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INTRODUCTION

This chapter gives a brief introduction to the PCLD-789D card and its features.

Sections include:

- Card specifications
- PCLD-789D block diagram
- Component layout

Introduction

The PCLD-789D is a powerful front-end signal conditioning and channel multiplexing daughter board. It has been designed to multiplex the analog input channels of the PCL-711B, PCL-812PG, PCL-818, PCL-818H, PCL-818HD and PCL-818L Rev. A2 data acquisition cards. This daughter board also works with any other data acquisition card which supports both +12 V and +5 V power supplies and 4-bit programmable TTL/CMOS digital control and analog input channels. This board multiplexes 16 differential input channels into one analog output channel. Up to 10 PCLD-789Ds can be cascaded to expand the analog inputs of a single data acquisition card to 160 channels. The board has a high grade instrumentation amplifier to provide switch selectable gains of 1, 2, 10, 50, 100, 200, 500, 1000 or user definable gain. This function allows users to perform accurate low level analog signal measurement.

Signal conditioning functions such as filtering and current shunt are also covered by the on-board passive circuitry. The PCLD-789D also contains a cold junction compensation (CJC) sensing circuit to allow direct measurement of thermocouple transducers. All types of thermocouples can be handled with software compensation and linearization.

Features

- Multiplexing of 16 differential inputs to one analog output channel
- Expanding analog inputs to the maximum of 160 channels by cascading multiple PCLD-789Ds. (For PCL-711B, PCL-818, PCL-812PG, PCL-818L Rev A2, PCL-818H and PCL-818HD, the maximum channels available is 128)
- High grade instrumentation amplifier provides switch selectable gains of 1, 2, 10, 50, 100, 200, 500, 1000 or user definable gains
- On-board cold junction compensation circuits for direct thermocouple measurement. The PCLD-789D supports a multitude of thermocouple types. Comes with built-in signal conditioning functions such as filtering, attenuation and current shunt
- Screw clamp terminal blocks permit easy and reliable signal connections

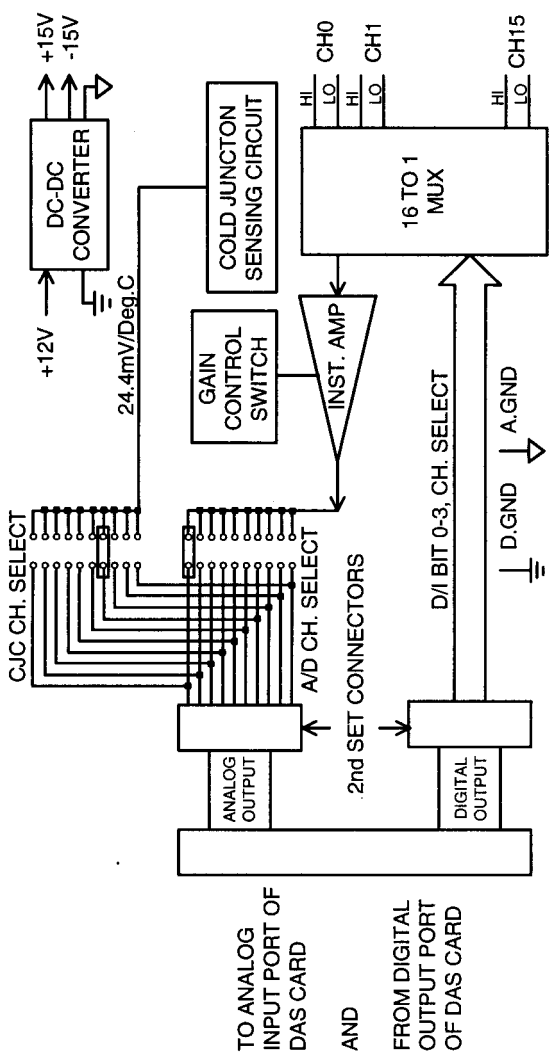
Specifications

- **Input Channel:** 16 differential channels
- **Input Range:** ± 10 V maximum, varies with gain selection
- **Input Conditions:**

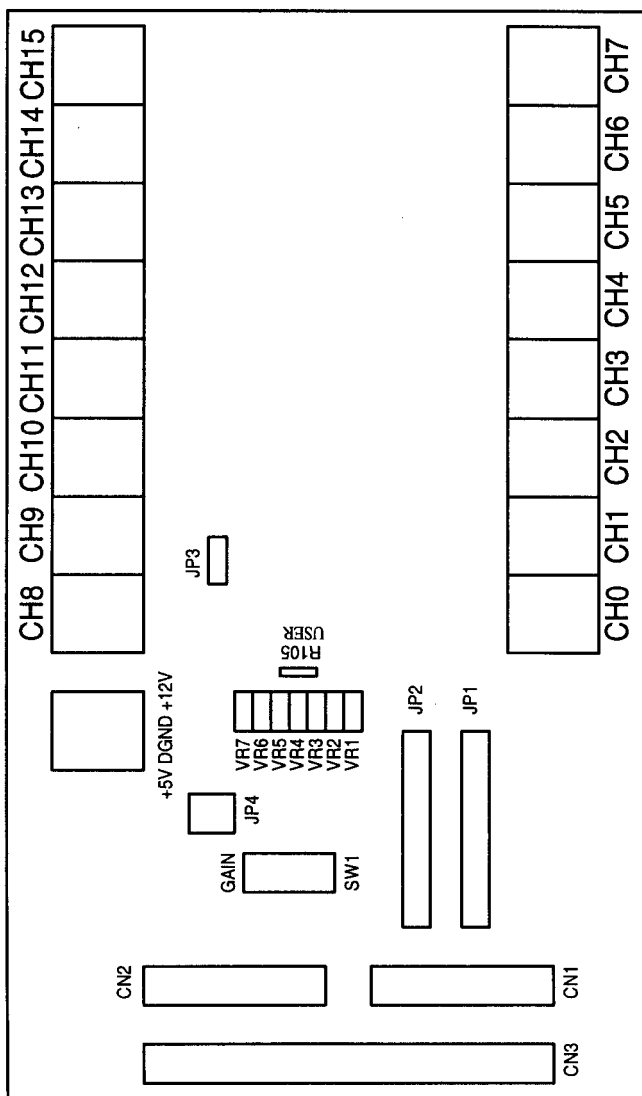
Input Conditions

Gain	Common Mode Rejection	Accuracy	Settling Time	Input Voltage
1000	125 dB	0.171% of FSR ± 1 LSB	75 μ Sec.	± 10 mV
500	-	0.098% of FSR ± 1 LSB	35 μ Sec.	± 20 mV
200	-	0.073% of FSR ± 1 LSB	15 mSec.	± 50 mV
100	115 dB	0.0488% of FSR ± 1 LSB	15 μ Sec.	± 100 mV
50	-	0.0244% of FSR ± 1 LSB	15 μ Sec.	± 200 mV
10	105 dB	0.0244% of FSR ± 1 LSB	15 μ Sec.	± 1 V
2	-	0.0244% of FSR ± 1 LSB	15 μ Sec.	± 5 V
1	85 dB	0.0244% of FSR ± 1 LSB	15 μ Sec.	± 10 V

- **Overvoltage Protection:** 30 V continuous
- **Common Mode Voltage:** ± 10 V maximum
- **Output Range:** ± 10 V maximum
- **Output Current:** 0.06 mA maximum
- **Cold Junction Compensation:**
+24.4 mV/Deg.C. (0.0 V at 0.0 Deg.C)
- **Power Consumption:** +5 V (30 mA maximum)
+12 V (80 mA maximum)
- **Connector Type:**
20 pin flat cable connector and DB-37 connector
- **Maximum Daisychain:** Up to 10 pcs for a gain = 1
- **Dimensions:**
20.5 cm (L) x 11.43 cm (W) (8.07" (L) x 4.5" (W))
- **Weight:** 0.527 lbs (0.239 Kg)



PCLD-789D Block Diagram



Connector, switch and VR locations

Installation

This chapter gives a general procedure for setting up and installing your card.

Sections include:

- Initial inspection
- Gain switch settings
- Jumper settings
- Power supply
- Connector pin assignments

Initial Inspection

Inside the shipping container, you should find:

- PCLD-789D card
- Two 20-pin flat cable connectors
- One 37-pin DB-type connector
- Utility diskette
- This users manual

The PCLD-789D was carefully inspected both mechanically and electrically before shipment. It should be free of marks and scratches and in perfect electrical order on receipt.

When unpacking, check the unit for signs of shipping damage (damaged box, scratches, dents, etc.). If there is damage to the unit or it fails to meet specifications, notify our service department or your local sales representative immediately. Also, call the carrier immediately and retain the shipping carton and packing material for inspection by the carrier. We will make arrangements to repair or replace the unit.

Remove the PCLD-789D interface card from its protective packaging carefully. Keep the anti-vibration package. Whenever you are not using the board, please store it in the package for protection.

Warning! *Discharge your body's static electric charge by touching the back of the grounded chassis of the system unit (metal) before handling the board. You should avoid contact with materials that hold a static charge such as plastic, vinyl and styrofoam. Handle the board only by its edges to avoid static damage to its integrated circuits. Avoid touching the exposed circuit connectors.*



Installation

After you have unpacked the PCLD-789D you will need to configure the card to suit your particular application. This is done simply by inserting or removing the appropriate jumpers. Also some of the filter characteristics can be altered by changing components on the card. The jumpers and switches are as follows:

PCLD-789D Jumpers and switches	
Function	Name
Gain setting	SW1
Cold junction compensation output	JP1
Analog output channel selection	JP2
Filter selection 2nd stage	JP3
Power supply select	JP4
Filter selection 1st stage channel 0~15	JP5~JP20
Thermo measurement channel 0~15	JP21~JP36

Default Settings

For the most common working configurations the card is shipped with the above jumpers preset to default positions as follows:

PCLD-789D Default Settings	
Function	Default
Gain setting	Gain = 1
Cold junction compensation output	Channel 7
Analog output channel selection	Channel 0
Filter selection 2nd stage	Off
Power supply select	Int (PC supply)
Filter selection 1st stage channel 0~15	On
Thermo measurement channel 0~15	On

Gain Switch Setting (SW1)

The PCLD-789D uses a high grade instrumentation amplifier to provide switch selectable gains of 1, 2, 10, 50, 100, 200, 500 and 1000 or user definable gain. The specific gain is selected through an 8 position DIP switch (SW1) labeled "GAIN". Refer to the diagram on page 5 for the location of the switch. The following table illustrates the switch setting and corresponding gain.

Switch Position								
1	2	3	4	5	6	7	8	Gain
*	●	○	○	○	○	○	○	1
	○	●	○	○	○	○	○	2
	○	○	●	○	○	○	○	10
	○	○	○	●	○	○	○	50
	○	○	○	○	●	○	○	100
	○	○	○	○	○	●	○	200
	○	○	○	○	○	○	●	500
	○	○	○	○	○	○	○	1000
	○	○	○	○	○	○	○	USER

○ = OFF ● = ON * = Default

Note: USER refers to user definable gains which are covered in chapter 4

Jumper Settings

CJC Output Channel Jumper (JP1)

PCLD-789D provides cold-junction compensation (CJC) for thermocouple applications. This is done by placing a shorting link in JP1. JP1 consists of 10 channels 0 through 9 and a not used position "X". This feature permits up to 5 PCLD-789Ds to be connected to a 10 channel analog input card. Place the jumper in the output channel according to the channel of the analog input card selected for that PCLD-789D board.

If the CJC is required, place the jumper in the channel position allocated to the PCLD-789D.

Analog Output Channel Jumper (JP2)

PCLD-789D supports 10 separate jumper selectable analog output channels. This is done by placing a shorting link in JP2. JP2 consists of 10 channels 0 through 9 and a not used position "X". This feature permits up to 10 PCLD-789Ds to be connected to a 10 channel analog input card. Place the jumper in the output channel according to the channel of the analog input card selected for that PCLD-789D board (see below).

Identifying Channel Allocations

If the PCLD-789D is one of several cards connected to a DAS board then it must be identifiable from the others. When setting up the DAS card you will have used the software utility to allocate it's analog input channels to the various amplifier/multiplexer cards. Each amplifier/multiplexer card will have its own channel number different from the others.

Using both Analog and CJC

The DAS card's output is limited to ten addresses. Each card uses one address for the analog output channel jumper JP2 (which is the same as the DAS card's input channel). This allows up to ten amplifier/multiplexer cards to be cascaded. If a card uses CJC then that card will use two addresses, one for the analog output channel and one for the CJC. This limits the number of cards that can use CJC to five (five x two addresses = ten addresses).

2nd Stage Low Pass Filter Jumper (JP3)

JP3 is a second stage low pass filter to reject the output noise from the PCLD-789D's amplifier (JP5 through JP20 are used to reduce unwanted high frequency input noise). This low pass filter is constructed with a 0.1 μ F capacitor and a 5.11 K Ω resistor. The time constant is 0.511 msec., i.e. the cutoff frequency is 310 Hz. If this cut-off frequency is not suitable, you can replace the resistor R73 (located below JP3) to meet your application requirements. The default setting is with the filter disconnected.

Filter On



Filter Off (default)



Low Pass Filter Jumpers (JP5 to JP20)

To reject high frequency noise from the low frequency input signals, the PCLD-789D provides low pass filtering on each of the input channels. Jumpers JP5 through JP20 control the use of the filtering function on different input channels. For low frequency input signals, such as thermocouple signals, place the jumper on the selected channels. For high frequency signals, remove the jumper from the selected channels. The cards default setting is on with the jumper in-place.

The low pass filter is constructed with one $1\mu\text{F}$ capacitor and two $1.2\text{ k}\Omega$ resistors. The time constant is 2.4 msec., i.e. the cut-off frequency is 66 Hz. If this cut-off frequency is not suitable for the applications, the users can change it by changing the resistors and/or capacitor.

Filter Off Filter On (default)



Cut-off frequency calculation

If you need to change either of the above cut-off frequencies you will need to calculate the value of the filter components. Firstly the cut-off frequency can be calculated using:

$$\text{Freq} = \frac{1}{2 \times \pi \times C \times R}$$

Where C and R are the values of the capacitor and resistor(s) in the filter network. The easiest way to change the cut-off frequency is to change the resistor(s). Firstly decide the cut-off frequency required and use the equation below to find the resistor value. Remember to add the values of the resistors together when more than one is used.

$$R = \frac{1}{\text{Freq} \times 2 \times \pi \times C}$$

Thermo Measuring Jumper (JP21 to JP36)

These jumpers are used in certain thermo measuring applications where isolation from other channels are required. By shorting the jumpers each CH LO terminal is connected to GND via a 10 K Ω resistor. The board is shipped with the jumpers shorted, this is the default position.

Off



On (default)



CH 7

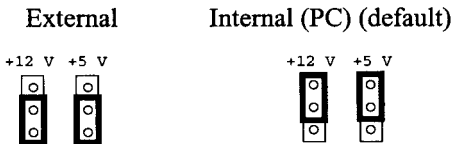
Power supply

The PCLD-789D requires both +5 V and +12 V power supplies for correct operation. You can get the power supply from your PC or an external source selectable via JP4. There are two power supply entry points on the PCLD-789D, via the connectors (CN2, CN3) or a three lead terminal block for an external supply.

Connectors CN2 (pins 19 +5 V, pin 20 +12 V) and CN3 (pins 19 +5 V, pin 13 +12 V) are wired to use the PC's power supply. This is the case if you connect the PCLD-789D to our DAS cards, such as the PCL-711, PCL-812, PCL-812PG, PCL-818, PCL-818L Rev A2, PCL-818H and PCL-818HD.

Power Supply selection (JP4)

To use PC's power supply or external power supply, please set jumper JP4 in the correct way, according to the following diagram:



An alternative to the PC's supply is a three-lead terminal block designed for those who want to use an external power supply. (Please refer to the diagram on page 5 to find the position of this terminal block). It is recommended to use an external power supply for a daisy chain configurations where power consumption is likely to be higher.

Pin assignments are shown below.



Connector Pin Assignments

PCLD-789D is equipped with two 20-pin insulation displacement (mass termination) connectors and one DB-37 pin connector. Connector 1 is used for the analog outputs. Connector 2 is for the multiplexer control digital inputs, digital ground and + 5 V, + 12 V power. Connector 3 is designed to support PCLD-789D daisy chaining as it contains all the pin functions of connector 1 and 2. The diagram on page 5 specifies the location of each of the connectors. The following diagrams illustrate the pin assignment of each connector.

► Connector CN1 – Analog output

ANA out 0	1 2	A.GND
ANA out 1	3 4	A.GND
ANA out 2	5 6	A.GND
ANA out 3	7 8	A.GND
ANA out 4	9 10	A.GND
ANA out 5	11 12	A.GND
ANA out 6	13 14	A.GND
ANA out 7	15 16	A.GND
ANA out 8	17 18	A.GND
ANA out 9	19 20	A.GND

► Connector CN2 — Multiplexer input control, ground and power supply

D/I 0	1	2	D/I 1
D/I 2	3	4	D/I 3
	5	6	
	7	8	
	9	10	
	11	12	
	13	14	
	15	16	
D.GND	17	18	D.GND
+5 V	19	20	+12 V

► Connector CN3 – Analog output channels, multiplexer input control, ground and power supply

ANA out 0	1	20	A.GND
ANA out 1	2	21	A.GND
ANA out 2	3	22	A.GND
ANA out 3	4	23	A.GND
ANA out 4	5	24	A.GND
ANA out 5	6	25	A.GND
ANA out 6	7	26	A.GND
ANA out 7	8	27	A.GND
A.GND	9	28	A.GND
A.GND	10	29	A.GND
N/C	11	30	N/C
S0	12	31	N/C
+12 V	13	32	S1
S2	14	33	S3
D.GND	15	34	D.GND
N/C	16	35	N/C
N/C	17	36	N/C
N/C	18	37	N/C
+5 V	19		

3

SIGNAL CONNECTIONS

This section explains the nature of floating and non-floating signals. It also explains how to properly connect the input signals to the PCLD-789D.

Sections include:

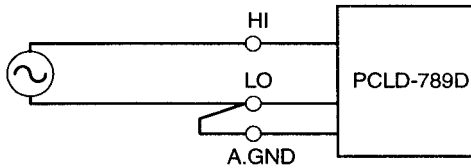
- Analog input connection
- Analog output connection

Analog Input Connection

PCLD-789D can multiplex up to 16 analog inputs. Input channel selection is issued and controlled by the data acquisition card's 4-bit TTL/CMOS digital output. The following explains the nature of floating and non-floating signal sources and how to properly connect the input signals.

Floating Source Connection

Since the PCLD-789D has only differential input channels, each input channel must have two signal wires. The differential input responds only to the voltage difference between the high and low inputs. If the signal source has no connection to ground, it is called "floating source". A connection must exist between Low and Ground to define common input voltage for floating signal source. To measure a floating source, the input channel should be connected as:



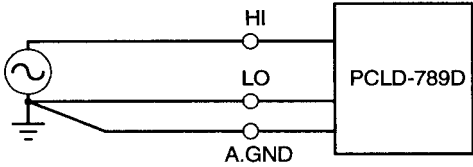
Non-Floating Source Connection

If the signal source has one side connected to local ground. The signal source ground and the PCLD-789D ground will not be at exactly the same voltage as they are connected through the ground return of the equipment and building wiring. The difference between the ground voltages forms a common mode voltage.

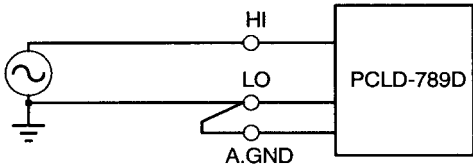
NOTE: For thermocouple measurement do not connect A.GND to CH LO. Users should short jumpers JP21~JP36 (one for each channel) to satisfy isolation requirements. Refer to the previous chapter for detailed information.

To avoid ground loop noise effects, the signal ground should be connected to the low input signal. The low input should not be

connected to the PCLD-789D ground directly. For better grounding, in some cases, a wire connection between the PCLD-789D ground and signal source ground is necessary. The next two diagrams explain the correct and incorrect connections of a differential input with local ground.



Correct connection



Incorrect connection

Analog Output Connection

The PCLD-789D provides 10 jumper selectable output channels. Users may choose to use any one of the channels to output data. To select a specific output channel, simply place the analog output channel jumper (JP2) in the required channel allocation.

The output channel configuration is mainly determined by the pin assignment compatibility between the analog input connector of the data acquisition card and the PCLD-789D output connector. It is also limited by the number of channels available on the data acquisition card. Since the analog input channel configuration are different amongst the PCL-711B, 812PG, 818, 818L Rev A2, 818H and 818HD the details of connecting PCLD-789D outputs to the above cards are discussed separately in the following sections. The other data acquisi-

tion cards follow the same rule and the users can determine the signal connections easily by referring to the operating manual and checking the pin assignments.

Output to the PCL-818 and 818H

The PCL-818 and 818H can handle up to 16 single-ended or 8 differential input channels. Due to the connector pin assignment limitation, only 8 differential input channel configurations can be used. The following table describes the channel connections.

PCL-818/818H Connections

Output Jumper	PCLD-789D CN1 Pin Assign.	PCL-818/818H Pin Assign.	PCL-818(CN1)/818H(CN3) Pin Assign.
0	1, 2	A/D 0	1, 2
1	3, 4	A/D 1	3, 4
2	5, 6	A/D 2	5, 6
3	7, 8	A/D 3	7, 8
4	9, 10	A/D 4	9, 10
5	11, 12	A/D 5	11, 12
6	13, 14	A/D 6	13, 14
7	15, 16	A/D 7	15, 16
8	17, 18	X	X
9	19, 20	X	X

Note: "X" means channels are not supported by the PCL-818 or 818H

Output to the PCL-812 and 812PG

The PCL-812 and 812PG can handle up to 16 signal ended input channels. All of the 10 PCLD-789D output channels can be supported by the PCL-812/812PG analog input channels. The following table describes the channel connections.

PCL-812/818PG Connections

Output Jumper	PCLD-789D CN1 Pin Assign.	PCL-812/812PG Input Channel	PCL-812 CN1/812PG Pin Assign.
0	1, 2	A/D 0, AGND	1, 2
1	3, 4	A/D 1, AGND	3, 4
2	5, 6	A/D 2, AGND	5, 6
3	7, 8	A/D 3, AGND	7, 8
4	9, 10	A/D 4, AGND	9, 10
5	11, 12	A/D 5, AGND	11, 12
6	13, 14	A/D 6, AGND	13, 14
7	15, 16	A/D 7, AGND	15, 16
8	17, 18	A/D 8, AGND	17, 18
9	19, 20	A/D 9, AGND	19, 20

Output to the PCL-711B

The PCL-711B can handle up to 8 single-ended input channels. The following table describes the channel connections.

PCL-711B Connectors

Output Jumper	PCLD-789D CN1 Pin Assign.	PCL-711B Input Channel	PCL-711B CN1 Pin Assign.
0	1, 2	A/D 0, AGND	1, 2
1	3, 4	A/D 1, AGND	3, 4
2	5, 6	A/D 2, AGND	5, 6
3	7, 8	A/D 3, AGND	7, 8
4	9, 10	A/D 4, AGND	9, 10
5	11, 12	A/D 5, AGND	11, 12
6	13, 14	A/D 6, AGND	13, 14
7	15, 16	A/D 7, AGND	15, 16
8	17, 18	X	X
9	19, 20	X	X

Note: " X " means channels are not supported by the PCL-711B

Output to the PCL-818HD/818L Rev A2

The PCL-818HD/818L Rev A2 can handle up to 8 single-ended input channels. The following table describes the channel connections.

PCL-818HD/818L Rev A2 Connectors

Output Jumper	PCLD-789D CN3 PinAssign.	PCL-818HD/818L Rev A2 Input Channel	PCL-818HD/818L Rev A2 Pin Assign.
0	1, 20	A/D 0, AGND	1, 20
1	2, 21	A/D 1, AGND	2, 21
2	3, 22	A/D 2, AGND	3, 22
3	4, 23	A/D 3, AGND	4, 23
4	5, 24	A/D 4, AGND	5, 24
5	6, 25	A/D 5, AGND	6, 25
6	7, 26	A/D 6, AGND	7, 26
7	8, 27	A/D 7, AGND	8, 27
8	X	X	X
9	X	X	X

Note: " X " means channels are not supported by the PCL-818HD/818L Rev A2

Operation

This section explains how to create input gains which are not provided by the PCLD-789D's selectable gain. It also explains the different methods of measurement possible with this card.

Sections include:

- Gain settings
- Input and output channel selection
- Cascading multiple PCLD-789Ds
- Open thermocouple detection
- Cold junction compensation
- Current measurement
- Signal amplifier

PCLD-789D Gain Settings

PCLD-789D uses a high grade instrumentation amplifier to provide switch selectable gains of 1, 2, 10, 50, 100, 200, 500 and 1000 or user a definable gain. Different gains are selected through an 8 position DIP switch labeled as "GAIN". Page 10, chapter 2 (Gain Switch Setting) illustrates the switch settings and corresponding gains.

The PCLD-789D allows the users to create input gains which are not provided. To create a input gain, first set all positions of the DIP switch to the OFF position. Next, place a resistor into the space marked as "USER" on the PCLD-789D. Refer to page 5, chapter 1 for the resistor location "USER". The resistance is determined by the gain to be created. The calculation of this resistance is:

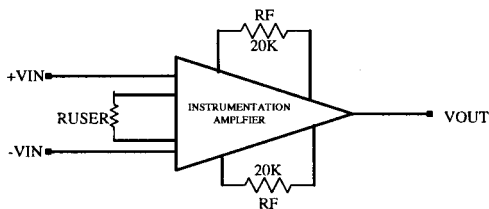
$$R_{user} (R105) = (2 \times 20,000) / (\text{Voltage Gain} - 1)$$

the above formula is obtained from

$$\text{Voltage Gain} = ((2 \times R_F) / R_{user}) + 1$$

Where R_F is fixed $20 \text{ K}\Omega \pm 0.1 \%$

The following diagram illustrates the amplifier diagram:



Instrumentation amplifier

If several input signals are connected to a single PCLD-789D simultaneously, to avoid amplifier output saturation, the selected gain should be based on the largest input signal. Each type of thermocouple has its own suitable gain. To assure correct temperature measurements, do not connect thermocouples requiring different gains in a single PCLD-789D. A list of different types of thermocouples and their suitable gains are listed on the next page:

Thermocouple Gains

Thermocouple Type	Temperature Deg. C	Output Range (mV)	Suitable Gain
T	-200 to +200	-10 to +10	200
J	-200 to +600	+10 to +35	100
E	0 to +700	-5 to +55	50
K	-200 to +1200	-10 to +55	50
R	0 to +1769	0 to +25	200
S	0 to +1769	0 to +20	200

Input Channel Selection

PCLD-789D can multiplex up to 16 differential or single-ended analog inputs. Input channel selection is controlled from the data acquisition control card by a 4 bit TTL/CMOS digital output. The digital output addresses and their corresponding channels are listed below:

Address/Channel Allocation

Address	Channel #	Address	Channel #
0000	0	1000	8
0001	1	1001	9
0010	2	1010	10
0011	3	1011	11
0100	4	1100	12
0101	5	1101	13
0110	6	1110	14
0111	7	1111	15

Output Channel Selection

The PCLD-789D supports 10 separate jumper selectable output channels. The output channel is selected by placing the JP2 (AMP Output) jumper in the desired channel. Please refer to chapter 3 for more information regarding the channel configuration between the PCLD-789D and the PCL-711B, 812PG, 818, 818H, 818HD and 818L Rev A2.

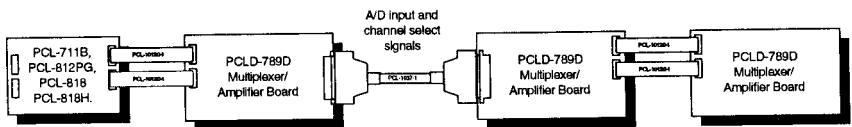
Cascading Multiple PCLD-789Ds

The PCLD-789D is designed with the flexibility to expand the number of analog input channels. Up to ten PCLD-789Ds can be daisy chained to provide 160 channels of standard voltage or current measurement if all of the output channels of the PCLD-789D are used.

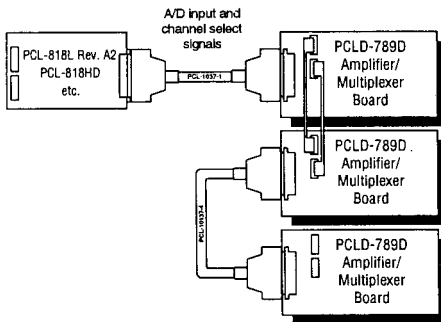
For thermocouple measurement with cold-junction compensation on each card, up to 5 PCLD-789Ds can be cascaded to provide 80 channels of thermocouple measurements. If only one cold-junction compensation card is required for all PCLD-789Ds, up to 9 cards can be cascaded to offer 144 channels of thermocouple measurement.

Daisy chaining is accomplished through Connectors CN1, CN2 and CN3. Each PCLD-789D must be set up with a unique output channel and each of these output channels correspond to an input channel of the data acquisition card.

The following diagrams illustrate the cascading of multiple PCLD-789Ds,



Cascading multiple PCLD-789Ds

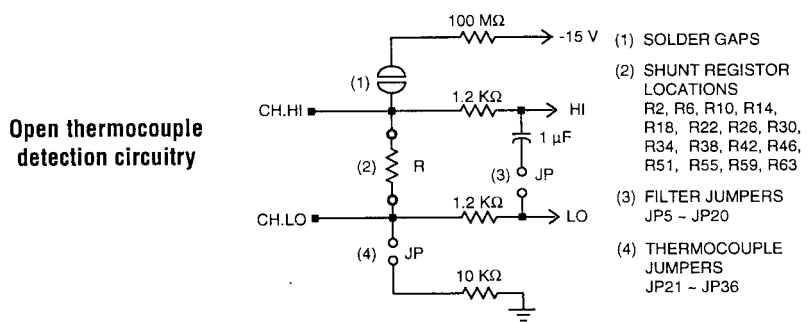


Alternative cascading of multiple PCLD-789Ds

Open Thermocouple Detection

The PCLD-789D provides open thermocouple detection through biasing resistor circuitry. These bias resistors are not normally connected. On the back of the P.C.B. there is one solder gap and one jumper for each input channel. If open thermocouple detection is required, short the solder gaps and JP21~36 to connect the biasing resistors.

Under normal conditions, the input voltage generated by a thermocouple is very small. If a thermocouple opens, the bias resistors will slowly change the input voltage to -15 V. This significant input voltage change will signify the opening of the thermocouple. Users can use a simple application program to detect the voltage changes and open thermocouple. The following diagram illustrates the open thermocouple detection circuitry:



Cold Junction Compensation

PCLD-789D provides on-board cold-junction compensation circuitry to support thermocouple measurement. The circuitry generates a +24.4 mV/Deg.C compensation signal with a zero volt output at 0 Deg.C. The CJC output is controlled by JP1 (CJC Output) jumper. You may choose to use any one of the 10 CJC output channels by placing the jumper in the desired channel. Be aware of the Connector 1 output channels are used by the CJC outputs as well as the analog outputs.

Current Measurement

The PCLD-789D can easily perform current measurement. Each input channel has two plated through holes for the simple installation of shunt resistors. The locations of these holes are by the side of each channel's screw terminal block. Based on the resistance of the resistor installed and input voltage, you can calculate the input current.

Signal Amplifier

The on-board high grade instrumentation amplifier makes the PCLD-789D an ideal device to measure small signals of transducer and strain gauges. You can choose any one of the 1, 2, 10, 50, 100, 200, 500 and 1000 gain options or create a special gain. In addition to the gain setting, user should also be aware of the use of each channel's filter jumper (JP5 to JP20). For low frequency input signals, enable the filter function by placing the jumper in the channel. This will reduce the noise level of the input signals. For high frequency signals, the filter function should be disabled to avoid signal decay. See chapter 2 for more detailed information.

APPLICATIONS

This chapter provides information on using the PCLD-789D in different applications. It gives details of the DAC cards that can be used with this card and some application examples.

Sections include:

- Use with the PCL-818, 818H, 818HD and 818L Rev A2
- Use with the PCL-812PG
- Use with the PCL-711B
- Cascading multiple PCLD-789Ds

APPLICATIONS

This chapter provides the information for using the PCLD-789D in different applications. Since the PCLD-789D is a daughter board, it must be used with a data acquisition card (DAC). This chapter covers the use of some data acquisition cards with the PCLD-789D through application examples. It also provides explanations on how to use the PCLD-789D with certain transducers and thermocouples. All application programs mentioned in this chapter are contained on the PCLD-789D software disk provided with this card.

The software disk contains:

- Demonstration programs (BASICA, TURBO C++ 3.0)
- Call by functions
- Direct I/O
- Calibration program
- Test programs (all files used in the following examples)

Use with the PCL-818, 818H, 818HD and 818L Rev A2

The above high performance data acquisition cards can support up to 128 input channels by cascading 8 PCLD-789Ds. The above cards come with a software driver, so you can use this driver for application programming or for writing application programs without using the above card's driver routines.

This section will use a T-type thermocouple measurement application to demonstrate how to use the PCLD-789D with the PCL-711B, 818, 818H, 818HD and 818L Rev A2 data acquisition cards. Please note that this application program, DEMO818H.BAS, is written in BASICA and utilizes the PCL-818H driver routines. The major steps of the program are listed below:

- Step 0 Install the PCL-818H driver by executing PCL-818H.exe.
- Step 1 Load PCL818H.BIN driver to BASICA work space.

- Step 2 Use PCL-818H driver Function 0 to initialize driver.
- Step 3 Load thermocouple voltage/temperature conversion table to array, define A/D data array and input selected gain option.
- Step 4 Get cold-junction compensation reference from PCLD-789D.
- Step 5 Get thermocouple analog inputs using Function 3 (single A/D conversion).
- Step 6 Convert A/D data to volts with specified gain and further convert voltage data to temperature data.
- Step 7 Display temperature data.

The PCL-711B, 818, 818H, 818HD and 818L Rev A2 all follow the same above routine.

DEMO818H.BAS contains different types of thermocouple voltage/temperature conversion parameters and calculation routines. To help the users writing thermocouple application programs, a subroutine program, called THERMO.BAS, written in BASIC is provided in the PCLD-789D software utility disk as are all the above mentioned programs.

Note: PCL-818H.exe and PCL-818H.bin are both on the utility disk

Use with the PCL-812PG

The PCL-812PG can support up to 160 input channels by cascading 10 PCLD-789Ds. This section will use a J-type thermocouple measurement application to demonstrate how to use the PCLD-789D with the PCL-812PG data acquisition card. Please note that this application program, DEMO812PG.BAS, is written in BASIC and handles all PCL-812PG I/O port instructions directly. The major steps of the program are listed below :

- Step 0 Set the A/D reference voltage on the PCL-812PG to ± 10 V.
- Step 1 Load thermocouple voltage/temperature conversion table to array and select J-type measurement.

- Step 2 Define A/D data and temperature data arrays and input the selected gain option.
- Step 3 Get cold-junction compensation reference from PCLD-789D.
- Step 4 Get thermocouple analog inputs.
- Step 5 Convert A/D data to volts with specified gain and further convert voltage data to temperature data.
- Step 6 Display temperature data.

Use with the PCL-711B

The PCL-711B (Multi-Lab Card) can support up to 128 input channels by cascading 8 PCLD-789Ds. This section will use a J-type thermocouple measurement application to demonstrate how to use the PCLD-789D with PCL-711B data acquisition card. Please note that this application program, DIO711B.BAS, is written in BASICA and handles all PCL-711B I/O port instructions directly. The major steps of the program are listed below:

- Step 1 Load thermocouple voltage/temperature conversion table to array and select J-type measurement.
- Step 2 Define A/D data and temperature data arrays and input selected gain option.
- Step 3 Get cold-junction compensation reference from PCLD-789D.
- Step 4 Get thermocouple analog inputs.
- Step 5 Convert A/D data to volts with specified gain and further convert voltage data to temperature data.
- Step 6 Display temperature data.

Cascading Multiple PCLD-789Ds

This section will provide an application example for using 5 PCLD-789Ds to measure 80 analog signal points with the PCL-818, 818H, 818HD and 818L Rev A2 data acquisition cards. Please note that the application program, CSD818H.BAS, is written in BASICA and utilizes the PCL-818H driver routines. The major steps of the program are listed below:

- Step 0 Install the PCL-818H driver by executing PCL-818H.exe.
- Step 1 Load PCL-818H.BIN driver to BASICA work space.
- Step 2 Use PCL-818H driver Function 0 to initialize driver.
- Step 3 Define data arrays and obtain each PCLD-789D's gain setting.
- Step 4 Get PCLD-789D input signals using PCL-818H driver functions.
- Step 5 Convert A/D data to volts with specified gain.
- Step 6 Display measured data.
- Step 7 Repeat Step 4 through 6 for next PCLD-789D.

Note: PCL-818H.EXE and PCL-818H.BIN are both on the utility disk.

CALIBRATION

This sections contains information for the calibration of your PCLD-789D.

Sections include:

- Calibrating the amplifier offset
- Calibrating the amplifier gains
- Calibrating the CJC circuitry

Calibration

In data acquisition and control, it is important to constantly calibrate your measurement device to maintain its accuracy. A calibration program, CALB789D.BAS, is provided in the PCLD-789D's software diskette to assist your calibration work. The calibration program is written in BASICA. To use it, simply load the program into BASICA and run the program. It is strongly recommend that users do not change the program unless it is absolutely necessary. Once the calibration program has been loaded and executed, it uses a graphic display and prompts to guide you through the calibration process. In addition to the calibration program, it is necessary to have a 4 and 2/1 digit digital multimeter, a voltage calibrator or a very stable and noise free DC voltage source to perform the amplifier offset and gain calibration. For cold-junction compensation circuitry calibration, a digital thermometer or other temperature measurement device accurate to ± 2 degrees C is required.

Calibrating the Amplifier Offset

The amplifier offset calibration includes input offset and output offset adjustments. The complete procedure for conducting the offset calibration is as follows:

1. Connect the PCLD-789D with a compatible data acquisition card e.g. PCL-818H to obtain a +5 V and +12 V power supply and select the analog input channel through the 4-bit digital output data control. For example, if input channel 7 is selected, you should program the data acquisition card to send digital data to "0111".
2. Short the terminal ports of the selected analog input channel by wiring the analog ground, high input signal and low input signal ports together. For example, if input channel 7 is selected, the A.GND, CH7 HI and CH7 LO should be shorted.
3. Put the analog output (AMP output) jumper in any one of the output channels.

4. Identify the selected output channel (STEP 3) pins and analog ground (Connector 1). Connect these pins to the DVM's input and common ports
5. Adjust the input offset by setting the gain switch to 1000 or 500 and tuning VR9 to obtain a reading of zero (0) on the DVM.
6. Adjust the output offset by setting the gain switch to 1 and tuning VR10 to obtain a reading of zero (0) on the DVM.

This concludes the Amplifier offset calibration.

Calibrating the Amplifier Gains

The PCLD-789D amplifier gain calibrations are controlled by VR1 through VR7. The corresponding gain of each VR is listed below:

VR1: Gain = 2	VR5: Gain = 200
VR2: Gain = 10	VR6: Gain = 500
VR3: Gain = 50	VR7: Gain = 1000
VR4: Gain = 100	

Amplifier gain calibration is as follows:

1. Connect the PCLD-789D to a compatible data acquisition card e.g. PCL-818H to obtain a +5 V and +12 V power supply. Select the analog input channel through the 4-bit digital output data control.
2. Connect the analog input wires to the desired input terminal ports. Chapter 3-1 covers the details of analog input connections.
3. Put the analog output (AMP output) jumper in any one of the output channels.
4. Identify the selected output channel (STEP 3) pins and analog ground (Connector 1). Connect these pins to the DVM's input and common inputs

5. Adjust the 2 gain offset by setting the gain switch to 2 and tuning VR1 to obtain the required reading on the DVM. The required reading is based on the input voltage and gain setting.

For example, if the input voltage is +1 V, the required reading should be +2 V.

6. Repeat the STEP 5 until all of the gains have been calibrated.

This concludes the Amplifier gain calibration.

Calibrating the CJC Circuitry

As soon as the cold-junction compensation circuitry calibration function has been selected, follow the steps listed below to perform the calibration.

1. Put the CJC jumper in any one of the CJC output channels.
2. Identify the above selected channel output and ground pins on Connector 1 (CN1) and connect these pins to the DVM's input and ground ports.
3. Use the digital thermometer to measure the temperature around the temperature sensor D2. To assure the correct measurement put the temperature sensor as close as possible to D2.
4. Since the PCLD-789D CJC circuitry generates a +24.4 mV/Deg. C. compensation signal with a zero volt output at 0 Deg.C., the corresponding voltage of the measured temperature can be calculated using the following formula:
$$V_t = (24.4 \text{ mV/Deg.C.}) \times \text{Measured Temperature.}$$
5. Adjust VR8 to obtain a DVM reading equal to the voltage (V_t) calculated in the previous step.

This concludes the CJC circuitry calibration.