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User's Guide

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CIO-DAS48-I

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1 INTRODUCTION

The CIO-DAS48-PGA board is an extension of the popular CIO-DAS08 architecture. The channels have been expanded to 48 single -ended inputs or 24 differential inputs. The 24 Differential inputs can be adapted for electrical current measurements.

1. Gains are software-programmable for X0.5, X1, X2, X4 and X8.

2. Analog inputs are differential (24) or single-ended (48). In differential mode, up to three optional 10K SIPs can be installed to provide ground reference to the CH LO inputs. The SIPs are installed in banks of 8 inputs each.

3. A current measurement conversion kit contains six, four-resistor-SIPs which, when installed on the CIO-DAS48-PGA, convert the 24 differential voltage measurements inputs into 24 current measurement inputs. The current measurement resistor kit is installed at the factory on the CIO-DAS48-I version. The current measurement resistor kit is not provided with the CIO-DAS48-PGA, but may be ordered separately and installed by the user. The part number is CIO-DAS48-ISIP

4. A DC/DC converter supplies stable ±15V power to the analog circuitry. It is possible to construct the board without the DC/DC converter. This reduces the cost but limits the ranges of analog inputs. It is available with orders of 10 or more units.

2 SOFTWARE INSTALLATION

The board has a bank of address switches, a channel configuration switch and two jumpers to set before installing the board in your computer. By far the simplest way to configure your board is to use the *Insta*Cal™ program provided as part of your software package. *Insta*Cal™ will show you any available options, how to configure the switches to match your application requirements, and will create a configuration file that your application software (and the Universal Library) will refer to so the software you use will automatically know the exact configuration of the board.

Please refer to the *Software Installation Manual* regarding the installation and operation of *Insta*Cal™. The following hard copy information is provided as a matter of completeness, and will allow you to set the hardware configuration of the board if you do not have immediate access to *Insta*Cal™ and/or your computer.

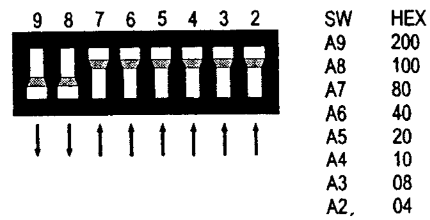
You can then run TEST and test the installation of the board. Follow the instructions for signal connection displayed on the screen.

3.1 BASE ADDRESS

The base address of the CIO-DAS48-PGA is set by switching a bank of eight DIP switches on the board. This bank of switches is labeled ADDRESS and numbered 9 to 2 on the board.

NOTE: Ignore the word "ON" and the numbers printed on the switch

The address logic works by adding up the weights of individual switches to total a base address. A switch is active when down. Figure 3-1 shows switches 9 and 8 being down, all others are up. Weights 200h and 100h are active, equaling a 300h base address.



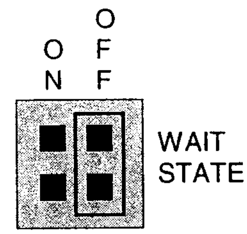
BASE ADDRESS SWITCH - Address 300H shown here.

Figure 3-1. Base Address Switches

3.2 WAIT STATE

A wait state may be enabled on the CIO-DAS48-PGA by selecting WAIT STATE ON at the jumper provided on the board (Figure 3-2). Enabling the wait state causes the personal computer's bus transfer rate to slow down whenever the CIO-DAS48-PGA is written to or read from.

The wait state jumper is provided in case you one day own a personal computer with an I/O bus transfer rate which is too fast for the CIO-DAS48-PGA. If your board were to fail sporadically in random ways, you could try using it with the wait state ON.



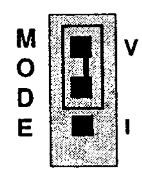
WAIT STATE JUMPER BLOCK - No wait state is selected here. For a wait state, place jumper on the two leftmost pins.

Figure 3-2. Wait State Jumper

3.3 MODE V-I JUMPER

The jumper labeled MODE V-I is set to match the type of input, voltage (V) or current (I) (Figure 3-3).

Move the jumper from V to I *only* if you have installed the CIO-DAS48-ISIP kit. If you have ordered the CIO-DAS48-I, the V-I jumper should already be in the "I" position.



Voltage (V) or Current (I) MODE Jumper. Install CIO-DAS48-ISIP kit before using (I) Position.

Figure 3-3. V/I Mode Jumper

3.4 DIFF / SINGLE SWITCH

This switch (Figure 3-4) sets board logic for 48 single-ended channels ("48 SINGLE" position) or 24 differential channels ("24 DIFF" position). If the board is configured for current measurements (set the V-I jumper to "I") and set the DIFF / SINGLE switch to "24 DIFF". If you purchased a CIO-DAS48-I, check that the switch is in the "24 DIFF" position.

In voltage mode, (V-I jumper "V" position), the board can be used for either single-ended or differential voltage measurements.

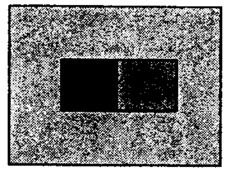


Figure 3-4. DIFF/SINGLE Switch

3.5 CONFIGURING A CIO-DAS48-PGA FOR CURRENT LOOP MEASUREMENTS

If you are configuring a CIO-DAS48-PGA to do current measurements, do the following operations:
(The CIO-DAS48-I is already configured for current measurements at the factory, so no changes are needed.)

1. Remove (clip off) the SIPs from RN7, RN8, and RN9, if installed. These SIPs must not be installed if the board is to be used for current measurement
2. Install the resistor "CIO-DAS48-ISIP" kit. Install ISIPs in RN1, RN2, RN3, RN4, RN5, and RN6.
   Special instructions and solder are packaged with the CIO-DAS48-ISIP kit. Follow the installation instructions carefully and use the solder provided. Use of other solder, or failure to follow instructions will probably result in a degradation of the analog input's accuracy and will require out-of-warranty repair.
   The selection of the ISIPs is critical. Variations in either value or tolerance from those supplied in the CIO-DAS48-ISIP will result in inaccurate measurements.
3. Set the MODE jumper to "I" position.
4. Switch the DIFF / SINGLE switch to "24 DIFF" position.
5. Install the board and run the *Insta*Cal calibration procedure for current mode.

After installation, the inputs are committed to current measurement and cannot be used for voltage measurement.

Removal of the ISIPs restores the CIO-DAS48-PGA the inputs to voltage measurement. Removal must be done by clipping off the SIPs. If you want to de-solder the SIPs the board must be returned to the factory. If you want to re-install the 10k SIPs in RN7, RN8, and RN9 (to have "Modified-Differential" inputs), you must return the board to the factory.

It is not possible to install only a portion of the ISIPs and have a mixture of current and voltage inputs. You must install all six SIPs from the CIO-DAS48-ISIP package and set the MODE V-I jumper to I.

3.6 INSTALLING IN THE COMPUTER

1. Turn the power off.

2. Remove the cover of your computer. Please be careful not to dislodge any of the cables installed on the boards in your computer as you slide the cover off.

3. Locate an empty expansion slot in your computer.

4. Push the board firmly down into the expansion bus connector. If it is not seated fully it may fail to work and could short circuit the PC bus power onto a PC bus signal. This could damage the motherboard in your PC as well as the CIO-DAS48-PGA.

4.1 CONNECTOR DIAGRAM

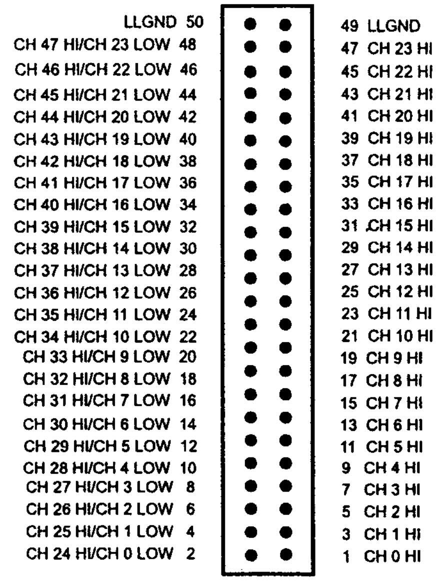
The connector pin names CH 0 HI through CH 47 HI define the single-ended configuration of the CIO-DAS48-PGA inputs.

The connector pin names CH 0 LOW & HI through CH 23 LOW & HI define the differential configuration of the CIO-DAS48-PGA inputs.

Current connections are made between CH# HI and CH# LOW. The positive terminal of the current to be measured must be connected to CH# HI (see *Current Loop Measurements* below).

The CIO-DAS48-PGA analog connector is a 50-pin header-type connector accessible from the rear of the PC through the expansion backplate.

The connector accepts female 50-pin header connectors, such as those on the C50FF-2, a 2-foot cable. This cable is compatible with the CIO-MINI50 screw terminal board.



CIO-DAS48-PGA CONNECTOR - View from component side of the board.

Figure 4-1. Connector Pinout

4.2 SINGLE ENDED INPUTS

Single-ended inputs are two-wire connections between the signal source and the A/D board. A single wire carries the signal, and is connected from the signal source to Channel ## HI. The ground from the signal source must be connected to LLGND, pins 49 or 50.

4.3 DIFFERENTIAL INPUTS

Differential inputs are 3-wire analog hookups consisting of a signal high, signal low and chassis ground. The signal source high is connected to Channel N HI, the signal source low is connected to Channel N LOW, the signal source GND is connected to LLGND

The benefits of differential inputs are the ability to reject noise which affects both signal high and low, and the ability to compensate for ground loops or potentials between signal low and chassis ground.

4.4 MODIFIED DIFFERENTIAL

Modified differential inputs for voltage measurements provide much of the environmental-noise immunity and common mode rejection of fully differential inputs with the convenience of a two wire hookup.

Although differential inputs are often preferable to single-ended inputs, there are occasions when the floating nature of a differential input can prevent making a valid reading. In those cases, the CIO-DAS48-PGA inputs can be converted to modified differential.

Near the 50-pin connector on the board are positions for optional Single Inline Packages (SIP) of 10K resistors. Installing the SIP in RN7, RN8 and RN9 converts the analog inputs from fully differential to modified differential with a 10K reference to ground.

NOTES: ALL THREE SIPS MUST BE INSTALLED. IT IS NOT POSSIBLE TO MIX CHANNELS.

After the SIPs are installed, signal connections require on Signal Source Hi be connected to Channel N HI and signal source low be connected to Channel N LOW. No connection to LLGND is needed.

NOTE

Special instructions and solder are packaged with the 10K SIP. Follow the installation instructions carefully and use the solder provided. Use of other solder, or failure to follow instructions will probably result in a degradation of the analog input's accuracy and will require out-of-warranty repair.

4.5 CURRENT LOOP MEASUREMENTS (CIO-DAS-48-I version)

The CIO-DAS48-I is configured for current loop measurements in the 4 to 20 mA range. (Ranges of 2 to 10mA, 1 to 5 mA and 0.5 to 2.5 mA are also possible but are less commonly used.) A typical current loop system uses 24V to power the current loop. Current output devices are available in two-wire and three-wire configurations. Use the figures below as guides in connecting devices to the CIO-DAS48-I.

4.5.1 TWO-WIRE DEVICES

The "floating device" configuration is required for most systems using two-wire devices due to the restriction on common mode range for the CIO-DAS48-I. If the power supply were connected to the CIO-DAS48-I input, as in a "grounded device" system, the common mode input range spec would be violated and inaccurate measurements would result.

Figure 4-2 shows a "floating device" configuration for a two-wire, 4 to 20 mA device. This is the correct configuration that ensures that the common mode range input specification is not violated.

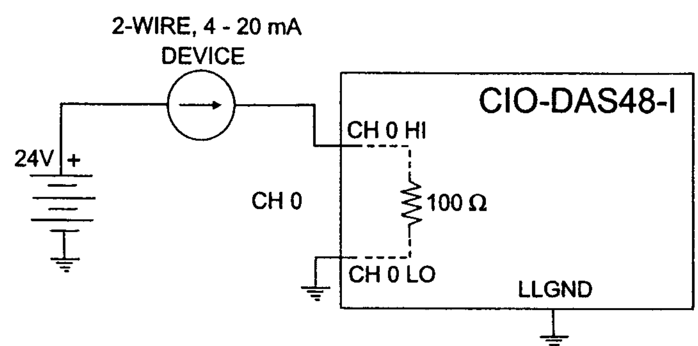


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Figure 4-2 Floating Device Configuration

Figure 4-3 below shows a "grounded device" configuration for a two-wire, 4 to 20mA device. DO NOT USE this configuration. The 24V supply connection, direct to the input, violates the common mode range input specification of the CIO-DAS48-I.

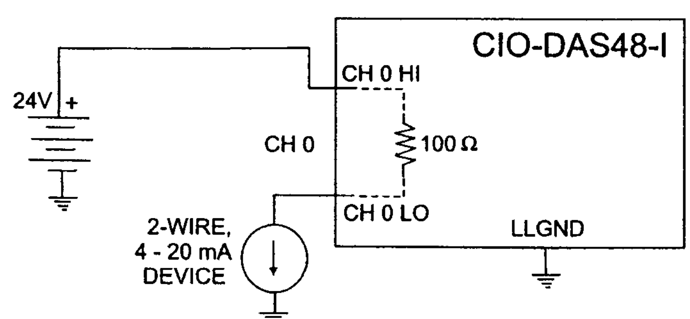


Figure 4-3 Grounded Device Configuration - CAUTION - DO NOT USE

4.5.2 THREE-WIRE DEVICES

Figure 4-4 below shows a three-wire, 4 to 20 mA device connected to channel 0 of the CIO-DAS48-I. Three-wire devices will typically specify the maximum load resistance for the current output. The input resistance of the CIO-DAS48-I is 100 ohms (determined by the CIO-DAS48-ISIP installed). Add this value to any other load resistances in the loop. Typically, the maximum resistance specified for three-wire devices is on the order of 1 kohm.

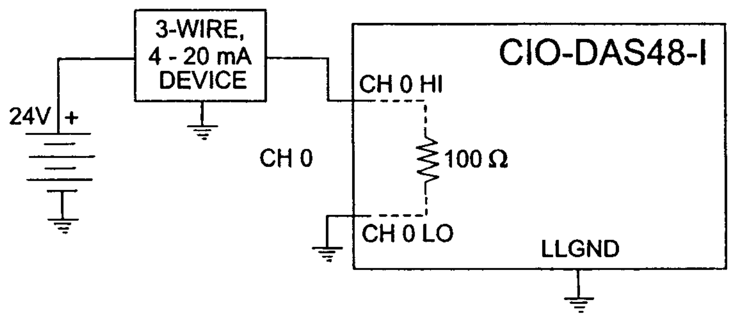


Figure 4-4 Connecting a Three-Wire Device

5.1 ANALOG INPUTS

If you are an Electrical Engineer, this section may be skipped. But, if you are like most users, the best way to connect your analog inputs may not be obvious. Though complete coverage of this topic is beyond the scope of this manual, the following section provides some explanations and helpful hints regarding these analog input connections.

Prior to describing connection schemes, you should have at least a basic understanding of single-Ended/differential inputs and system grounding/isolation. If you are already comfortable with these concepts, you may wish to skip to the next section (on wiring configurations).

5.1.1 Single-Ended and Differential Inputs

The CIO-DAS48-PGA provides either eight differential or 16 single-ended input channels. The concepts of single-ended and differential inputs are described in the following section.

5.1.2 Single-Ended Inputs

A single-ended input measures the voltage between the input signal and ground. In this case, in single-ended mode the CIO-DAS48-PGA measures the voltage between the input channel and LLGND. The single-ended input configuration requires only one physical connection (wire) per channel and allows the CIO-DAS48-PGA to monitor more channels than the (2-wire) differential configuration using the same connector and onboard multiplexor. However, since the CIO-DAS48-PGA is measuring the input voltage relative to its own low level ground, single-ended inputs are more susceptible to both EMI (Electro Magnetic Interference) and any ground noise at the signal source. Figure 5-1 shows the single-ended input configuration.

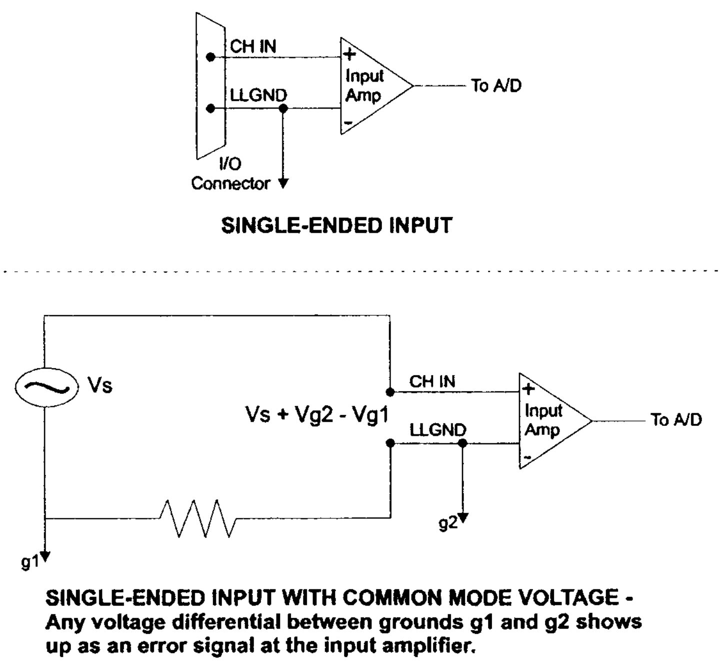
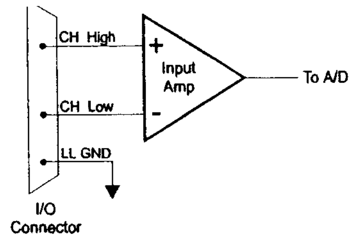


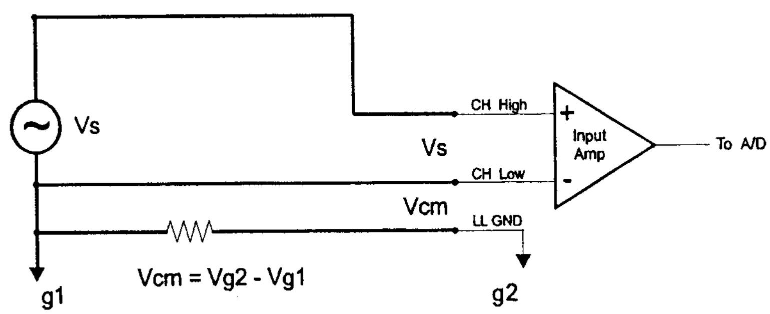
Figure 5-1. Single-Ended Input Theory

5.1.3 Differentiall Inputs

Differential inputs measure the voltage between two distinct input signals. Within a certain range (referred to as the common mode range), the measurement is almost independent of signal source to CIO-DAS48-PGA ground variations. A differential input is also much more immune to EMI than a single-ended one. Most EMI noise induced in one lead is also induced in the other, the input only measures the difference between the two leads, and the EMI common to both is ignored. This effect is a major reason there is twisted pair wire as the twisting assures that both wires are subject to virtually identical external influence. Figure 5-2 below shows a typical differential input configuration.



DIFFERENTIAL INPUT



DIFFERENTIAL INPUT - Common Mode Voltage (Vcm) is ignored by differential input configuration. However, note that Vcm + Vs must remain within the amplifier's common mode range of ±10V.

Figure 5-2. Differential Input Theory

Before moving on to the discussion of grounding and isolation, it is important to explain the concepts of common mode, and common mode range (CM Range). Common mode voltage is depicted in the diagram above as Vcm. Though differential inputs measure the voltage between two signals, without (almost) respect to the either signal's voltages relative to ground, there is a limit to how far away from ground either signal can go. Though the CIO-DAS48-PGA has differential inputs, it will not measure the difference between 100V and 101V as 1 Volt (100V would destroy the board). This limitation or common mode range is depicted graphically in

Figure 5-3. The CIO-DAS48-PGA common mode range is ± 10 Volts. Even in differential mode, no input signal can be measured if it is more than 10V from the board's low level ground (LLGND).

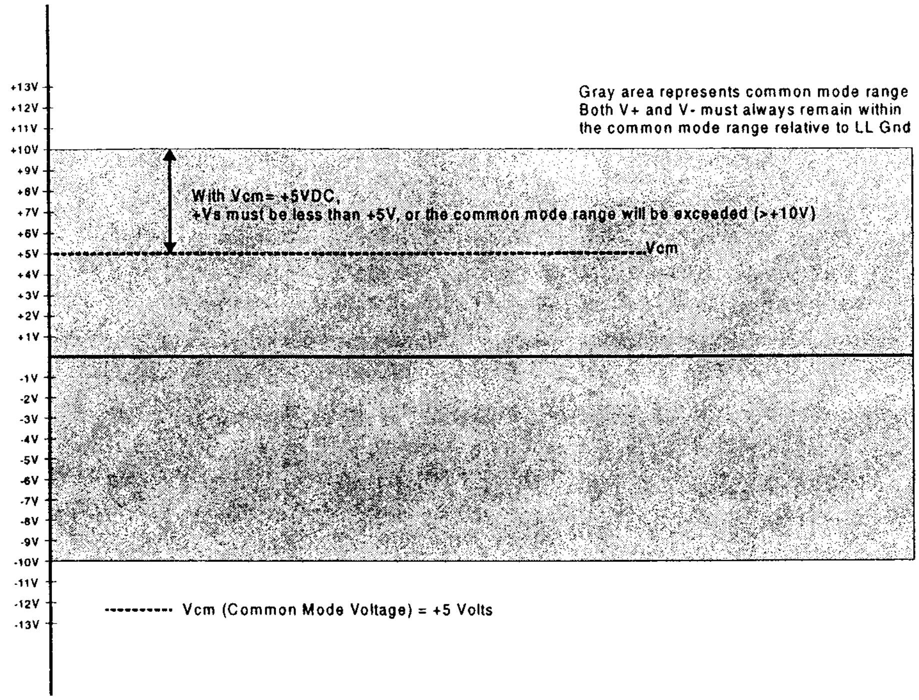


Figure 5-3. Common Mode Theory

5.1.4 System Grounds and Isolation

There are three scenarios possible when connecting your signal source to your CIO-DAS48-PGA board.

1. The CIO-DAS48-PGA and the signal source may have the same (or common) ground. This signal source may be connected directly to the CIO-DAS48-PGA.

2. The CIO-DAS48-PGA and the signal source may have an offset voltage between their grounds (AC and/or DC). This offset it commonly referred to a common mode voltage. Depending on the magnitude of this voltage, it may or may not be possible to connect the CIO-DAS48-PGA directly to your signal source. We will discuss this topic further in a later section.

3. The CIO-DAS48-PGA and the signal source may already have isolated grounds. This signal source may be connected directly to the CIO-DAS48-PGA.

Which system do you have?

Make the following test: Using a battery powered voltmeter[1], measure the voltage between the ground signal at your signal source and at your PC. Measure both the AC and DC Voltages.

If both AC and DC readings are 0.00 volts, you may have a system with common grounds. However, since voltmeters will average out high frequency signals, there is no guarantee. Please refer to the section below titled Common Grounds.

If you measure reasonably stable AC and DC voltages, your system has an offset voltage between the grounds category. This offset is referred to as a Common Mode Voltage. Please be careful to read the following warning and then proceed to the section describing Common Mode systems.

---

[1] *If you do not have access to a voltmeter, skip the experiment and take a look at the following three sections. You may be able to identify your system type from the descriptions provided.*

WARNING

If either the AC or DC voltage is greater than 10 volts, do not connect the CIO-DAS48-PGA to this signal source. You are beyond the boards usable common mode range and will need to either adjust your grounding system or add special Isolation signal conditioning to take useful measurements. A ground offset voltage of more than 30 volts will likely damage the CIO-DAS48-PGA board and possibly your computer. Note that an offset voltage much greater than 30 volts will not only damage your electronics, but it may also be hazardous to your health.

This is such an important point, that we will state it again. If the voltage between the ground of your signal source and your PC is greater than 10 volts, your board will not take useful measurements. If this voltage is greater than 30 volts, it will likely cause damage, and may represent a serious shock hazard! In this case you will need to either reconfigure your system to reduce the ground differentials, or purchase and install special electrical isolation signal conditioning.

If you cannot obtain a reasonably stable DC voltage measurement between the grounds, or the voltage drifts around considerably, the two grounds are most likely isolated. The easiest way to check for isolation is to change your voltmeter to it's ohm scale and measure the resistance between the two grounds. It is recommended that you turn both systems off prior to taking this resistance measurement. If the measured resistance is more than 100 Kohm, it's a fairly safe bet that your system has electrically isolated grounds.

5.1.5 Systems with Common Grounds

In the simplest (but perhaps the least likely) case, your signal source will have the same ground as the CIO-DAS48-PGA. This would typically occur when providing power or excitation to your signal source directly from the CIO-DAS48-PGA. There may be other common ground configurations, but it is important to note that any voltage between the CIO-DAS48-PGA ground and your signal ground is a potential error voltage if you set up your system based on a common ground assumption.

As a safe rule of thumb, if your signal source or sensor is not connected directly to an LLGND pin on your CIO-DAS48-PGA, it's best to assume that you do not have a common ground even if your voltmeter measured 0.0 Volts. Configure your system as if there is ground offset voltage between the source and the CIO-DAS48-PGA.

5.1.6 Systems with Common Mode (ground offset) Voltages

The most frequently encountered grounding scenario involves grounds that are somehow connected, but have AC and/or DC offset voltages between the CIO-DAS48-PGA and signal source grounds. This offset voltage my be AC, DC or both and may be caused by a wide array of phenomena including EMI pickup, resistive voltage drops in ground wiring and connections, etc. Ground offset voltage is a more appropriate term to describe this type of system, but since our goal is to keep things simple, and help you make appropriate connections, we'll stick with our somewhat loose usage of the phrase Common Mode.

5.1.7 Small Common Mode Voltages

If the voltage between the signal source ground and CIO-DAS48-PGA ground is small, the combination of the ground voltage and input signal will not exceed the CIO-DAS48's ±10V common mode range, (i.e. the voltage between grounds, added to the maximum input voltage, stays within ±10V), This input is compatible with the CIO-DAS48-PGA and the system may be connected without additional signal conditioning. Fortunately, most systems will fall in this category and have a small voltage differential between grounds.

5.1.8 Large Common Mode Voltages

If the ground differential is large enough, the CIO-DAS48's ± 10V common mode range will be exceeded (i.e. the voltage between CIO-DAS48-PGA and signal source grounds, added to the maximum input voltage you're trying to measure exceeds ±10V). In this case the CIO-DAS48-PGA cannot be directly connected to the signal source. You will need to change your system grounding configuration or add isolation signal conditioning. (Please look at our ISO-RACK and ISO-5B-series products to add electrical isolation, or give our technical support group a call to discuss other options).

NOTE

Relying on the earth prong of a 120VAC for signal ground connections is not advised.. Different ground plugs may have large and potentially even dangerous voltage differentials. Remember that the ground pins on 120VAC outlets on different sides of the room may only be connected in the basement. This leaves the possibility that the "ground" pins may have a significant voltage differential (especially if the two 120 VAC outlets happen to be on different phases!)

5.1.9 CIO-DAS48-PGA and Signal Source already have Isolated Grounds

Some signal sources will already be electrically isolated from the CIO-DAS48-PGA. The diagram below shows a typical isolated ground system. These signal sources are often battery powered, or are fairly expensive pieces of equipment (since isolation is not an inexpensive proposition), isolated ground systems provide excellent performance, but require some extra effort during connections to assure optimum performance is obtained. Please refer to the following sections for further details

5.2 WIRING CONFIGURATIONS

Combining all the grounding and input type possibilities provides us with the following potential connection configurations. The combinations along with our recommendations on usage are shown in Table 5-1 below.

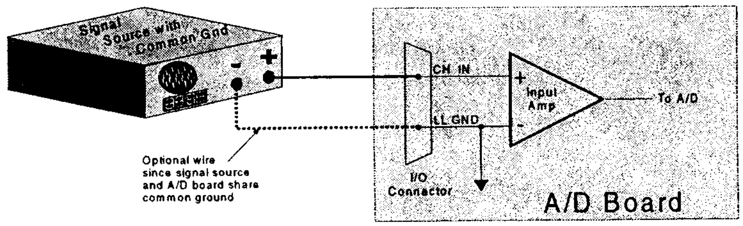
Table 5-1. Wiring Configurations

GROUND CATEGORY	INPUT CONFIGURATION	OUR VIEW
Common Ground	Single-Ended Inputs	Recommended
Common Ground	Differential Inputs	Acceptable
Common Mode Voltage < ±10V	Single-Ended Inputs	Not Recommended
Common Mode Voltage < ±10V	Differential Inputs	Recommended
Common Mode Voltage > ± 10V	Single-Ended Inputs	Unacceptable without adding Isolation
Common Mode Voltage > ±10V	Differential Inputs	Unacceptable without adding Isolation
Already Isolated Grounds	Single-ended Inputs	Acceptable
Already Isolated Grounds	Differential Inputs	Recommended

The following sections show recommended input wiring schemes for each of eight possible input configuration/grounding combinations.

5.2.1 Common Ground / Single-Ended Inputs

Single-ended is the recommended configuration for common ground connections. However, if some of your inputs are common ground and some are not, we recommend you use the differential mode. There is no performance penalty (other than loss of channels) for using a differential input to measure a common ground signal source. However the reverse is not true. The diagram below shows a recommended connection diagram for a common ground / single-ended input system.

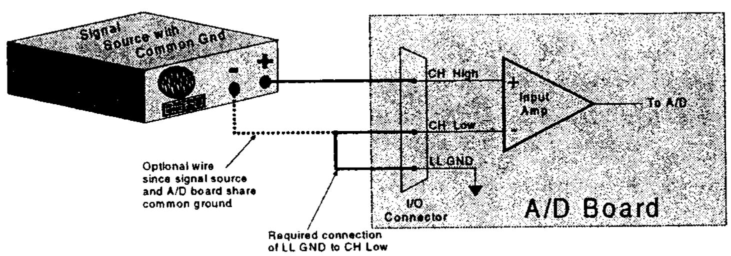


Signal source and A/D board sharing common ground connected to single-ended input.

Figure 5-4. Common Ground / Single-Ended Inputs

5.2.2 Common Ground / Differential Inputs

The use of differential inputs to monitor a signal source with a common ground is a acceptable configuration though it requires more wiring and offers fewer channels than selecting a single-ended configuration. Figure 5-5 below shows the recommended connections in this configuration.

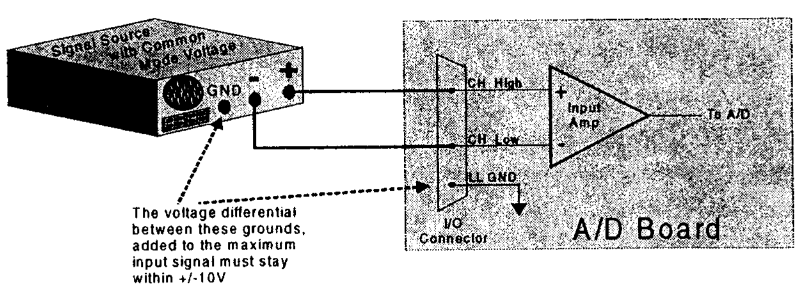


Signal source and A/D board sharing common ground connected to differential input.

Figure 5-5. Common Ground / Differential Inputs

5.2.3 Common Mode Voltage < ±10V/Single-Ended Inputs

This is not a recommended configuration (Figure 5-6). In fact, the phrase common mode has no meaning in a single-ended system and this case would be better described as a system with offset grounds. Try this configuration, no system damage should occur and depending on the overall accuracy you require, you may receive acceptable results.

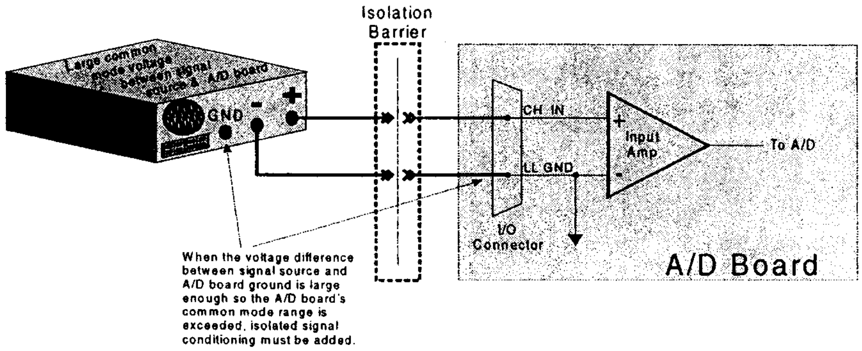


Signal source and A/D board with common mode voltage connected to a differential input.

Figure 5-6. Common Mode Voltage < ±10V/Single-Ended Inputs

5.2.4 Common Mode Voltage < ±10V/Differential Inputs

Systems with varying ground potentials should always be monitored in the differential mode. Care is required to assure that the sum of the input signal and the ground differential (referred to as the common mode voltage) does not exceed the common mode range of the A/D board (±10V on the CIO-DAS48-PGA). Figure 5-7 below shows recommended connections in this configuration.

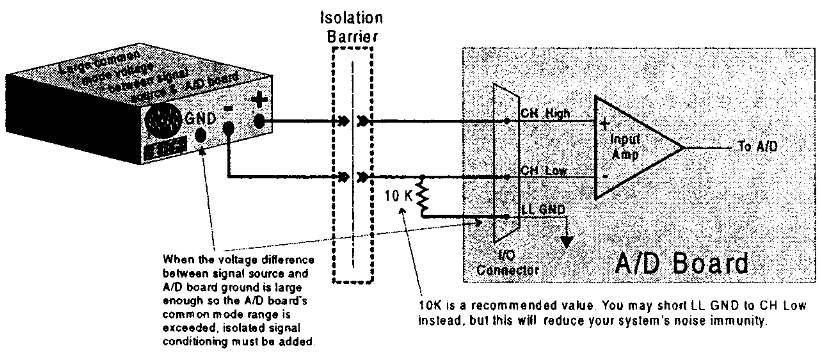


System with a Large Common Mode Voltage,
Connected to a Single-Ended Input

Figure 5-7. Common Mode Voltage < ±10V/Differential Inputs

5.2.5 Common Mode Voltage > ±10V

The CIO-DAS48-PGA will not directly monitor signals with common mode voltages greater than ±10V. You will either need to alter the system ground configuration to reduce the overall common mode voltage, or add isolated signal conditioning between the source and your board (see Figure 5-8).

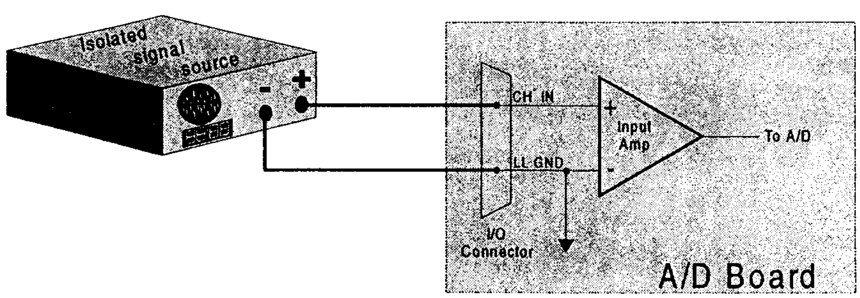


System with a Large Common Mode Voltage,
Connected to a Differential Input

Figure 5-8. Common Mode Voltage > ±10V

5.2.6 Isolated Grounds / Single-Ended Inputs

Single-ended inputs can be used to monitor isolated inputs, though the use of the differential mode will increase you system's noise immunity. Figure 5-9 below shows the recommended connections is this configuration.

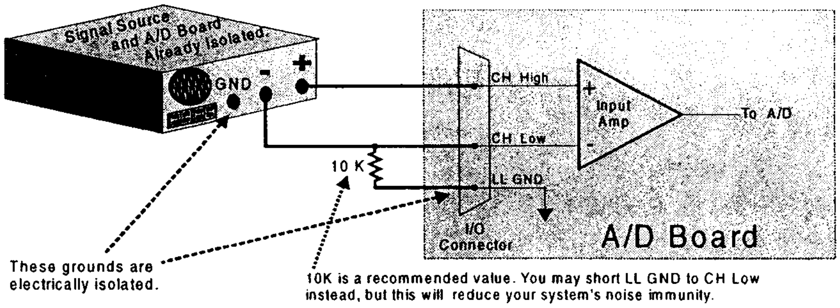


Isolated Signal Source
Connected to a Single-Ended Input

Figure 5-9. Isolated Grounds / Single-Ended Inputs

5.2.7 Isolated Grounds / Differential Inputs

Optimum performance with isolated signal sources is assured with the use of the differential input setting. Figure 5-10 below shows the recommend connections is this configuration..



Already isolated signal source and A/D board connected to a differential input.

Figure 5-10. Isolated Grounds / Differential Inputs

6 CONTROL & DATA REGISTERS

The CIO-DAS48-PGA is controlled and monitored by writing to and reading from four consecutive 8-bit I/O addresses. The first address, or BASE ADDRESS, is determined by setting a bank of Address switches on the board.

The register bit descriptions follow the format :

7	6	5	4	3	2	1	0
A/D8	A/D9	A/D10	A/D11 LSB	CH8	CH4	CH2	CH1

Where the numbers along the top row are the bit positions within the 8-bit byte and the numbers and symbols in the bottom row are the functions of that bit.

To write to or read from a register in decimal or HEX, the following weights apply:

BIT POSITION	DECIMAL VALUE	HEX VALUE
0	1	1
1	2	2
2	4	4
3	8	8
4	16	10
5	32	20
6	64	40
7	128	80

To write control words or data to a register, the individual bits must be set to 0 or 1 then combined to form a byte. The registers and their function are listed in Table 6-1.

Table 6-1. Register Functions

ADDRESS	READ FUNCTION	WRITE FUNCTION
BASE	A/D Bits 8 to 11 (LSB)	Start 8-Bit A/D Conversion
BASE +1	A/D Bits 0 (MSB) to 7	Start 12-Bit A/D Conversion
BASE +2	EOC, MUX Address	MUX Address
BASE +3	Gain Status, SINGLE/DIFF Switch	Programmable Gain Control

6.1 A/D DATA & START CONVERSION REGISTERS

BASE ADDRESS

7	6	5	4	3	2	1	0
A/D8	A/D9	A/D10	A/D11 LSB	0	0	0	0

A read/write register.

READ

On read, it contains the least-significant four digits of converted analog input data.

These four bits of analog input data must be combined with the eight bits of data in BASE + 1, forming a complete 12-bit number. The data is in the format 0 = minus full scale (–FS). 4095 = plus full scale (+FS).

WRITE

Writing any data to the register causes an immediate 8-bit A/D conversion.

BASE ADDRESS + 1

7	6	5	4	3	2	1	0
A/D 0 MSB	A/D1	A/D2	A/D3	A/D4	A/D5	A/D6	A/D7

READ

On read the most significant A/D byte is read.

The A/D Bits code corresponds to the voltage on the input according to the table below.

DECIMAL	HEX	BIPOLAR	UNIPOLAR
4095	FFF	+ Full Scale	+ Full Scale
2048	800	0 Volts	½ Full Scale
0	0	– Full Scale	– Full Scale

WRITE

Writing to this register starts a 12-bit A/D conversion.

A note of caution: Place several NO-OP instructions between consecutive 12-bit A/D conversions to avoid over-running the A/D converter.

6.2 STATUS AND CONTROL REGISTER

BASE ADDRESS +2

7	6	5	4	3	2	1	0
EOC	0	MUX5	MUX4	MUX3	MUX2	MUX1	MUX0

This register address is two registers, one is read-active and one is write-active.

READ = STATUS

EOC = 1 the A/D is busy converting and data should not be read.

EOC = 0 the A/D is not busy and data can be read.

MUX 5 to MUX 0 is the current multiplexer channel. The current channel is a binary-coded number between 0 and 47 for single ended inputs or between 0 and 23 for differential inputs.

WRITE = CONTROL

7	6	5	4	3	2	1	0
0	0	MUX5	MUX4	MUX3	MUX2	MUX1	MUX0

MUX5 to MUX0. Set the current channel address by writing a binary-coded number between 0 and 47 to these six bits.

NOTE: Every write to this register sets the current A/D channel MUX setting to the number in bits 5 to 0.

6.3 PROGRAMMABLE GAIN REGISTER

The addition of a software programmable register which controls the input amplifier allows you to select unipolar/bipolar ranges and gains of 1, 2, 4, or 8 via software command.

The register's layout when written to is :

BASE ADDRESS + 3

BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
X	X	X	X	R3	R2	R1	R0

The register's layout when read from is :

BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
MUXM	0	0	0	0	0	0	0

MUXM = Mux Mode. This bit = 0 when the channel configuration switch is set for 24 differential channels. It is = 1 when the switch is set for 48 single-ended channels. This is a read-back-only bit and has no ability to control the channel configuration.

R3 to R1 = The programmable Gain/Range setting. The gain/range of the board is controlled by writing a control code to the register. The codes are:

These are the ranges available for the CIO-DAS48-PGA. Gains of 0.5, 1, 2, 4, and 8 are often called binary gains.

UNI-POLAR			**CONTROL CODES**					
GAIN	**RANGE I**	**RANGE V**	**DEC**	**HEX**	**R3**	**R2**	**R1**	**R0**
1	4 to 20 mA	0 to 10	1	1	0	0	0	1
2	2 to 10 mA	0 to 5	3	3	0	0	1	1
4	1 to 5 mA	0 to 2.5	5	5	0	1	0	1
8	0.5 to 2.5 mA	0 to 1.25	7	7	0	1	1	1

While the current input ranges are available in unipolar mode, they are not available in bipolar mode

BI-POLAR		**CONTROL CODES**					
GAIN	**RANGE V**	**DEC**	**HEX**	**R3**	**R2**	**R1**	**R0**
0.5	±10	8	8	1	0	0	0
1	±5	0	0	0	0	0	0
2	±2.5	2	2	0	0	1	0
4	±1.25	4	4	0	4	0	0
8	±0.625	6	6	0	1	1	0

To set the input range of the CIO-DAS48-PGA board, select the desired range from the table and write the code in decimal or hexadecimal to base address + 3.

POWER CONSUMPTION	
+5V:	620 mA typical, 800 mA max
ANALOG INPUT SECTION	
A/D converter type	AD574
Resolution	12 bits
Number of channels	48 single-ended or 24 differential (configurable as 24 modified differential via installation of SIP resistor)
Input Ranges	
Type	Voltage input or current input, configurable by jumper and installation of SIP resistors for current configuration (CIO-DAS48-I configured for current mode at the factory)
CIO-DAS48-PGA	±10V, ±5V, ±2.5V, ±1.25V, ±0.625V, 0 to 10V, 0 to 5V, 0 to 2.5V, 0 to 1.25V software selectable
CIO-DAS48-I	4 to 20 mA, 2 to 10 mA, 1 to 5 mA, and 0.5 to 2.5 mA, software-selectable
Polarity	Unipolar/Bipolar, software-selectable
A/D pacing	Software polled
Data transfer	Software polled
A/D conversion time	25 µs
Throughput	20 kHz, PC dependent
Accuracy	±0.01% of reading ±1 LSB
Linearity	±1 LSB
No missing codes guaranteed	12 bits
Gain drift (A/D specs)	±25 ppm/°C
Zero drift (A/D specs)	±10µV/°C
Common Mode Range	±10V
CMRR	72 dB
Input leakage current (@ 25 Deg C)	100 nA
Input impedance	
CIO-DAS48-PGA	10 MegOhms minimum
CIO-DAS48-I	100 Ohms
Absolute maximum input voltage	±35V
ENVIRONMENTAL	
Operating temperature range	0 to 50°C
Storage temperature range	−20 to 70°C
Humidity	0 to 95% non-condensing

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