

User Manual

PCI-1720U

12-bit, 4-ch Isolated Analog
Output Universal PCI Card

ADVANTECH

Enabling an Intelligent Planet

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5. Write the RMA number visibly on the outside of the package and ship it prepaid to your dealer.

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Declaration of Conformity

CE

This product 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.

CE

This product has passed the CE test for environmental specifications. Test conditions for passing included the equipment being operated within an industrial enclosure. In order to protect the product from being damaged by ESD (Electrostatic Discharge) and EMI leakage, we strongly recommend the use of CE-compliant industrial enclosure products.

FCC Class A

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Class B

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FM

This equipment has passed the FM certification. According to the National Fire Protection Association, work sites are classified into different classes, divisions and groups, based on hazard considerations. This equipment is compliant with the specifications of Class I, Division 2, Groups A, B, C and D indoor hazards.

Technical Support and Assistance

1. Visit the Advantech web site at www.advantech.com/support where you can find the latest information about the product.
2. Contact your distributor, sales representative, or Advantech's customer service center for technical support if you need additional assistance. Please have the following information ready before you call:
 - Product name and serial number
 - Description of your peripheral attachments
 - Description of your software (operating system, version, application software, etc.)
 - A complete description of the problem
 - The exact wording of any error messages

Warnings, Cautions and Notes

Warning! *Warnings indicate conditions, which if not observed, can cause personal injury!*



Caution! *Cautions are included to help you avoid damaging hardware or losing data. e.g.*



There is a danger of a new battery exploding if it is incorrectly installed. Do not attempt to recharge, force open, or heat the battery. Replace the battery only with the same or equivalent type recommended by the manufacturer. Discard used batteries according to the manufacturer's instructions.

Note! *Notes provide optional additional information.*



Document Feedback

To assist us in making improvements to this manual, we would welcome comments and constructive criticism. Please send all such - in writing to: support@advantech.com

Packing List

Before setting up the system, check that the items listed below are included and in good condition. If any item does not accord with the table, please contact your dealer immediately.

Safety Instructions

1. Read these safety instructions carefully.
2. Keep this User Manual for later reference.
3. Disconnect this equipment from any AC outlet before cleaning. Use a damp cloth. Do not use liquid or spray detergents for cleaning.
4. For plug-in equipment, the power outlet socket must be located near the equipment and must be easily accessible.
5. Keep this equipment away from humidity.
6. Put this equipment on a reliable surface during installation. Dropping it or letting it fall may cause damage.
7. The openings on the enclosure are for air convection. Protect the equipment from overheating. **DO NOT COVER THE OPENINGS.**
8. Make sure the voltage of the power source is correct before connecting the equipment to the power outlet.
9. Position the power cord so that people cannot step on it. Do not place anything over the power cord.
10. All cautions and warnings on the equipment should be noted.
11. If the equipment is not used for a long time, disconnect it from the power source to avoid damage by transient overvoltage.
12. Never pour any liquid into an opening. This may cause fire or electrical shock.
13. Never open the equipment. For safety reasons, the equipment should be opened only by qualified service personnel.
14. If one of the following situations arises, get the equipment checked by service personnel:
 15. The power cord or plug is damaged.
 16. Liquid has penetrated into the equipment.
 17. The equipment has been exposed to moisture.
 18. The equipment does not work well, or you cannot get it to work according to the user's manual.
 19. The equipment has been dropped and damaged.
 20. The equipment has obvious signs of breakage.
21. **DO NOT LEAVE THIS EQUIPMENT IN AN ENVIRONMENT WHERE THE STORAGE TEMPERATURE MAY GO BELOW -20° C (-4° F) OR ABOVE 60° C (140° F). THIS COULD DAMAGE THE EQUIPMENT. THE EQUIPMENT SHOULD BE IN A CONTROLLED ENVIRONMENT.**
22. **CAUTION: DANGER OF EXPLOSION IF BATTERY IS INCORRECTLY REPLACED. REPLACE ONLY WITH THE SAME OR EQUIVALENT TYPE RECOMMENDED BY THE MANUFACTURER, DISCARD USED BATTERIES ACCORDING TO THE MANUFACTURER'S INSTRUCTIONS.**
23. The sound pressure level at the operator's position according to IEC 704-1:1982 is no more than 70 dB (A).

DISCLAIMER: This set of instructions is given according to IEC 704-1. Advantech disclaims all responsibility for the accuracy of any statements contained herein.

Safety Precaution - Static Electricity

Follow these simple precautions to protect yourself from harm and the products from damage.

- To avoid electrical shock, always disconnect the power from your PC chassis before you work on it. Don't touch any components on the CPU card or other cards while the PC is on.
- Disconnect power before making any configuration changes. The sudden rush of power as you connect a jumper or install a card may damage sensitive electronic components.

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Chapter 1

General Information

1.1 Introduction

PCI-1720U is an isolated digital-to-analog output card for the Universal PCI bus. It provides four 12-bit analog output channels with isolation protection of 2,500 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

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

PCI-bus Plug & Play

The PCI-1720U 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 VDC 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
- BoardID switch
- Universal PCI Bus

1.3 Applications

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

Chapter 2

Installation

2.1 Initial Inspection

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

As you unpack the PCI-1720U, check 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

PCI-1720U 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-1720U 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-1720U 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 PCI slot. Remove the screw that secures the expansion slot cover to the system unit. Save the screw to secure the interface card to the retaining bracket.
5. Carefully grasp the upper edge of the PCI-1720U. 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-1720U 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 on.

Chapter 3

Jumpers and I/O
Connectors

3.1 Introduction

The PCI-1720U is a Plug & Play compatible 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-1720U's jumpers. You may need to refer to the figure below for help in identifying jumper locations.

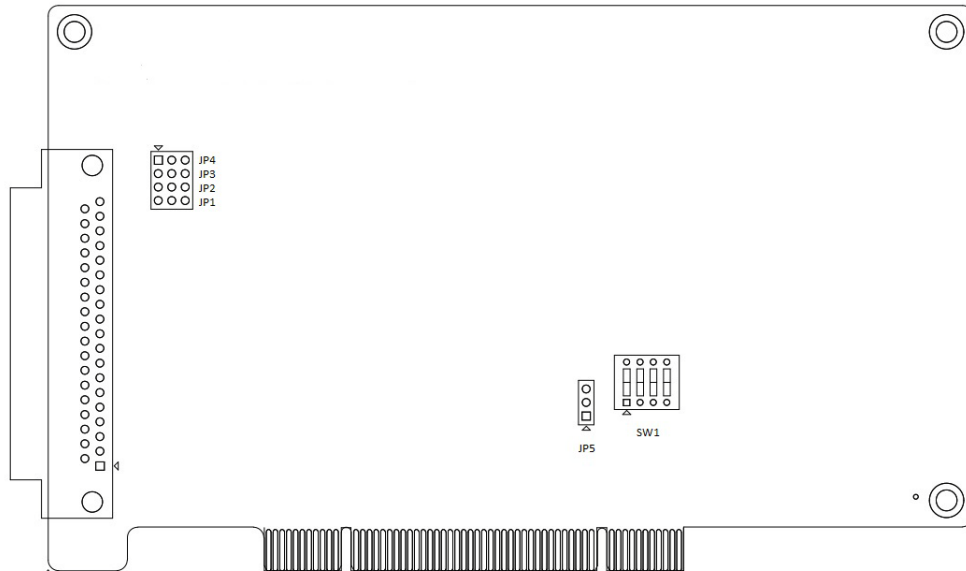


Figure 3.1 PCI-1720U Jumper Locations

3.2 Jumper Settings

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-1720U output voltage range to 0 ~ 5 V. The figure below shows the correct jumper settings for the PCI-1720U’s current sink range.

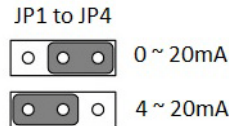


Figure 3.2 Jumper Settings for PCI-1720U’s Current Sink Range

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

3.2.1 Jumper JP5 Setting for the Reset State

Jumper JP5 gives the PCI-1720U a new and valuable capability. With JP5 enabled, the PCI-1720U “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 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 0~5V and all the output values are 0V.

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

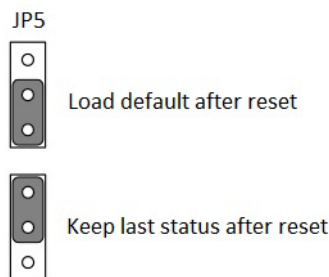


Figure 3.3 Jumper JP5 Setting for the Reset State

3.3 Connector and Pin Assignments

The PCI-1720U uses one DB-37 female connector, which connects D/A signals to external devices. The following figure shows the pin assignments of the connector.



Figure 3.4 PCI-1720U Pin Assignments

3.3.1 Signal Descriptions of I/O Connector

Table 3.1: Signal Description of I/O Connector

Signal	Reference	Direction	Description
VOUT <0...3>	AGND	Output	Analog Voltage Output Channels 0 through 3. These pins supply the voltage outputs for the analog outputs.
ISINK<0...3>	AGND	Input	Current Sink Channels 0 through 3. These pins provide the current loop sink input
+12V OUT	AGND	Output	+12 VDC Source. This pin is a power supply for current loop exciting voltage
AGND	-	-	Analog Ground. The analog output voltage and +12VDC source are referenced to these pins.
NC	-	-	No Connection to pin

3.4 Setting the BoardID Switch (SW1)

BoardID settings are used to get the board's unique identifier. The PCI-1720U has a built-in DIP switch (SW1), which is used to define each card's unique identifier. When there are multiple identical cards in the same chassis, the BoardID switch helps differentiating the boards by identifying each card's device number with the switch setting. PCI-1720U's unique identifier has been set to 0 with the BoardID switch at the factory. If you need to adjust it to other numbers, set SW1 by referring to DIP switch setting.

Table 3.2: Board ID Setting (SW1)

BoardID(dec)	Switch Position			
	1 (ID3)	2(ID2)	3(ID1)	4(ID0)
* = default	1 (ID3)	2(ID2)	3(ID1)	4(ID0)
0*	ON	ON	ON	ON
1	ON	ON	ON	OFF
2	ON	ON	OFF	ON
3	ON	ON	OFF	OFF
4	ON	OFF	ON	ON
5	ON	OFF	ON	OFF
6	ON	OFF	OFF	ON
7	ON	OFF	OFF	OFF
8	OFF	ON	ON	ON
9	OFF	ON	ON	OFF
10	OFF	ON	OFF	ON
11	OFF	ON	OFF	OFF
12	OFF	OFF	ON	ON
13	OFF	OFF	ON	OFF
14	OFF	OFF	OFF	ON
15	OFF	OFF	OFF	OFF

Note: On: 0, Off: 1

Chapter 4

Register Structure and
Format

4.1 Overview

We advise users to program the PCI-1720U using DAQNav Driver provided by Advantech to avoid the complexity of low-level programming by register.

The most important consideration in programming the PCI-1720U card at 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

PCI-1720U requires 12 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: Register Functions

Base Addr. + Hex	7	6	5	4	3	2	1	0
0H	R	N/A						
	W	D/A output channel 0						
		D7	D6	D5	D4	D3	D2	D1 D0
1H	R	N/A						
	W	D/A output channel 0						
					D11	D10	D9	D8
2H	R	N/A						
	W	D/A output channel 1						
		D7	D6	D5	D4	D3	D2	D1 D0
3H	R	N/A						
	W	D/A output channel 1						
					D11	D10	D9	D8
4H	R	N/A						
	W	D/A output channel 2						
		D7	D6	D5	D4	D3	D2	D1 D0
5H	R	N/A						
	W	D/A output channel 2						
					D11	D10	D9	D8
6H	R	N/A						
	W	D/A output channel 3						
		D7	D6	D5	D4	D3	D2	D1 D0

Table 4.1: Register Functions

7H	R	N/A			
	W	D/A output channel 3			
		D11	D10	D9	D8

4.2.1 D/A Output Channel 0 to 3

The write-only registers of $\text{BASE} + 2(n)$ and $\text{BASE} + (2(n) + 1)$ 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 $\text{BASE} + 8$ 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

D An_U/B	D An_5/10	D/A channel n output range
0	0	0 ~ 5V
0	1	0 ~10V
1	0	-5 ~ 5V
1	1	-10 ~10V

* $n = 0, 1, 2, 3$

4.2.3 Synchronized Output Prompt Register

During normal operation, the PCI-1720U 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-1720U 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: Register for D/A Voltage Range and Polarity

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	$V_{ref} (4095 / 4096)$
1000	0000	0001	$V_{ref} (2049 / 4096)$
1000	0000	0000	$V_{ref} (2048 / 4096)$
0111	1111	1111	$V_{ref} (2048 / 4096)$
0000	0000	0001	$V_{ref} (1 / 4096)$
0000	0000	0000	$V_{ref} (0 / 4096)$

- Note!**
1. V_{ref} is the reference source voltage that you selected. V_{ref} is +5 V or +10 V.
 2. Nominal full scale is given by $FS = V_{ref} (4095/4096)$.
 3. Nominal LSB magnitude is given by $LSB = V_{ref} ((1/4096)$.



Table 4.7: Bipolar Binary Code Table

Digital	Input	Code	Examples of Analog Output Voltage
MSB		LSB	
1111	1111	1111	$V_{ref} (2047 / 4096)$
1000	0000	0001	$V_{ref} (1 / 2048)$
1000	0000	0000	0
0111	1111	1111	$-V_{ref} (1 / 2048)$
0000	0000	0001	$-V_{ref} (2047 / 2048)$
0000	0000	0000	$-V_{ref} (2048 / 2048)$

- Note!**
1. V_{ref} is the reference source voltage that you selected. V_{ref} is +5 V or +10 V.
 2. Nominal full scale is given by $FS = V_{ref} (2047/2048)$.
 3. Nominal LSB magnitude is given by $LSB = V_{ref} (1/2048)$.



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-1720U.

5.2 D/A Voltage Output Connections

PCI-1720U 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.

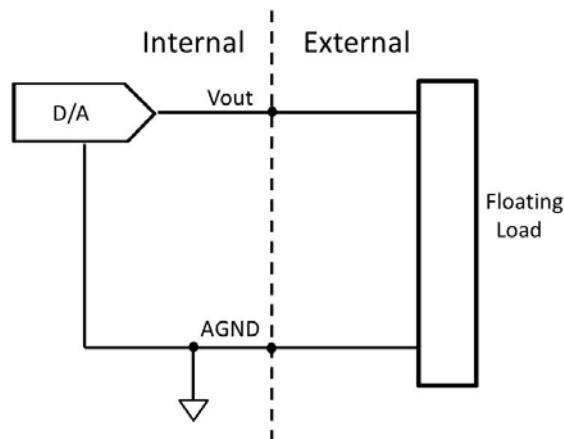


Figure 5.1 Floating-load Connection for D/A Voltage Output

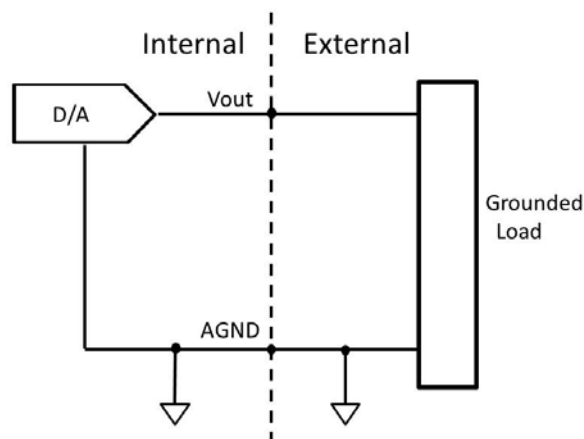


Figure 5.2 Grounded-load Connection for D/A Voltage Output

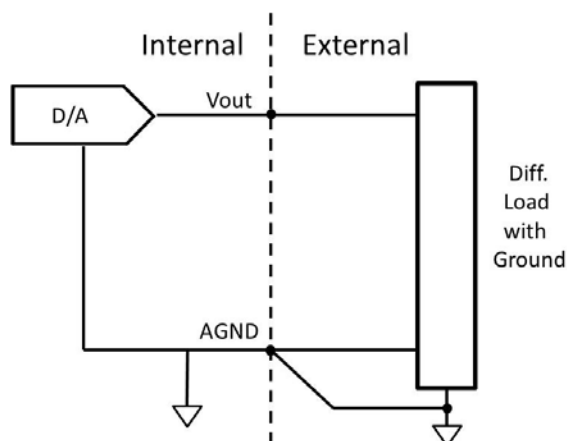


Figure 5.3 Differential-load Connection for D/A Voltage Output

5.3 Current Sink Connections

The PCI-1720U's current loop output uses a 0 ~ 5V (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 than 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.

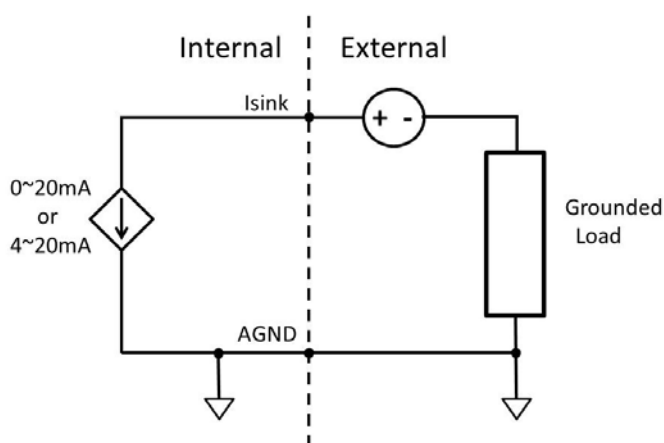


Figure 5.4 Grounded-load connection with a floating power supply

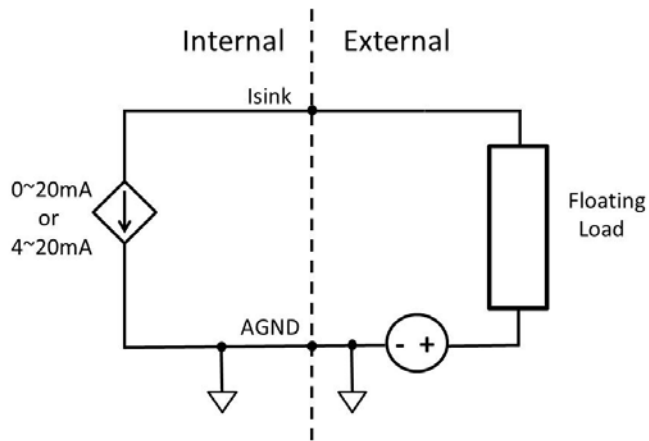


Figure 5.5 Floating-load connection with a grounded power supply

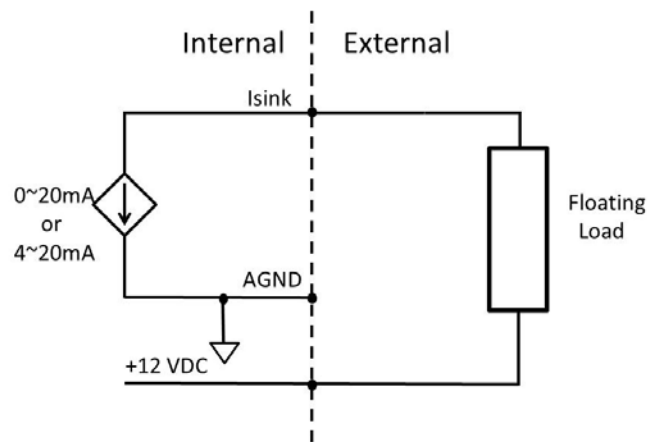


Figure 5.6 Floating-load Conn. with an Internal +12 VDC Power Supply

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-1720U is as shown below.

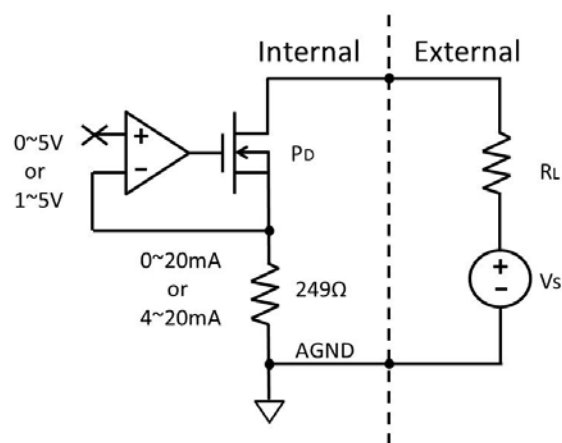


Figure 5.7 PCI-1720U Current Sink Circuitry

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.

$$VS > (RL + 249) (0.02)$$

$$VS \leq 50$$

$$PD = (VS - (RL + 249) \times 0.02) \times 0.02 < 0.2$$

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 k Ω ($40 / 0.02 - 249 > RL$).

Select RL = 200 Ω , PD = 0.62 > 0.2 fail!

Reselect RL = 1 k Ω , PD = 0.3 > 0.2 fail!

Reselect RL = 1.5 k Ω , PD = 0.1 < 0.2 OK!

Appendix **A**

Specifications

A.1 PCI-1720U Specifications

Table A.1: Isolated Analog Output

Number of Channels	4
Resolution	12 bits
Output Rate	Static
Optical Isolation	2500 VDC
Driving Capability	5 mA
Output Range	Bipolar: ± 5 V, ± 10 V Unipolar: 0 ~ 5 V, 0 ~ 10 V Current Loop: 0 ~ 20 mA, 4 ~ 20 mA
Slew Rate	2.5 V/us @ ± 10 V 1.5 V/us @ ± 5 V, 0 ~ 10 V 0.7 V/us @ 0 ~ 5 V
Accuracy	Relative: ± 1 LSB; Differential Non-Linearity: ± 1 LSB (monotonic)

Table A.2: General Specifications

I/O Connector Type	37-pin D-type female
Dimensions	175 mm x 100 mm (6.9" x 3.9")
Power Consumption	+5 V @ 350 mA (typical), 500 mA (max.) +12 V @ 200 mA (typical), 350 mA (max.)
Temperature	Operating: 0 ~ +60° C (32 ~ 140° F) Storage: -20 ~ +70° C (-4 ~ 158° F)
Relative Humidity	5 – 95% RH non-condensing (refer to IEC 68-2-3)
Certifications	CE / FCC

Appendix **B**

Block Diagram

B.1 PCI-1720U Block Diagram

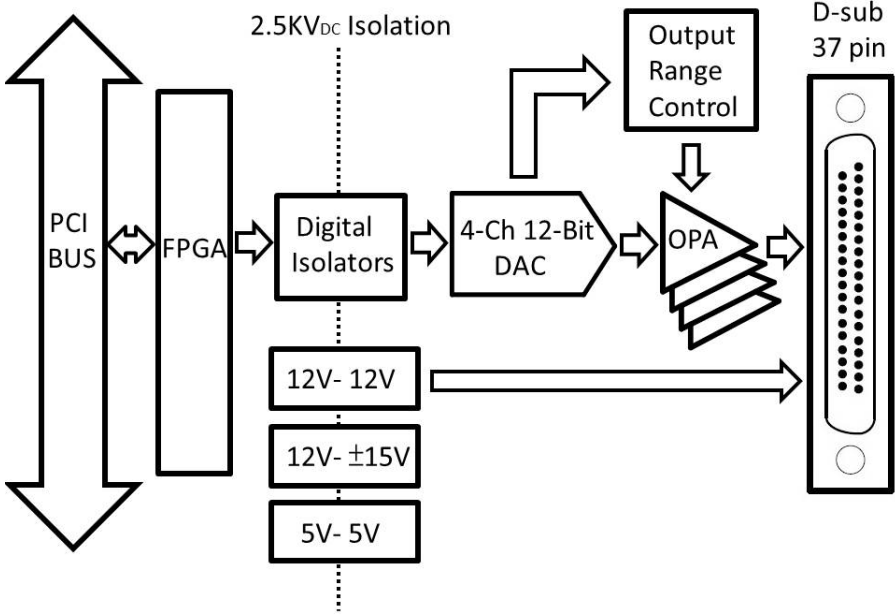


Figure B.1 PCI-1720U Block Diagram

Appendix **C**

Calibration

C.1 Overview

The PCI-1720U 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-1720U's VRs.

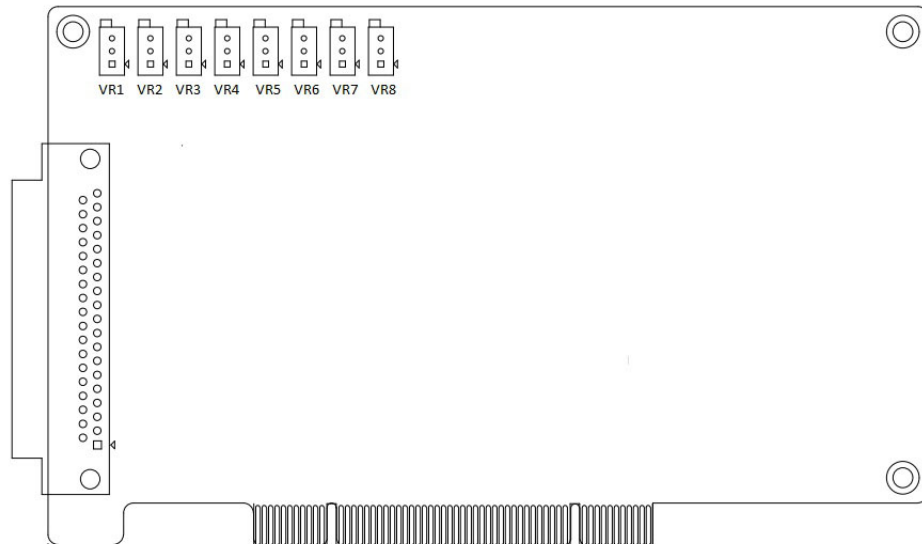


Figure C.1 PCI-1720U VR assignment

- 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-1720U. Standard procedures for performing a calibration are given below.

C.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 VR_n (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 VR_n (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.

C.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 VR_n (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 VR_n (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.

C.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 VR_n (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 3.2).
3. Set all digital input codes to 1. Now, adjust VR_n (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.

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