PCI-1720

4-channel Isolated D/A
Output Card

User's manual

Copyright

Acknowledgments

CE notification

The PCI-1720, developed by ADVANTECH CO., LTD., has passed the CE test for environmental specifications when shielded cables are used for external wiring. We recommend the use of shielded cables. This kind of cable is available from Advantech. Please contact your local supplier for ordering information.

On-line Technical Support

For technical support and service please visit our support website at **http:/support.advantech.com**

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CHAPTER 1

General Information

1.1 Introduction

The PCI-1720 is an isolated digital-to-analog output card for the PCI bus. It provides four 12-bit analog output channels with isolation protection of 2500 V_{DC} between the outputs and the PCI bus. This is ideal for industrial applications where high-voltage protection is required.

Keeping the Output Settings and Values after System Reset

Users can set the four outputs independently to different ranges: 0 to +5 V, 0 to +10 V, ±5 V, ±10 V, 0 to 20 mA (sink) or 4 to 20 mA (sink). When the system is hot reset (the power is not shut off), the PCI-1720 can either retain the last analog output settings and values, or return to its default configuration based on the jumper setting. This practical function eliminates danger caused by misoperation during unexpected system resets.

PCI-bus Plug and Play

The PCI-1720 uses a PCI controller to interface the card to the PCI bus. The controller fully implements the PCI bus specification Rev 2.1. All bus relative configurations, such as base address and interrupt assignment, are automatically controlled by software.

1.2 Features

* Four 12-bit D/A output channels

* Multiple output ranges

* 2500 V_{DC} isolation between the outputs and the PCI bus

* Keeps the output settings and values after system reset

* One 37-pin D-type connector for easy wiring

1.3 Applications

* Process control
* Programmable voltage source
* Programmable current sink
* Servo control

1.4 Specifications

D/A Output

* Channels: 4 isolated D/A channels
* Resolution: 12 bits
* Output ranges: Unipolar: 0 ~ +5 V, 0 ~ +10 V
  Bipolar: ±5 V, ±10 V
  Current loop (sink): 0 ~ 20 mA, 4 ~ 20 mA
* Throughput: 500 kHz
* Accuracy: ±0.024%
* Isolation voltage: 2500 V_{DC} between the outputs and the PCI bus
* Temperature drift: Typical:10 PPM/°C (0 ~ 60°C)
  Maximun:20 PPM/°C (0 ~ 60°C)
* Output current: ±5 mA max.
* Current loop excitation voltage: 50 V max.
* On-board 12 V_{DC} excitation voltage (80 mA max.)

Power consumption

* +5 V @ 350 mA (typical), 500mA (Max.)

* +12V @ 200 mA (typical), 350mA (Max.)

Physical

* Connector: 37-pin D-type connector

* Dimensions: 175 x 100 mm (6.9" x 3.9")

Environment

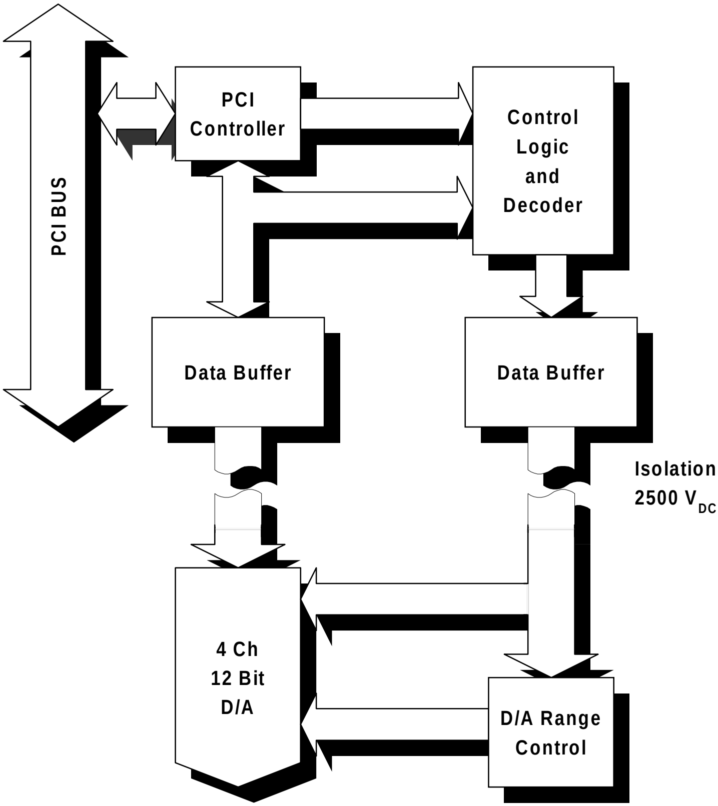
* Operating temperature: 0 ~ +60°C (32 ~ 140°F)

* Storage temperature: -20 ~ +70°C (-4 ~ 158°F)

* Operating humidity: 5 ~ 95 % RH non-condensing (refer to IEC 68-2-3)

* MTBF: over 71,280 hrs @ 25°C, grounded, fix environment

1.5 Block Diagram



CHAPTER 2

Installation

2.1 Initial Inspection

Before installing the PCI-1720, check the card for visible damage. We have carefully inspected the card both mechanically and electrically before shipment. It should be free of marks and in perfect order upon receipt.

As you unpack the PCI-1720, check it for signs of shipping damage (damaged box, scratches, dents, etc.). If it is damaged or 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 materials for inspection by the carrier. We will then make arrangements to repair or replace the unit.

2.2 Unpacking

The PCI-1720 contains components that are sensitive and vulnerable to static electricity. Discharge any static electricity on your body to ground by touching the back of the system unit (grounded metal) before you touch the board.

Remove the PCI-1720 card from its protective packaging by grasping the card's rear panel. Handle the card only by its edges to avoid static discharge which could damage its integrated circuits. Keep the antistatic package. Whenever you remove the card from the PC, protect the card by storing it in this package.

You should also avoid contact with materials that hold static electricity such as plastic, vinyl and styrofoam.

Check the product contents inside the packing. There should be one card, one CD-ROM, and this manual. Make sure nothing is missing.

2.3 Installation Instructions

The PCI-1720 can be installed in any PCI slot in the computer. However, refer to the computer user's manual to avoid any mistakes and danger before you follow the installation procedure below:

1. Turn off your computer and any accessories connected to the computer.

Warning! *TURN OFF your computer power supply whenever you install or remove any card, or connect and disconnect cables.*

2. Disconnect the power cord and any other cables from the back of the computer.
3. Remove the cover of the computer.
4. Select an empty 5 V PCI slot. Remove the screw that secures the expansion slot cover to the system unit. Save the screw to secure the interface card retaining bracket.
5. Carefully grasp the upper edge of the PCI-1720. Align the hole in the retaining bracket with the hole on the expansion slot and align the gold striped edge connector with the expansion slot socket. Press the card into the socket gently but firmly. Make sure the card fits the slot tightly.
6. Secure the PCI-1720 by screwing the mounting bracket to the back panel of the computer.
7. Attach any accessories (37-pin D type cable, wiring terminal, etc.) to the card.
8. Replace the cover of your computer. Connect the cables you removed in step 2.
9. Turn the computer power on.

CHAPTER 3

Jumpers and I/O Connectors

The PCI-1720 is a “plug-and-play” card, i.e. the system BIOS assigns the system resources such as the base address and the interrupt number automatically. There are only 2 functions with 5 jumpers to configure to your applications requirements. The following sections offer the necessary information for setting the PCI-1720’s jumpers. You may need to refer to the figure below for help in identifying jumper locations.

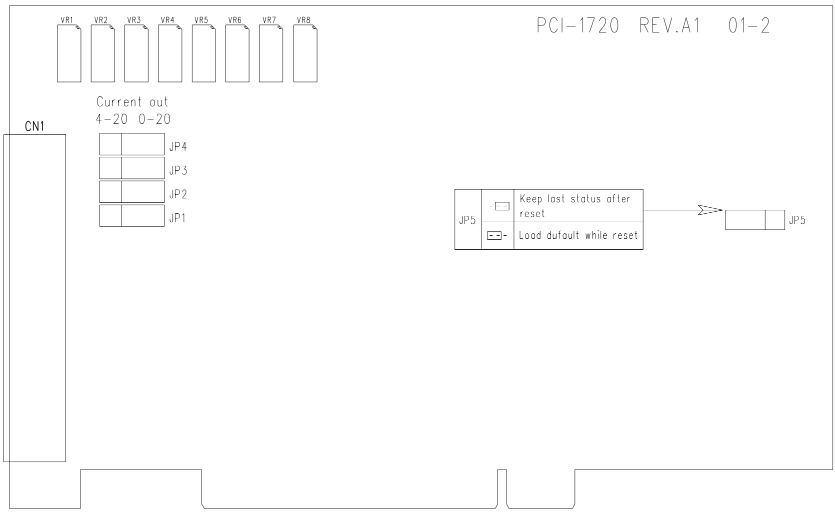


Figure 3-1: PCI-1720 jumper locations

3.1 Jumper Settings

3.1.1 Using jumpers to set current sink ranges

Jumpers JP1 to JP4 are used to select each channel’s current sink range, either 4 ~ 20 mA or 0 ~ 20 mA. Jumpers JP1 to JP4 correspond with D/A channel 0 to channel 3 respectively. In order to use the current sink range, you have to set the PCI-1720 output voltage range to 0 ~ 5 V. The figure below shows the correct jumper settings for the PCI-1720’s current sink range.

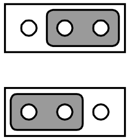


Figure 3-2: Jumper settings for PCI-1720's current sink range

Note!: *In order to maintain accurate outputs for your field applications, it is important that you calibrate the PCI-1720's variable resistors (VRs) from time to time. Calibration instructions are provided in* ***Appendix A****.*

3.1.2 Jumper JP5 Setting for the Reset State

Jumper JP5 gives the PCI-1720 a new and valuable capability. With JP5 enabled, the PCI-1720 "memorizes" all D/A output settings and output values, and, in the event of a "hot" reset, i.e., the power is not shut off, the settings and output values present at each channel just prior to reset are still maintained. This feature is very useful for user's field applications. For example, it may allow a computer be "hot" reset without requiring the whole control system to shutdown. (Since output values are left unchanged.)

Complete loss of power to the card clears all settings and output values even if JP5 is enabled; i.e. if the power to the card is disconnected, the card's initial power-on state will be the default state. The default state is the output range for all channels is 0 ~ 5 V and all the output values are 0 V.

When jumper JP5 is disabled, power-off or “hot” reset results in outputs returning to their default state.

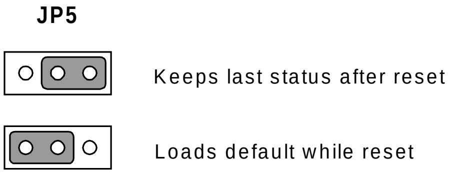


Figure 3-3: Jumper JP5 setting for the reset state

3.2 Connector and pin assignments

The PCI-1720 uses one DB-37 female connector, which is located on the card at CN1 (see Figure 3-1) and connects D/A signals to external devices. The following figure shows the pin assignments of the connector.

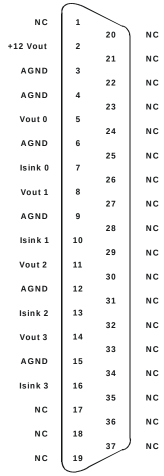


Figure 3-4: PCI-1720 pin assignments

3.2.1 Signal Descriptions of I/O Connector

Signal Name	Reference	Direction	Description
V_{OUT}<0...3>	AGND	Output	**Analog Voltage Output Channels 0 through 3.** These pins supply the voltage outputs for the analog outputs.
I_{SINK}<0...3>	AGND	Input	**Current Sink Channels 0 through 3.** These pins provide the current loop sink input.
+12 V_{OUT}	AGND	Output	**+12 V_{DC} Source.** This pin is a +12 V_{DC} power supply (80mA max.) for current loop exciting voltage.
AGND	-	-	**Analog Ground.** The analog output voltage and +12 V_{DC} source are referenced to these pins.
NC	-	-	**No Connection to pin**

CHAPTER 4

Register Structure and Format

4.1 Overview

The PCI-1720 is delivered with an easy-to-use 32-bit DLL driver for user programming under the Windows 95/98/NT operating system. We advise users to program the PCI-1720 using the 32-bit DLL driver provided by Advantech to avoid the complexity of low-level programming by register.

The most important consideration in programming the PCI-1720 card at a register level is to understand the function of the card's registers. The information in the following sections is provided only for users who would like to do their own low-level programming.

4.2 I/O Port Address Map

The PCI-1720 requires 10 addresses in the PC's I/O space. The address of each register is specified as an offset from the card's base address. For example, BASE + 0 is the card's base address and BASE + 7 is the base address plus seven bytes.

Table 4-1 shows the function of each register and its address relative to the card's base address.

Table 4-1: PCI-1720 register format and function description

Base Address + decimal	Data								Function description	R/W
	7	6	5	4	3	2	1	0		
+0	D7	D6	D5	D4	D3	D2	D1	D0	D/A output channel 0	W
+1					D11	D10	D9	D8		
+2	D7	D6	D5	D4	D3	D2	D1	D0	D/A output channel 1	W
+3					D11	D10	D9	D8		
+4	D7	D6	D5	D4	D3	D2	D1	D0	D/A output channel 2	W
+5					D11	D10	D9	D8		
+6	D7	D6	D5	D4	D3	D2	D1	D0	D/A output channel 3	W
+7					D11	D10	D9	D8		
+8	DA3_ U/B	DA3_ 5/10	DA2_ U/B	DA2_ 5/10	DA1_ U/B	DA1_ 5/10	DA0_ U/B	DA0_ 5/10	D/A voltage range and polarity	R/W
+9									Synchronized output prompt register	W
+15								SC0	Synchronized output control bit	R/W

* "R" means readable and "W" means writable

4.2.1 D/A Output Channel 0 to 3

The write-only registers of BASE + 2(n) and BASE + (2(n) + 1) accept data for D/A output channel n (n = 0, 1, 2, 3).

Table 4-2: Register for D/A data

Base Address + decimal	Data								Function description	R/W
	7	6	5	4	3	2	1	0		
+2(n)	D7	D6	D5	D4	D3	D2	D1	D0	D/A output channel n	W
+(2(n)+1)					D11	D10	D9	D8		

D11 ~ D0 Digital to Analog data

D0 is the LSB (Least Significant Bit) and D11 is the MSB (Most Significant Bit) of the D/A data.

Note!: *To write D/A data, write the low byte first, then write the high byte.*

4.2.2 D/A Voltage Range and Polarity

The read-writable register of BASE + 8 allows users to set the D/A voltage range and polarity.

Table 4-3: Register for D/A voltage range and polarity

Base Address + decimal	Data								Function description	R/W
	7	6	5	4	3	2	1	0		
+8	DA3_ U/B	DA3_ 5/10	DA2_ U/B	DA2_ 5/10	DA1_ U/B	DA1_ 5/10	DA0_ U/B	DA0_ 5/10	D/A voltage range and polarity	R/W

Table 4-4: Output range of D/A channel n

DAn_U/B	DAn_5/10	D/A channel n output range
0	0	0 to +5 V
0	1	0 to +10 V
1	0	-5 to +5 V
1	1	-10 to +10

* n = 0,1,2,3.

4.2.3 Synchronized Output Prompt Register

During normal operation, the PCI-1720 will accept digital values one at a time from the host PC, convert these values to analog values, and immediately output these analog values from the channels directed by the host PC.

However, the PCI-1720 has the capability to store each analog value in its proper channel buffer as it is generated, then simultaneously output one analog value from each of its four channels on receipt of a synchronizing character. Any character can act as a synchronizing character, but it must be written to the BASE + 9 register to prompt synchronized output.

4.2.4 Synchronized Output Control Bit

Table 4-5: Synchronized output control bit

Base Address + decimal	Data								Function description	R/W
	7	6	5	4	3	2	1	0		
+15								SC0	Synchronized output control bit	R/W

The register BASE + 15 stores the synchronized output control bit. When the SC0 bit is set to 1, the synchronized data output function is enabled and analog values will not be output until a character is written to the BASE + 9 register. When the SC0 bit is set to 0, the synchronized data output function is disabled. Analog data output occurs as soon as an output channel receives an element of output data.

4.3 Unipolar and Bipolar Binary Code Tables

Table 4-6: Unipolar binary code table

Digital Input Code			Examples of Analog Output Voltage
MSB		LSB	
1111	1111	1111	Vref (4095/4096)
1000	0000	0001	Vref (2049/4096)
1000	0000	0000	Vref (2048/4096)
0111	1111	1111	Vref (2047/4096)
0000	0000	0001	Vref (1/4096)
0000	0000	0000	Vref (0/4096)

Notes: *1. Vref is the reference source voltage that you selected. Vref is +5 V or +10 V.*

2. Nominal full scale is given by FS = Vref ((4095/4096).

3. Nominal LSB magnitude is given by LSB = Vref ((1/4096).

Table 4-7: Bipolar binary code table

Digital Input Code			Examples of Analog Output Voltage
MSB		LSB	
1111	1111	1111	Vref ((2047/2048)
1000	0000	0001	Vref ((1/2048)
1000	0000	0000	0
0111	1111	1111	-Vref ((1/2048)
0000	0000	0001	-Vref ((2047/2048)
0000	0000	0000	-Vref ((2048/2048)

Notes: *1. Vref is the reference source voltage that you selected. Vref is +5 V or +10 V.*

2. Nominal full scale is given by FS = Vref ((2047/2048).

3. Nominal LSB magnitude is given by LSB = Vref ((1/2048).

CHAPTER 5

Signal Connections

5.1 Overview

Making correct signal corrections is important for accurate data transmissions. Since most data acquisition applications involve some form of voltage measurement, making a sound signal connection will also protect your equipment against possible damage. This chapter shows you how to make proper signal connections to use PCI-1720.

5.2 D/A Voltage Output Connections

PCI-1720 supports four channels of D/A voltage output. Only one output signal wire is used with each channel. The voltage output is referenced to a common ground (AGND).

There are three types of voltage output connections:

1. Floating load.
2. Grounded load.
3. Differential load with ground.

They are shown in the following illustrations.

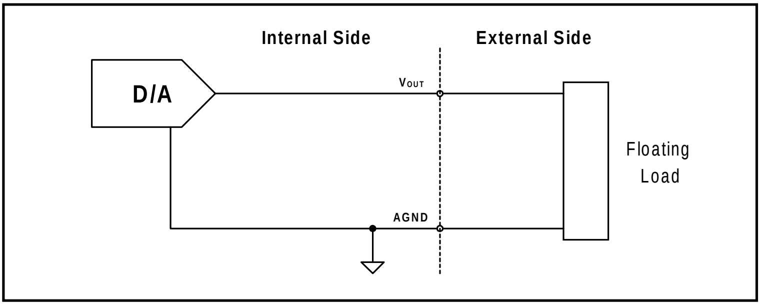


Figure 5-1: Floating-load connection for D/A voltage output

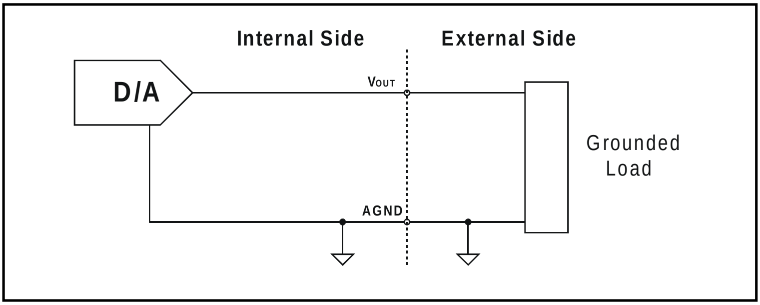


Figure 5-2: Grounded-load connection for D/A voltage output

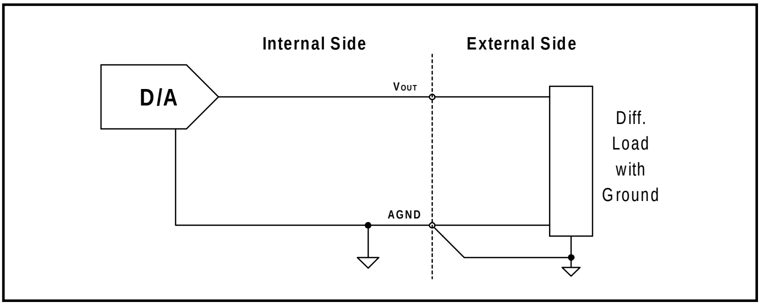


Figure 5-3: Differential-load connection for D/A voltage output

5.3 Current Sink Connections

The PCI-1720's current loop output uses a 0 to +5 V (unipolar) voltage output as each channel’s driving source. Current drive circuits consist of a power field-effect transistor (FET). The current output’s voltage bias must be less then 50 V for accurate results. The card also provides an internal +12 V power source for current loop excitation.

You can use three types of current sink connections:

1. Grounded load with a floating power supply.

2. Floating load with a grounded power supply.

3. Floating load with an internal +12 V power supply.

These are shown in the following illustrations.

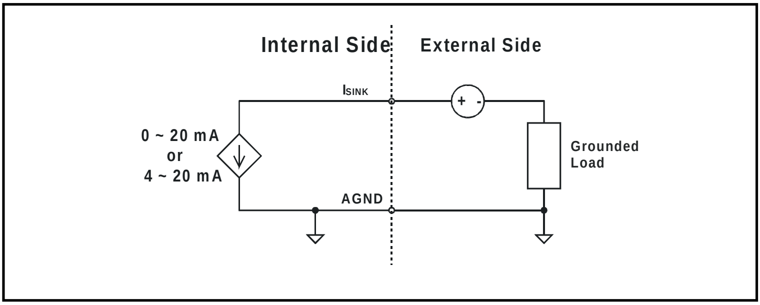


Figure 5-4: Grounded-load connection with a floating power supply

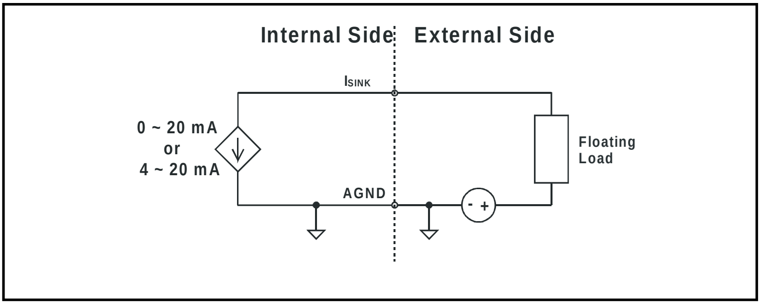


Figure 5-5: Floating-load connection with a grounded power supply

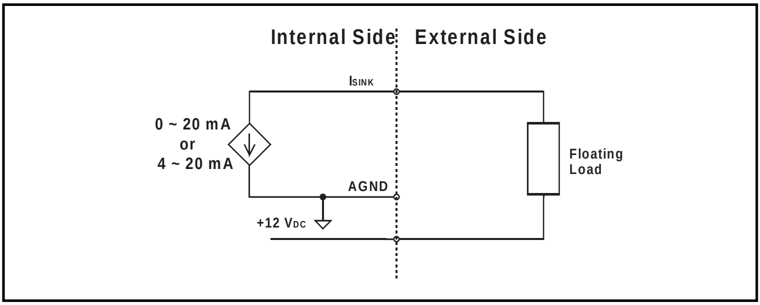


Figure 5-6: Floating-load connection with an internal +12 V_{DC} power supply

5.4 Current Sink Load and Power Supply

You have to select the current sink load and power supply carefully. The current sink circuitry of the PCI-1720 is as shown below.

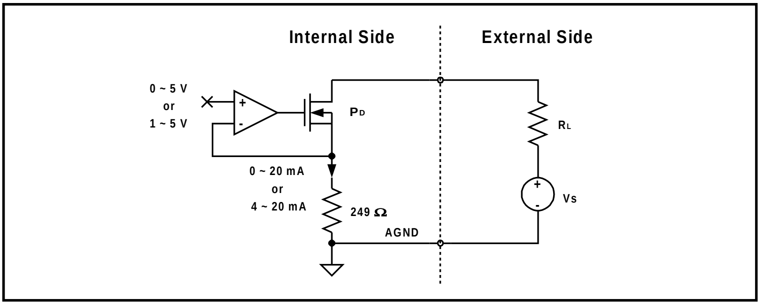


Figure 5-7: PCI-1720 current sink circuitry

where

VS: Power supply voltage of current sink.

RL: Load of current sink.

PD: Power dissipation of FET.

When you determine VS and RL, three conditions must be satisfied.

$$\begin{cases} VS > (RL + 249)\,(0.02) \\ VS \leq 50 \\ PD = (VS - (RL + 249) \times 0.02) \times 0.02 < 0.2 \end{cases}$$

Example 1 If you use the internal power supply VS = +12 V, RL must be less than 351 Ω (12 / 0.02 - 249 > RL). Select RL = 200 Ω, PD = 0.0604 < 0.2 OK!

Example 2 If you use the external power supply VS = +40 V, RL must be less than 1.75 kΩ (40 / 0.02 - 249 > RL).
Select RL = 200 Ω, PD = 0.62 > 0.2 fail!

Reselect RL = 1 kΩ, PD = 0.3 > 0.2 fail!

Reselect RL = 1.5 kΩ, PD = 0.1 < 0.2 OK!

APPENDIX A

Calibration

A.1 Overview

The PCI-1720 card uses eight variable resistors (VRs), two for each channel, which allow you to calibrate each of the card's four output channels. The following information outlines the function of each VR. Refer to the illustration shown below for the locations of the PCI-1720's VRs.

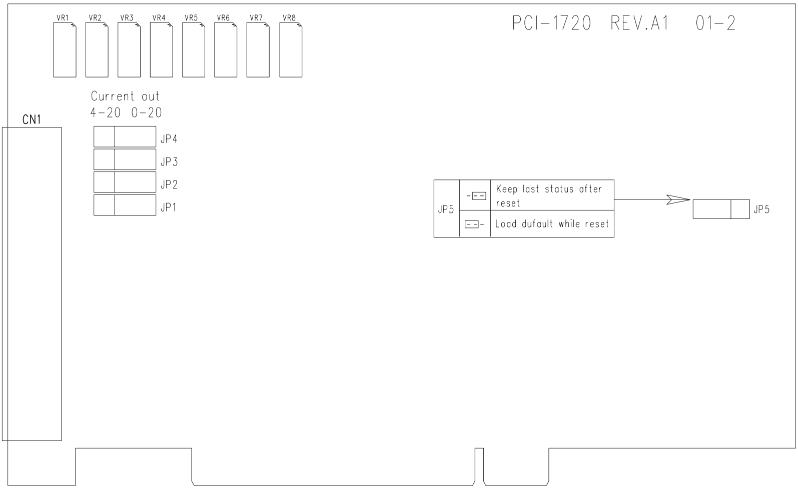


Figure A-1: PCI-1720 VR assignment

VR1	Channel 0's full scale (gain) adjustment.
VR2	Channel 1's full scale (gain) adjustment.
VR3	Channel 2's full scale (gain) adjustment.
VR4	Channel 3's full scale (gain) adjustment.
VR5	Channel 0's offset adjustment.
VR6	Channel 1's offset adjustment.
VR7	Channel 2's offset adjustment.
VR8	Channel 3's offset adjustment.

You should use a precision voltmeter/ammeter to obtain accurate readings when calibrating the PCI-1720. Standard procedures for performing a calibration are given below.

A.2 Unipolar Output Calibration

1. Select an appropriate output range for the channel to be calibrated.
2. Set all digital input codes to 0. Then adjust VRn (n = 5, 6, 7, 8 depending on what channel is to be calibrated, see prior page) until your voltmeter's reading is 0.000 volts.
3. Set all digital input codes to 1 (see Unipolar Binary Code Table in Section 4.3). Now, adjust VRn (n = 1, 2, 3, 4 depending on what channel is to be calibrated, see prior page) until your voltmeter shows a reading equal to the output voltage shown in the Unipolar Binary Code Table in Section 4.3.
4. Repeat steps 2 and 3 until both of them are satisfied.

A.3 Bipolar Output Calibration

1. Select an appropriate output range for the channel to be calibrated.
2. Set all digital input codes to 100000000000. Adjust VRn (n = 5, 6, 7, 8 depending on what channel is to be calibrated, see prior page) until your voltmeter's reading is 0.000 volts.
3. Set all digital input codes to 1 (see Bipolar Binary Code Table in Section 4.3). Now, adjust VRn (n = 1, 2, 3, 4 depending on what channel is to be calibrated, see prior page) until your voltmeter shows a reading equal to the output voltage shown in the Bipolar Binary Code Table in Section 4.3.
4. Repeat steps 2 and 3 until both of them are satisfied.

A.4 Current Sink Calibration

1. Select the 0 ~ +5 V (unipolar) output range for the channel to be calibrated.
2. Set all digital input codes to 0. Then adjust VRn (n = 5, 6, 7, 8 depending on what channel is to be calibrated, see prior page) until your ammeter's reading is 0.00 mA or 4.00 mA (Depending on jumper setting JP1 to JP4, see Section 3.1.1).
3. Set all digital input codes to 1. Now, adjust VRn (n = 1, 2, 3, 4 depending on what channel is to be calibrated, see prior page) until your ammeter shows a reading equal to 20.00 mA.
4. Repeat steps 2 and 3 until both of them are satisfied.