indicators

Both sides of the AFLs have bi-color LED indicators providing basic link diagnostics. Table 4 provides a functional description for each of the LEDs.

The LEDs on the transmitters indicate whether the input voltages are within the maximums of the link, typically +/-10Volts. If an input goes outside of the maximums its associated LED will turn red for the duration of the over voltage.

The LED's on the receiver indicate the status of the fiber link. The top LED indicates the presents of light on the optical fiber. The bottom LED indicates the synchronization of the link. The bottom LED will blink during the short time the link attempts to auto-synchronize. For the link to be functional BOTH the both LEDs must be solid green.

Board	LED	Green State	Red State
RX	Ch1 LED	Data Sync Locked	Data Sync Lost
	Ch2 LED	Channel Sync Locked	Channel Sync Lost
TX	Ch1 LED	Ch1, Voltage In Range	Ch1, Voltage Exceeding Range
	Ch2 LED	Ch2, Voltage In Range	Ch2, Voltage Exceeding Range

Table 2, LED Indicator Description

Connector Pin-outs

The 3U AFL comes with two connector options, either a 6pin connector, or a standard 96pin DIN connector. Both connectors provide power connections to the link, but the 96pin DIN additionally allows for rear analog connections. The 6pin connector is manufactured by AMP, part number 103906-5. The 96pin DIN is the standard 3 row Euro Card connector, AMP, part number 5650913-5.

Pin	Connection
1	+15Volts
2	+5Volts
3	-15Volts
4	GND
5	NC
6	NC

Table 3, 6 Pin Power Connector (AMP 103906-5)

Pins	Columns	Connection
1-4	ABC	NC
5	ABC	CH1 Signal
6	ABC	CH1 Return
7-8	ABC	NC
9	ABC	CH2 Signal
10	ABC	CH2 Return
11-20	ABC	NC
21,22	ABC	+5Volts
23,24	ABC	+15Volts
25,26	ABC	-15Volts
27,28	ABC	NC
29,30,31,32	ABC	GND

Table 4, 96 Pin DIN Connector (AMP 5650913-5)

Calibration

Link calibration is preformed before shipping to insure that both voltage offset and gain are within specifications and that the links are performing as expected. Calibration is done by adjusting two variable resistors controlling the gain and offset of the link. To simplify calibration only the receivers need to be calibrated. Transmitters and receivers are paired together and calibrated as a pair before shipping. The calibration controls are labeled on the cover plates of each receiver. User calibration shouldn't be needed, but is possible if Tx/Rx pairs need to be separated. The following steps are recommended for calibrating a link if needed, see Figure 4.

Analog Fiber Link Calibration Procedure

1. Connect and power a link pair as usual. Allow the link time to warm up. (Approximately 15 minutes)
2. Terminate/short both analog channels to ground on the transmitter.
3. Using a high precision voltage meter measure the receivers output signal and adjust the DC offset control until the meter reads 0 Volts. Repeat for both channels.
4. Apply a high accuracy known DC source to both transmitter channels. The voltage should be set to a voltage level near the limits of the link for best calibration.
5. Using the voltage meter measure the receivers output signal and adjust the Gain control until the meter reads the same as the DC sources output. Repeat for both channels.
6. [Optional] Using a function generator and oscilloscope verify the links performance over the frequency and voltage range of interest.

Figure 5, Calibration Procedure

Ordering Information

The following are guidelines for ordering the analog fiber links. Most links are made to order and therefore require 3-4 weeks for delivery (Required time may vary based on requirements). Custom solutions, where possible, can be provided. The base part number for ordering a standard analog fiber link is: AFL- followed by a combination of the following options, see Table 5.

Option	Ordering Code
+/- 2.5Volts Input Signal Range	-025V
+/- 5.0Volts Input Signal Range	-050V
+/- 10Volts Input Signal Range	-010V
6-PIN power connecter	-6p
96-PIN DIN	-96p
Rear Analog Signal Access	-RA
Digital TLL Port	-DP
Front Access ST Fiber Connection	-ST
IEEE Handles	-IEEE
VME Handles	-VME
Single Mode Fiber	-SM

Table 5, Ordering Options

For example the part number for a commonly configured AFL which has the 6-PIN power connector, +/- 10Volt input range, IEEE handles, and Front Access ST Fiber connection is: AFL-10BP-6P-ST-IEEE.