General Standards Corporation

High Performance Bus Interface Solutions

66-16CLI8CLO4

16-Bit Analog Input/Output Board

With 8 Current Loop inputs, 4 Current Loop Outputs, and 16-Bit Digital I/O Port

Available in PMC, PCI, cPCI and PC104-*Plus* and PCI Express form factors as:

PMC66-16CLI8CLO4:	**PMC**, Single-width
PCI66-16CLI8CLO4:	**PCI**, short length
cPCI66-16CLI8CLO4:	**cPCI,** 3U
PC104P66-16CLI8CLO4:	**PC104 *Plus***
PCIe-16CLI8CLO4:	**PCI Express**
PCIe104-16CLI8CLO4:	**PCIe, one-lane on PC/104 form factor**

Call for the availability of other form factors, such as XMC, CCPMC, etc.
(The description in this document applies primarily to the PMC form-factor.)

Features Include:

- **Eight 16-Bit 0-20mA or 4-20mA scanned analog input channels, Software-configurable also as unipolar voltage inputs; 16 single-ended or eight differential, scaled as 0 to +10V, 0 to-+5V or 0 to +2.5V.**
- **Four 16-Bit current-loop output channels, configurable as 0-20mA or 4-20mA ranges, driven by four voltage-output DACs scaled as 0 to +10V, 0 to +5V or 0 to +2.5V. Both the current-loop outputs and the outputs of the voltage-DACs are available at the system I/O connector.**
- **Current-loop outputs have -15V to +11V compliance using internal supplies, or Zero to +31V compliance using an external +34V loop supply**
- **Independent 32K-sample analog input and output FIFO buffers**
- **300K samples per second aggregate analog input sample rate (37.5 KSPS per channel for 8 active channels)**
- **350K samples per second per channel analog output clocking rate (1400 KSPS aggregate rate)**
- **Multiple-channel and single-channel input scanning modes**
- **Buffer amplifiers on all analog input lines**
- **Supports waveform and arbitrary function generation, with continuous and one-shot modes**
- **16-Bit bi-directional TTL digital port**
- **Internal rate generator controls input sampling, output sampling, or both simultaneously**
- **Supports multiboard synchronization of analog inputs and outputs**
- **Internal autocalibration of analog input and output channels**
- **Continuous and triggered-burst (one-shot) input and output Modes**
- **DMA engine minimizes host I/O overhead**
- **68-Pin SCSI system I/O connector with metal shell**
- **66MHz PCI support where applicable, with universal 5V/3.3V signaling**

Applications:

- ✓ **Voltage or Current I/O**
- ✓ **Servo Control**
- ✓ **Data Acquisition (DAS)**
- ✓ **Servo Loop Control**
- ✓ **Ground Loop Elimination**
- ✓ **Automatic Test (ATE)**

PRELIMINARY

REV 090712

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Functional Description:

The 66-16CLI8CLO4 provides both voltage and current analog input/output capability in a single industry-standard module. Analog inputs can be configured either as eight differential voltage inputs, 16 single-ended voltage inputs, or as current-loop terminations. Four analog output channels provide both voltage and current loop outputs. A 16-bit bidirectional digital port consists of 16 TTL lines that can be configured as inputs or outputs in groups of eight lines.

Analog inputs are configurable as voltage inputs with unipolar ranges of +10V, +5V or +2.5V, or as current-loop terminators with standard 0-20mA or 4-20mA ranges. A single 16-Bit A/D converter scans all analog inputs through a high-speed buffered analog multiplexer. Low-resistance switches connect current-loop terminators across the analog inputs under software control. The input channels can be configured as all voltage channels or all current-loop channels, or half of the inputs can be operated in voltage mode while the other half operates as current-loop terminations. Analog input data accumulates in a 32 K-sample buffer until retrieved by the control bus.

The analog outputs consist of four 16-Bit current-loop output channels, software-configurable with 0-20mA or 4-20mA ranges, driven by four voltage-output DACs scaled as 0 to +10V, 0 to +5V or 0 to +2.5V. Both the current-loop outputs and the single-ended outputs of the voltage-DACs are available at the system I/O connector. The voltage-DACs have the same output voltage range as that selected for the analog inputs. All analog outputs are accessed through a 32 K-Sample FIFO buffer that operates independently of the analog input data buffer.

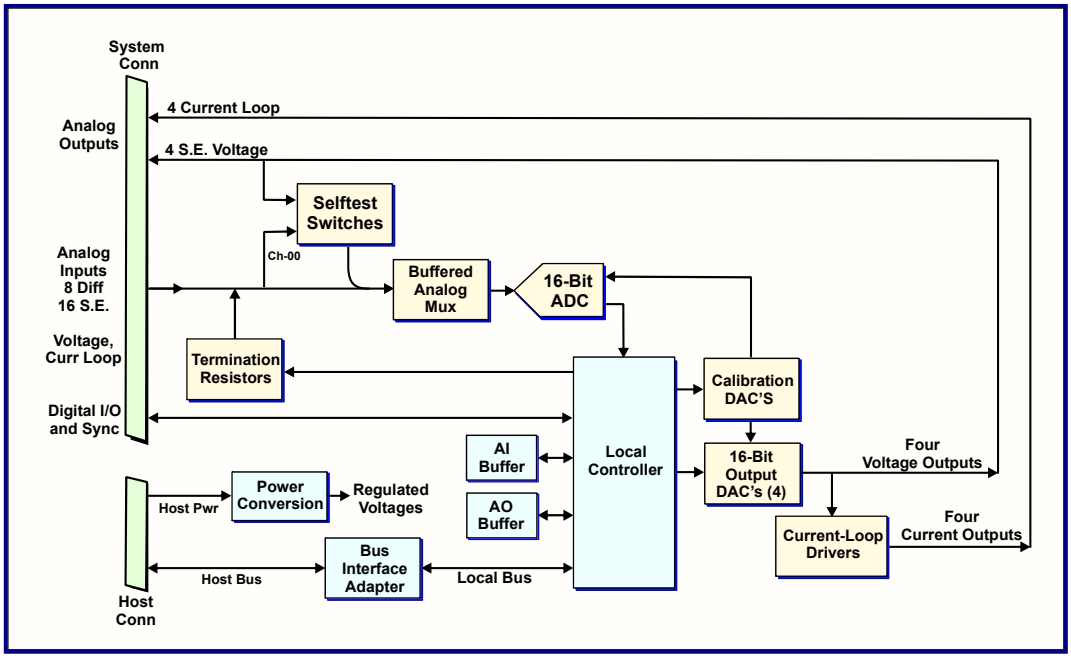

Figure 1. 66-16CLI8CLO4 Functional Organization

Internal autocalibration networks permit calibration to be performed without removing the board from the system. Software-controlled test configurations include a loopback mode for monitoring the analog output voltage channels. Gain and offset corrections of the analog input and output channels are performed by calibration DAC's that are updated during autocalibration.

The board is functionally compatible with the IEEE PCI local bus specification Revision 2.3 for PMC, PC104 *Plus*, or PCI products, or with the PCIe Specification revision 2.0 for PCI Express products. System input/output connections are made at the front panel through a single high-density connector. Operation over the specified temperature range is achieved with conventional convection cooling.

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ELECTRICAL SPECIFICATIONS

At +25 ^{O}C, with specified operating voltages

ANALOG INPUT CHANNELS

Input Characteristics:

Configuration:	16 input lines, configurable as 16 single-ended or 8 differential voltage channels, or as 8 current-loop termination channels. The inputs can be software-configured as (a) all voltage, (b) all current-;loop, or as (c) four voltage and four current-loop.
Input Ranges:	Software configurable as zero to +10, +5 or +2.5 Volts in voltage mode, or as 0-20mA or 4-20mA in current-loop mode.
Input Impedance:	Voltage Mode: LO inputs: 1.0 Megohms line-to-ground, ±15%, HI inputs: 10 Megohms line-to-ground, ±30%, in parallel with 100pfd. Independent of scan rate. Current Mode: 250 Ohms ±0.15%; 500 Ohms ±0.15% with 500-Ohm option (Effective sensed resistance at internal Kelvin connections. Resistance measured at input pins may be 2-3 Ohms higher).
Bias Current:	80 nanoamps maximum
Signal to Noise (SNR):	80 dB typical
Common Mode Rejection:	60 dB typical, DC-60 Hz, differential input mode.
Common Mode Range:	±12 Volts in differential or current-loop configuration with shorted inputs.
Maximum Input Voltage:	±12 Volts on either HI or LO input line for specified performance; for both voltage and current-loop modes.
Input Protection:	Any Input Line: ±30 Volts with power applied; ±15 Volts with power removed. Line-to-Line: Voltage Mode: Same as indicated for "Any Input Line" Current Mode: ±10V for 250-Ohm inputs; ±14V for 500-Ohm inputs.

Input Channel Performance:

Resolution:	16 Bits; 0.0015 percent of FSR
Maximum Conversion Rate:	300K conversions per second, minimum
Channels per scan:	2, 4, 8, or 16 Channels per scan (16 channels only in single-ended mode)
Maximum Scan Rate:	37.5K scans per second for 8-channel scan. 150 KSPS in 2-Channel mode. 300KSPS in single-channel mode. Scan rate equals the conversion rate divided by the number of channels per scan.
Minimum Scan Rate:	590 scans per second, using a single internal rate generator; 0.009SPS using both generators. Zero, using a software sync flag or an externally supplied sync input.
DC Accuracy: (Maximum composite error, referred to inputs)	Voltage Inputs:

Range	Zero-scale Accuracy	+Fullscale Accuracy
0 to +10V	±3.2mV	±4.5mV
0 to +5V	±2.3mV	±3.0mV
0 to +2.5V	±1.6mV	±2.4mV

Current Inputs (250-Ohm terminators, using the 0 to +5V input range):

Range	Zero-scale Accuracy	+Fullscale Accuracy
0-20mA	±15uA	±60uA
4-20mA	±22uA	±60uA

Crosstalk Rejection:	85dB, DC-10kHz
Integral Nonlinearity:	±0.003 percent of FSR, maximum
Differential Nonlinearity:	±0.0015 percent of FSR, maximum

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Analog Input Operating Modes and Controls:

Analog Input Modes:	Single Scan:	A software or hardware sync initiates a single scan of all active channels at the maximum conversion rate. As many as three target boards can be synchronized to a single initiator board.
	Continuous Scan:	Inputs are scanned continuously at the selected scan rate.
	Selftest:	Reference and loopback tests; autocalibration
	Multiple-Channel:	4, 8, 16 or 32 channels per scan
	Single-Channel:	Any single channel can be selected for digitizing at the maximum conversion rate.
	Two-Channel:	2-Channel scan size.
Input Data Buffer:	32K-sample FIFO with 0000h-7FFEh adjustable threshold flag; DMA is supported	

ANALOG OUTPUT CHANNELS

Output Characteristics:

Configuration:	Four single-ended voltage-output DACs driving four current-loop output channels. **Both the outputs of the voltage DACs and the current-loop outputs are available simultaneously at the system I/O connector.**
Ranges:	Voltage outputs: Same as selected for the input channels Current outputs: 0-20mA or 4-20mA (Requires 0 to +5V voltage range.)
Output Resistance:	Voltage outputs: 1.0 Ohm maximum. Current outputs: 30 Megohms minimum.
Output protection:	Voltage outputs withstand sustained short-circuiting to ground.
Output Compliance: (Current outputs)	-15V to +11V with internal supply; Vext - 34V to Vext -3.0V for external supply Vext. .
External Loop Supply (Vext):	+16V to +34V. (Output loads transfer to the internal supply with Vext < +16V).
Load Current: (Voltage outputs)	Zero to ±3ma per individual channel.
Load Capacitance:	Stable with zero to 2000 pF shunt capacitance
Noise:	1.0mV-RMS, 10Hz-1MHz typical (Voltage outputs).
Glitch Impulse:	5 nV-Sec typical, ±2.5V range. (Voltage outputs).

Output Channel Performance:

Resolution:	16 Bits (0.0015 percent of FSR)
Output clocking Rate:	Software adjustable from 590SPS to 350KSPS per channel; 0.009SPS to 350KSPS using both internal rate generators. DC to 350KSPS with hardware or software sync.
DC Accuracy: (Maximum composite error, no-load)	Voltage Outputs:

Range	Zero-scale Accuracy	+Fullscale Accuracy
0 to +10V	±2.7mV	±4.0mV
0 to +5V	±1.9mV	±3.2mV
0 to +2.5V	±1.3mV	±2.0mV

Current Outputs (When used with the 0 to +5V input range):

Range	Zero-scale Accuracy	+Fullscale Accuracy
0-20mA	±45uA	±65uA
4-20mA	±25uA	±65uA

Current Limit:	45mA maximum. (Current outputs).
Dynamic Response::	Voltage outputs: Settling time = 8us typically to 0.01% of halfscale step. Current outputs: Slew rate = 1.5mA per us typically.
Crosstalk Rejection:	85 dB minimum, DC-1000Hz

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Analog Output Operating Modes and Controls:

Clocking Modes:	Simultaneous Continuous Mode: Channel values in a designated channel group are stored in an intermediate buffer, and are transferred to the output DAC's when an output clock occurs. The clock can be generated either by an internal rate generator, by a software flag, or by an external hardware trigger. Simultaneous Burst Mode: A single function (i.e.: burst) is initiated by a software or hardware sync. During a burst, channel values in a designated channel group are stored in a transfer buffer, and then are transferred to the output DAC's when an output clock occurs. The burst terminates when a Burst End flag is encountered Channel-Sequential Modes: Same as simultaneous modes, except each value in the data buffer is written immediately to the associated output DAC. The group-end flag is ignored in this mode.
Channel Assignment:	A 2-bit field in the output buffer assigns the associated data field to a specific output channel.
Group End:	A single bit in the output buffer indicates the last value in a channel group.
Burst End:	A single bit in the output buffer indicates the last value in an output burst sequence.
Output Data Buffer:	32K-sample FIFO with 0000h-7FFEh adjustable threshold flag; DMA is supported

Rate Generators:

Analog inputs and outputs can be clocked from either of two independent rate generators, or both inputs and outputs can be synchronized to a single generator. Each rate generator uses a 16-bit adjustable frequency divider, and the dividers for the two generators can be operated in series to provide very low clocking rates.

Digital I/O Port:

The digital I/O port consists of 16 bidirectional data lines, one auxiliary input line and one auxiliary output line. An interrupt request can be generated in response to the auxiliary input. The data lines are organized as two data bytes, each of which can be configured independently as either an input or output byte. Standard TTL logic levels apply, with 8 ma source/sink capability per output line, and all lines are pulled up internally to +5V through 4.7K when configured as inputs.

Host Control Interface Compatibility:

PCI, PMC, cPCI and PC104 *Plus*:

Conforms to PCI Specification 2.3, with D32 read/write transactions and universal 5V/3.3V signaling..
Supports block-mode DMA transfers as bus master. Provides a multifunction interrupt.

PCI Express:

PCIe Specification revision 2.0; single-lane.
Supports block-mode DMA transfers as bus master.

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MECHANICAL AND ENVIRONMENTAL SPECIFICATIONS

Mechanical Characteristics:

PMC Form Factor

Height: 13.5 mm (0.53 in)
Depth: 143.75 mm (5.66 in)
Width: 74.0 mm (2.91 in)

PCI Express Form Factor

Height: 12.4 mm (0.49 in)
Depth: 167.6 mm (6.60 in)
Width: 110.1 mm (4.37 in)

Power Requirements:

(All current-loop outputs loaded with 20mA):

PCI, PMC, cPCI and PC104 *Plus*:

+5VDC ±0.2 VDC at 1.7 Amps typical, 2.0 Amps, maximum. Maximum power dissipation: 10 Watts*.

PCI Express:

+3.3±0.3VDC at 1.4 Amps typ; 1.6 Amps max. +12.0±0.8VDC at 0.5 Amp typ; 0.6 Amp max.
Maximum power dissipation: 10 Watts*.

* Plus 0.8 Watt if fullscale input current (20mA) is applied to all 250-Ohm terminators.

Environmental Specifications

Ambient Temperature Range:	
Standard Temperature:	Operating: 0 to +70 Degrees Celsius * Storage: -40 to +85 Degrees Celsius
Extended Temperature:	Operating: -40 to +80 Degrees Celsius * Storage: -40 to +85 Degrees Celsius * Air temperature at board surface.
Relative Humidity:	0 to 95%, non-condensing
Altitude:	Operation to 10,000 ft.
Cooling:	Conventional air cooling; 150 LFPM

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ORDERING INFORMATION

Specify the basic product model number followed by an option suffix "-A-B-C", as indicated below. For an industrial-temperature version, append the letter "I" to the end of the basic model number.

Example 1, model number **PMC66-16CLI8CLO4-4-R250-0** describes a PMC module with four current-loop output channels, 250-Ohm input terminators, and no custom features.

Example 2, model number **PMC66-16CLI8CLO4I-4-R250-0** describes an industrial-temperature PMC module with four current-loop output channels, 250-Ohm input terminators, and no custom features.

Table 1. Available Form Factors

Basic Model Number	Form Factor
PMC66-16CLI8CLO4	PMC (Native)
PCI66-16CLI8CLO4 [1]	PCI, short length
PC104P66-16CLI8CLO	PC104-*Plus (Native only)*
cPCI66-16CLI8CLO4 [1]	cPCI, 3U
PCIe-16CLI8CLO4 [1]	PCI Express
PCIe104-16CLI8CLO4 [2]	PCI Express, one-lane on PC/104 form factor

[1] Module installed and tested on an adapter, with mechanical and functional equivalency. Contact factory for availability in native form factors.

[2] PCIe104 supports only the PCIe bus.

Table 2. Ordering Options

Optional Parameter	Value	Specify Option As:
Number of Analog Outputs	No Output Channels	A = 0
	Four Current-loop output Channels [1]	A = 4
Input Termination Resistance	(Standard): 250 Ohms (Uses +5V input range.)	B = R250
	500 Ohms (Uses +10V input range.)	B = R500
Custom Features	No Custom Features	C = 0
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[1] The four current-Loop channels, when specified, are driven by four companion voltage DACs, and both the DAC voltage outputs and the current-loop outputs are available at the system I/O connector.

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SYSTEM I/O CONNECTIONS

Table 3. System Connector Pin Functions

ROW-A			ROW-B	
PIN	SIGNAL [1,2]		PIN	SIGNAL [2]
1	ANA INP00 HI		1	DIGITAL RTN
2	ANA INP00 LO		2	SYNC OUTPUT
3	ANA INP01 HI		3	DIGITAL RTN
4	ANA INP01 LO		4	SYNC INPUT
5	INPUT RTN		5	DIGITAL RTN
6	INPUT RTN		6	AUX DIGITAL IN
7	ANA INP02 HI		7	AUX DIGITAL OUT
8	ANA INP02 LO		8	DIG IO 00
9	ANA INP03 H		9	DIG IO 01
10	ANA INP03 LO		10	DIG IO 02
11	INPUT RTN		11	DIG IO 03
12	INPUT RTN		12	DIG IO 04
13	ANA INP04 HI		13	DIG IO 05
14	ANA INP04 LO		14	DIG IO 06
15	ANA INP05 HI		15	DIG IO 07
16	ANA INP05 LO		16	DIG IO 08
17	INPUT RTN		17	DIG IO 09
18	INPUT RTN		18	DIG IO 10
19	ANA INP06 HI		19	DIG IO 11
20	ANA INP06 LO		20	DIG IO 12
21	ANA INP07 HI		21	DIG IO 13
22	ANA INP07 LO		22	DIG IO 14
23	INPUT RTN		23	DIG IO 15
24	INPUT RTN		24	DIGITAL RTN
25	OUTPUT RTN		25	VTEST
26	ANA IOUT00		26	VTEST RTN
27	OUTPUT RTN		27	ANA VOUT00
28	ANA IOUT01		28	OUTPUT RTN
29	OUTPUT RTN		29	ANA VOUT01
30	ANA IOUT02		30	OUTPUT RTN
31	OUTPUT RTN		31	ANA VOUT02
32	ANA IOUT03		32	OUTPUT RTN
33	OUTPUT RTN		33	ANA VOUT03
34	EXT LOOP SUPPLY		34	OUTPUT RTN

[1] Analog inputs are shown as differential channels. In the single-ended mode, all 16 analog inputs are individual voltage channels. For example, in the S.E. mode ANA INP00 HI ANA INP00 LO and ANA INP01 HI are consecutive channels.

[2] Analog voltage-outputs are designated as ANA VOUTxx, where "xx" is the channel number. Current outputs are designated as ANA IOUTxx.

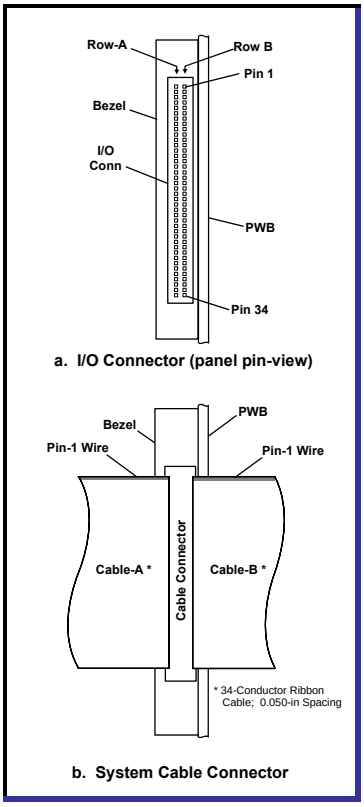

Figure 2. System Input/Output Connector

System Mating Connector:

68-pin 0.050" Subminiature connector with metal shield: AMP #749621-7 or equivalent.

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