AX5300P/AX5301

2 Ch. Isolated Analog Output/Extension Card with PCI Bus

User's Manual

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ESD Precautions

Integrated circuits on computer boards are sensitive to static electricity. To avoid damaging chips from electrostatic discharge, observe the following precautions:

- Do not remove boards or integrated circuits from their anti-static packaging until you are ready to install them.
- Before handling a board or integrated circuit, touch an unpainted portion of the system unit chassis for a few seconds. This helps to discharge any static electricity on your body.
- Wear a wrist-grounding strap, available from most electronic component stores, when handling boards and components.

Unpacking

The board is packed in an anti-static bag. The board has components that are easily damaged by static electricity. Do not remove the anti-static wrapping until proper precautions have been taken. Safety instructions in front of this User's Manual describe anti-static precautions and procedures.

After unpacking the board, place it on a raised surface and carefully inspect the board for any damage that might have occurred during shipment. Ground the board and exercise extreme care to prevent damage to the board from static electricity.

Integrated circuits will sometimes come out of their sockets during shipment. Examine all integrated circuits, particularly the BIOS, processor and keyboard controller chip to ensure that they are firmly seated. After unpacking the board, check and see if the following items are included and in good condition. If any of the items is missing or damaged, notify your dealer immediately.

- AX5300P/AX5301 Board
- CN-D 9P 180D (x2)
- Cable Hoods CN-9P (x2)
- AS59099 DAC Driver CD
- AX5300P/AX5301 User's Manual
- COM1/COM2 Ports Cable (AX5301)
- Bracket (AX5301)
- Screw 3mm (x3) (AX5301)
- Nut 3mm (x3) (AX5301)
- Bronze stick 6mm (x3) (AX5301)
- Warranty Card

Make sure that all of the items listed above are present.

What To Do If There Is A Problem

If there are damaged or missing parts, contact your supplier and/or dealer immediately. Do not attempt to apply power to the board if there is damage to any of its components.

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Chapter 1
Introduction

1.1 General Description

The AX5300P/AX5301 is an isolated analog output/extension board with PCI Bus interface. Both have two identical DAC channels providing voltage output, and either 4-20mA or 0-20mA current loop. Aside from a user definable external reference voltage input, both AX5300P and AX5301 also support individually user selectable analog outputs (unipolar or bipolar). Analog outputs range from 0V to 5V, 0V to 10V, -5V to +5V, -10V to +10V, or 4 to 20mA for process control current loops. Isolated and protected against shorts and ground, each analog output additionally supports one 12-bit D/A converter, and two 9-pin D type connectors for external connection.

Both AX5300P and AX5301 efficiently serve a wide variety of applications. The stable voltage and current outputs of AX5300P are typical tools used when directing control value positioning. It can also equip and deliver a programmable voltage source when generating control signals material transfer rate, fluid flow, power consumption, motor speed, temperature levels, etc.

1.2 Features

- 32-bit PCI Bus compatible analog output board with Plug & Play
- Two channels of isolated analog output with 12-bit resolution; up to 8 channels using the extension board AX5301
- Voltage outputs: 0V to 5V, 0V to 10V, -5V to +5V, -10V to +10V, or 4mA to 20mA / 0mA to 20mA for current loop
- Internal/external reference voltage available
- $500V_{DC}$ channel-to-channel and channel-to-bus isolation
- Onboard DC/DC converter; two 9-pin D-type male connectors
- Bundled with Windows 95/Windows NT driver and DOS DEMO programs

1.3 Specifications

- **Analog Outputs**
  - **Number of Channels:** 2 (can be extended to 8)
  - **Output Current for All Range:** ± 5mA max.
  - **Output Ranges:** 0 to 5V, 0 to 10V, -5 to +5V, -10 to +10V; 4-20mA or 0-20mA current loop
  - **Input Data Coding:** Straight binary (unipolar)
Offset binary (bipolar)
  - **Protection:** For short circuit
  - **Voltage Output Source Impedance:** 0.1Ω max.
- **Accuracy**
  - **Resolution:** 12 bits
  - **Nonlinearity:** ±1 LSB
  - **Differential Nonlinearity:** ±1/2 LSB
  - **Inherent Quantizing Error:** ±1/2 LSB
  - **Gain Error:** Adjustable to zero
  - **Zero Error:** Adjustable to zero
  - **System Accuracy:** ±0.0125% FSR (Voltage)
±0.02% FSR (Current)
- **Thermal Characteristics**
  - **Zero Drift:** ±10µV/°C
  - **Gain Drift:** ±20ppm of FSR/°C
  - **Differential Linearity Drift:** ±3ppm of FSR/°C
  - **Monotonicity:** Monotonic, 0 to +60°C

- **Dynamic Performance**
  - **Setting Time to 1/2 LSB**
    - 10V step: 33μs
    - 5V step: 16μs
  - **Slew Rate:** 0.3V/μs TYP (voltage)
    1.2mA/μs (current)
- **Interface Characteristic**
  - **Compatible Bus:** 32-bit PCI Bus compatible Plug and Play
  - **Isolated Voltage:** 500V_{DC}
  - **No. of Locations Occupied:** 8 consecutive addresses
  - **Data Path:** 12 bits
- **Power Requirements**
  - **+12V_{DC}:** 450mA
  - **+5V_{DC}:** 350mA
  - **Current Loop:** 4-20mA
  - **Loop Supply Voltage:** 6-40V_{DC}
  - **User Definable Reference Voltage:** -10V_{DC} to +10V_{DC}
- **Physical/Environmental**
  - **Dimensions:** AX5300P⇨106x173 mm
    AX5301⇨80x159 mm
  - **Weight:** AX5300P⇨186g
    AX5301⇨125g
  - **Connector:** Two male 9-pin D type connectors
  - **Operating Temperature Range:** 0°C to 60°C
  - **Storage Temperature Range:** -25°C to 85°C
  - **Relative Humidity:** 20% to 90%, non-condensing

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Chapter 2

Board Configuration and Installation

2.1 Base I/O Port Address

The AX5300P occupies eight consecutive I/O port spaces. The I/O port base addresses are assigned by the PCI Plug & Play BIOS. From the device driver, you can get the AX5300P base address and the slot number to where AX5300P is plugged into. For more detailed information, refer to the Chapter *"Programming the DAC Output"*.

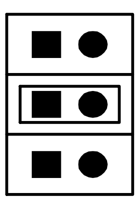
2.2 AX5300P Jumper Settings

The user defined analog outputs range from unipolar (0V to +5V or 0V to +10V), to bipolar (-5V to +5V or –10V to +10V), and/or from 0 to 20mA or 4 to 20mA for process control current loop. Besides –5V and –10V, user may use an external voltage source for reference. The following sections describe the jumper settings of AX5300P.

2.2.1 Selecting Reference Voltage Input

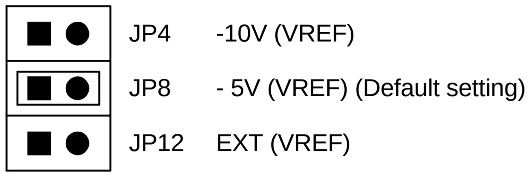
The three selections for reference voltage input are -5V, -10V and Vext. Graphic descriptions of their corresponding jumper settings are given below.

Channel #0



JP2	-10V (VREF)
JP6	- 5V (VREF) (Default setting)
JP10	EXT (VREF)

Channel #1



When external reference is selected, the corresponding channel's D/A voltage output is from 0V to –VREF (in unipolar mode) or from –VREF to VREF (in bipolar mode). The external voltage source ranges from –10V to +10V.

In the succeeding sections, the abbreviation VREF will stand for the selected reference voltage input, which may represent –5V, -10V or external reference.

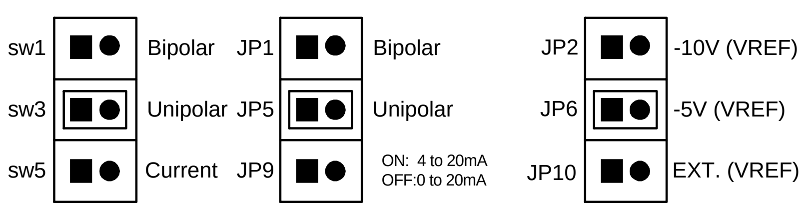
2.2.2 Selecting Output Ranges

Determine the output range of both channels by referring to the following table.

Ch.	Jumper Pins	Selection	Range
#0	SW1 & JP1	Bipolar	-|VREF| to +|VREF|
#1	SW2 & JP3	Bipolar	-|VREF| to +|VREF|
#0	SW3 & JP5	Unipolar	0V to +|VREF|
#1	SW4 & JP7	Unipolar	0V to +|VREF|
#0	SW5 & JP6	Current Sink	0 to 20mA
#1	SW6 & JP8	Current Sink	0 to 20mA
#0	SW5 & JP9 & JP6	Current Sink	4 to 20mA
#1	SW6 & JP11 & JP8	Current Sink	4 to 20mA

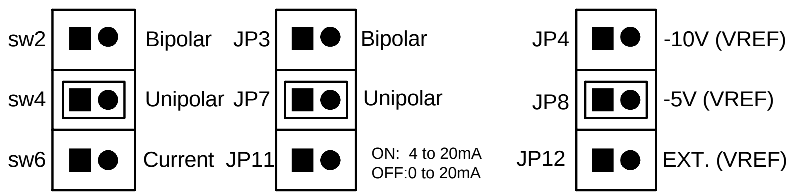
For example:

Channel #0: -5V (VREF) Unipolar (Default)



For example:

Channel #1: -5V (VREF) Unipolar (Default)



NOTE: *Use –5V reference voltage input when the board is set to current sink.*

2.2.3 Current Sink Select Jumper

The range for current sink can be switched between 4 to 20mA to 0 to 20mA by setting **JP9** (Channel #0) and **JP11** (Channel #1) to OPEN. When used under factory conditions, SHORT both jumpers to select 4 to 20mA current loops.

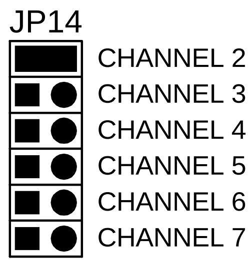
2.3 AX5301 Jumper Settings

The user defined analog outputs onboard the AX5301 include unipolar (0V to +5V or 0V to +10V), bipolar (-5V to +5V or –10V to +10V), and 0 to 20mA or 4 to 20mA for process control current loop. Besides –5V and –10V, user may use an external voltage source for reference. The following sections describe the jumper settings of AX5301.

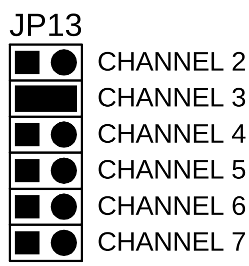
2.3.1 Setting Output Channel

The channel selection for output ports **P1** and **P2** on the AX5301 extended board are set via **JP14** and **JP13**. User may select the output port channel (1 each) from Channel2 to Channel7.

For example, user can set P1 as Channel2 by setting JP14 like this:



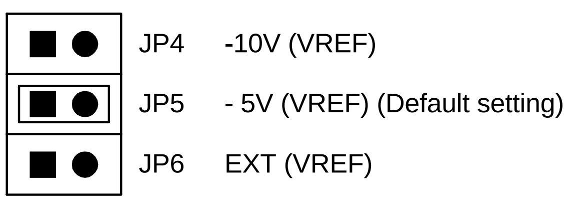
User may also set P2 as Channel3 by setting JP13 like this:



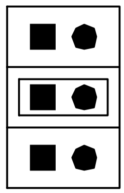
2.3.2 Selecting Reference Voltage Input

The three selections for reference voltage input are -5V, -10V and Vext. Their corresponding jumper settings are given below.

For P1



For P2



When external reference is selected, the corresponding channel's D/A voltage output is from 0V to –VREF (in unipolar mode) or from –VREF to VREF (in bipolar mode). The external voltage source ranges from –10V to +10V.

In the succeeding sections, the abbreviation VREF will stand for the selected reference voltage input, which may represent –5V, -10V or external reference.

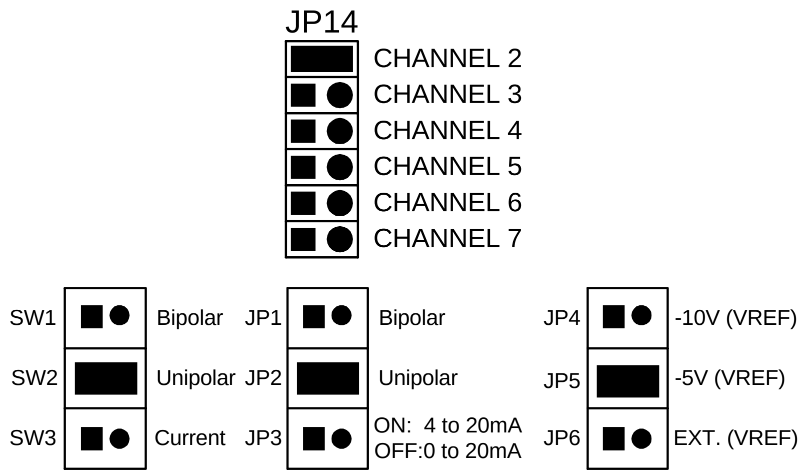
2.3.3 Selecting Output Ranges

Determine the output range of both channels by referring to table below.

	Jumper Pins	Selection	Range
P1	SW1 & JP1	Bipolar	$-\vert VREF\vert$ to $+\vert VREF\vert$
P2	SW4 & JP7	Bipolar	$-\vert VREF\vert$ to $+\vert VREF\vert$
P1	SW2 & JP2	Unipolar	0V to $+\vert VREF\vert$
P2	SW5 & JP8	Unipolar	0V to $+\vert VREF\vert$
P1	SW3 & JP5	Current Sink	0 to 20mA
P2	SW6 & JP11	Current Sink	0 to 20mA
P1	SW3 & JP3 & JP5	Current Sink	4 to 20mA
P2	SW6 & JP9 & JP11	Current Sink	4 to 20mA

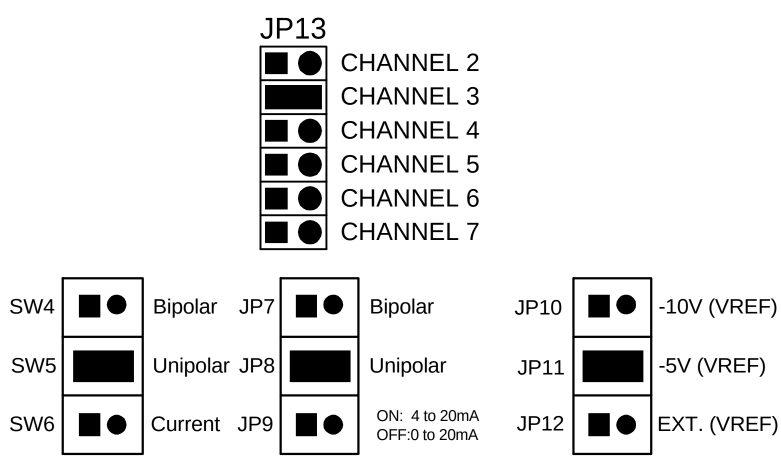
For example:

P1: CNANNEL2, -5V (VREF), Unipolar (Default)



For example:

P2 : CHANNEL3, -5V (VREF), Unipolar (Default)



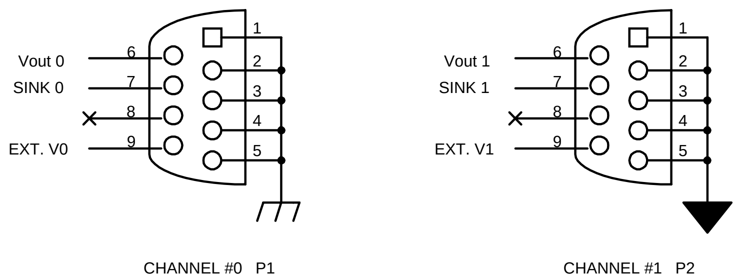
NOTE: *Use –5V reference voltage input when the board is set to current sink.*

2.3.4 Current Sink Select Jumper

The range for current sink can be changed from 4 to 20mA to 0 to 20mA by setting **JP3** (P1) and **JP9** (P2) to OPEN. In factory settings, set both jumpers as SHORT to select 4 to 20mA current loops.

2.4 Connector Pin Assignments

The analog outputs, current sink and voltage output, of the two channels, are available through two male 9-pin D type connectors. The AX5300P pin assignments are described below:



2.4.1 Pin Descriptions

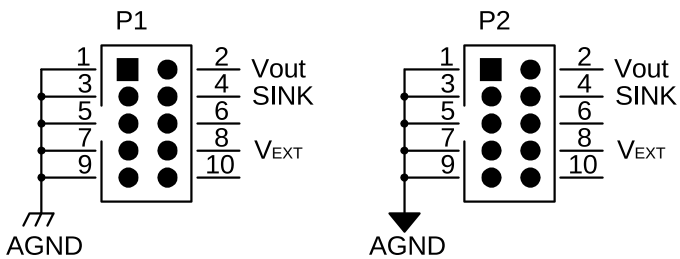
Connectors #1 (P1):

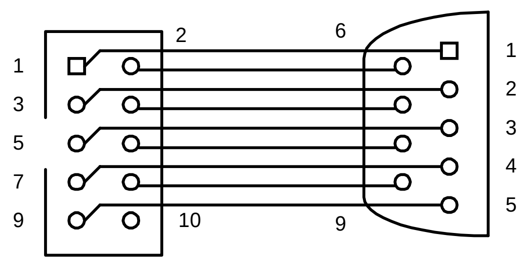
Pin	Signal	Description
1, 2, 3, 4, 5	Ground	Analog Ground
6	VOUT 0	Channel #0 Analog Voltage Output
7	Current Sink 0	Channel #0 Analog Current Loop
8	N/C	N/C
9	VEXT 0	Channel #0 Analog External Voltage Input

Connectors #2 (P2):

Pin	Signal	Description
1, 2, 3, 4, 5	Ground	Analog Ground
6	VOUT 1	Channel #1 Analog Voltage Output
7	Current Sink 1	Channel #1 Analog Current Loop
8	N/C	N/C
9	VEXT 1	Channel #1 Analog External Voltage Input

All AX5301 input and output signals are built in two 10-pin male connector labeled **P1** and **P2**. A cable connector, that converts the 10-pin male connector to 9-pin D-type connector, is bundled with the AX5301 module. The AX5301 pin assignments are described below.





Connectors #1 (P1):

Pin	Signal	Description
1, 3, 5, 7, 9	Ground	Analog Ground
2	VOUT	Connector#1 Analog Voltage Output
4	Current Sink	Connector#1 Analog Current Loop
6, 10	N/C	N/C
8	VEXT	Channel #1 Analog External Voltage Input

Connectors #2 (P2):

Pin	Signal	Description
1, 3, 5, 7, 9	Ground	Analog Ground
2	VOUT	Channel #2 Analog Voltage Output
4	Current Sink	Channel #2 Analog Current Loop
6, 10	N/C	N/C
8	VEXT	Channel #2 Analog External Voltage Input

2.5 Hardware Installation

The AX5300P/AX5301 board is shipped with protective electrostatic cover. When unpacking, touch the board's electrostatically shielded packaging with the metal frame of your computer to discharge the accumulated static electricity prior to touching the board. Refer to the ESD Precautions listed at the beginning of this manual.

The following summarizes the procedures the installation procedures of AX5300P/AX5301:

WARNING: *Turn OFF the PC and all accessories connected to the PC whenever installing or removing any peripheral board including the AX5300P board.*

2.5.1 AX5300P Installation

1. Turn OFF the PC and all power connected to other accessories.
2. Unplug all power cords and cables from the rear side of the PC.
3. Remove the PC cover (see your PC Operation Guide if you are not skillful about it).
4. Find an unused expansion slot. Remove the empty expansion slot cover and save the screw. You will need it later when affixing back the retaining bracket.
5. Grab the upper edge of the AX5300P board. Align the AX5300P board's retaining bracket with the expansion slot rear panel. Straighten the board's gold finger with the expansion slot and gently push the board into the slot.
6. Fasten the AX5300P board onto the chassis using the screw you removed earlier.
7. Replace the PC cover and connect the cables you detached in step 2.
8. Turn ON the PC and the power to other peripheral devices.

2.5.2 AX5301 Installation

1. Turn OFF the system power.
2. Unplug all power cords.
3. Remove the case cover if necessary.
4. Remove the top module if it is a non-stackthrough module.
5. Align the AX5301 with the AX5300P.
6. Install three spacers and fasten them if necessary.
7. Connect the cable if necessary (P1 and P2).
8. Stack the modules to each other until the height of the spacer (0.6") becomes the distance between modules. Restore all screws.
9. Repeat step 6 until all modules are set into position.
10. Return the case cover and connect all cables you removed prior to installing the AX5301.
11. Turn On the system power.

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Chapter 3
Register Structure & Format

3.1 AX5300P/AX5301 I/O Address Mapping

Listed on the following table are the locations of the D/A registers.

Location	Function	Type
Base address + 0	Channel 0 control register	W
Base address + 1	Channel 1 control register	W
Base address + 2	Channel 2 control register	W
Base address + 3	Channel 3 control register	W
Base address + 4	Channel 4 control register	W
Base address + 5	Channel 5 control register	W
Base address + 6	Channel 6 control register	W
Base address + 7	Channel 7 control register	W

w : write only

3.2 AX5300P Register Description

Refer to Appendix D *"Technical Reference"* before proceeding with this section. Data format for the D/A registers of AX5300P/AX5301 is as follows:

Channel #0~#7 Control Register (Base+0~Base+7, Write only)

base	7	6	5	4	3	2	1	0
+0~7	X	CLR	A1	A0	D3	D2	D1	D0

D3 – D0 : Data written to the register.

A1 A0 : Operation address, used to indicate the desired loading operation (i.e. load low byte, middle byte,. high byte, or DAC register).

A1	A0	Description
0	0	Load D3-D0 to LOW byte data register
0	1	Load D3-D0 to MIDDLE byte data register
1	0	Load D3-D0 to HIGH byte data register
1	1	Load 12-bit DAC register with data in LOW byte, MIDDLE byte and HIGH byte data registers.

$\overline{CLR}$: Always 1 unless user wants to clear the DAC register.
X : Don't care

Chapter 4

Programming the DAC Output

The AX5300P device driver is suitable for Plug & Play under DOS environment when generating information from PCI BIOS. This chapter describes in detail on how to install the device driver and use the device driver command to get base address, IRQ level, slot number. Testing programs are also provided for reference.

After successfully retrieving the information, user can use the information to act as parameter for driver function. All operations within this section will only work if the device driver *"AX5300P.SYS"* is successfully installed.

It is simple to program AX5300P with I/O output instructions in whatever application language. With D/A's having 12-bit resolution, data should be within the range 0-4095 decimal. Split the data into 3 byte (low, middle and high byte). For instance, the data 1024 (Dec) is split into 0100 (high byte), 0000 (middle byte) and 0000 (low byte), in binary.

4.1 Installing the Device Driver

Before executing any application program (including the following examples), this device driver must be installed. To install the device driver, type

SETUP [SOURCE DRIVE] [TARGET DRIVE] [DIRECTORY]

This will copy the device driver to the desired directory. And then add the following command line to your *config.sys*:

DEVICE = [PATH] AX5300P.SYS

Example

If you insert this diskette into drive A: and want to copy the file into C:\AX5300P. You must key in the following command line at the DOS prompt.

A:\SETUP A: C:\ AX5300P [ENTER]

Then add the following line to your *config.sys* file.

DEVICE = C:\AX5300P\AX5300P.SYS

Reboot your computer.

If the AX5300P is plugged in your system, the following message will appear :

```
* ************************************ *
* Copyright 1998 by AXIOMTEK Co., LTD  *
* Ver 1.0                              *
* AX5300P DEVICE DRIVER INSTALLED      *
* ************************************ *
```

Now AX5300P acts like a file. You can OPEN, CLOSE, WRITE (command), READ (base address, IRQ level, slot number) it via this device driver.

If there is no AX5300P in your system, the following message will appear:

AX5300P or PCI BIOS Not Found !!

Any attempt to OPEN the device driver will fail !

4.1.1 Using the Device Driver Command

The device driver is for the user to retrieve Base Address, IRQ Level, and Slot Number of AX5300P plugged in your system.

Before accessing the device driver, open it as needed. After accessing the device driver, close it as also needed. To get any information (Base Address, IRQ Level or Slot Number), you must first write a command to the device driver in order for the needed data to be read from the device driver.

There are three commands for user to obtain Base Address, IRQ level and Slot Number. The number following the command indicates card number.

To get base address, you must write the command string *"B?"* to the device driver and then read a WORD (two bytes) from the device driver. This is the base address you need.

To get the IRQ level, you must write the command string *"I?"* to the device driver and then read a WORD (two bytes) from the device driver. This is the IRQ level you need.

To acquire the slot number, you must write the command string *"S?"* to the device driver and then read a WORD (two bytes) from the device driver. This is the slot number you need.

NOTE: *The question mark **"?"** must be replaced by a card number. If Base Address returns to 0, it means all information retrieved by the card number are not available.*

4.2 Code Format

The data coding (input/output relationship) for current sink, unipolar output and bipolar output are described on the succeeding sections.

4.2.1 Unipolar Output

Analog Output(V) = (code ÷ 4096) x |VREF|

Code (Binary)			Output (V)
0000	0000	0000	0V
0100	0000	0000	|VREF| * (1024/4096)
1000	0000	0000	|VREF| * (2048/4096)
1111	1111	1111	|VREF| * (4095/4096)

4.2.2 Bipolar Output

Analog Output(V) = [(code - 2048) ÷ 2048] x |VREF|

Code (Binary)			Output (V)
0000	0000	0000	-|VREF| * (2048/2048)
0111	1111	1111	-|VREF| * (1/2048)
1000	0000	0000	0V
1111	1111	1111	+|VREF| * (2047/2048)

4.2.3 Current Sink

For 4 to 20mA Current Sink

Current Sink(mA) = [4 + (code ÷ 4096)] x (20 – 4)

Code (Binary)			Current Sink (mA)
0000	0000	0000	4
0100	0000	0000	8
1000	0000	0000	16
1111	1111	1111	20

For 0 to 20mA Current Sink

Current Sink (mA) = (code ÷ 4096) x 20

Code (Binary)			Current Sink (mA)
0000	0000	0000	0
0100	0000	0000	5
1000	0000	0000	10
1111	1111	1111	20

Code: data which is sent to DAC, its range is from 0 – 4095.

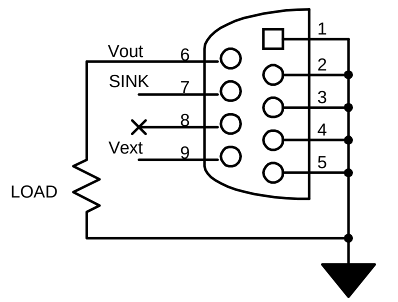
4.3 Isolated Circuit

Photo-couplers are used in the isolation circuit of AX5300P/AX5301. Any write pulse sent to DAC must pass through these photo-couplers. This takes about 0.45 milliseconds to reach the AD7542. User must wait before sending another 12-bit data to AX5300P.

4.4 Wiring

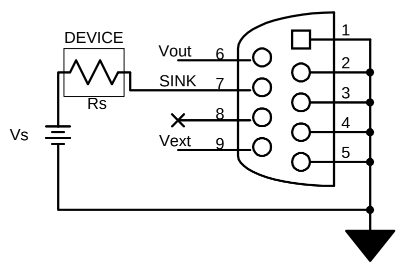
In this section the wiring connections from the male 9-pin D type connectors are provided.

Analog Voltage Output



NOTE: *Load resistance must not be less than (Vout/5mA).*

Analog Current Sink

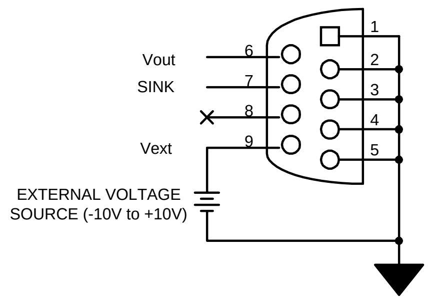


NOTE: *1. Vs : external power source*
Rs : total loop resistance

2. For Vs = 12Vdc, Rs ≤ 325Ω (for more details, refer to Appendix D "Current Sink Circuit").

Analog External Voltage Input

The V_{OUT} depends on the external voltage source. For instance, in unipolar mode connect a –8V external voltage source to pin 9 of the D type connector then the output range is from 0 to 8V.



4.5 Writing Data into D/A Register

A brief description for sending 1024 to D/A (Channel #0) is given below. As mentioned before, first split 1024 into 0100 (high byte), 0000 (middle byte) and 0000 (low byte).

NOTE: *base = base address of channel #0*
outportb = an I/O write to base address

```
outportb(base+0,0x40);    /* load 0x40 to base+0
                             0x40(hex)=0100 0000 (binary)
                             set CLR=1, A1A0=00,
                             D3-D0=0000 (low byte)      */
delay(2);                 /* delay 2 ms                    */
outportb(base+0,0x50);    /* load 0x50 to base+0
                             0x50(hex)=0101 0000(binary)
                             set CLR=1,A1A0=01,
                             D3-D0=0000 (middle byte) */
delay(2);                 /* delay 2 ms                    */
outportb(base+0,0x64);    /* load 0x64 to base+0
                             0x64(hex)=0110 0100(binary)
                             set CLR=1,A1A0=10,
                             D3-D0=0100 (high byte)    */
delay(2);                 /* delay 2 ms                    */
```

```
outportb(base+0,0x70);      /* load 0x70 to base+0
                            0x70(hex)=0111 0000(binary)
                            set CLR=1,A1A0=11,
                            D3-D0 don't care
                            Load 12-bit DAC register with
                            data in low byte, middle byte,
                            high byte data registers       */
delay(5);                   /* delay 5 ms                      */
```

4.6 Programming Examples

4.6.1 Example Program in QBASIC 4.5

Determine the reference voltage input and output range / mode of AX5300P (Channel #0), refer to Section 2.2 for the setting of jumpers and Section 4.4 for the wiring. Execute below program. Input 12-bit data and it will be sent to the analog output of Channel #0.

```
DECLARE SUB DELAY (a)
'DEMO PROGRAM FOR QB4.5 USER
'DELAY ROUTINE
'MAIN PROGRAM
OPEN "5300PDRV" FOR OUTPUT AS #1
OPEN "5300PDRV" FOR BINARY AS #2
PRINT #1, "B1"
GET #2, 1, BL%
GET #2, 1, BH%
PRINT #1, "S1"
GET #2, , S%
CLOSE #1
CLOSE #2
BL = BL%
BH = BH%
ADDR = BH * 256 + BL
PRINT "BASE ADDRESS: ", HEX$(ADDR)
PRINT "SLOT NUMBER: ", S%
IF ADDR <> 0 THEN PRINT "The information are correct"
'OUT ADDR, &HFF'ENABLE AX5300P, CHANNEL 0
'EXIT IF CH NOT 0
DO UNTIL CH <> 0
```

```
PRINT "TYPE CHANNEL AND DATA LIKE THIS: CHANNEL,DATA"
INPUT "INPUT DATA:"; CH, DAT
PRINT CH, DAT

'SEND LOW BYTE
    DATL = DAT AND &HF
    SDATL = DATL OR &H40
    OUT ADDR, SDATL
    DELAY (2)
'GENERATE AND SEND MIDDLE BYTE
    DATM = DAT AND &HF0
    DATM = DATM / 16
    SDATM = DATM OR &H50
    OUT ADDR, SDATM
    DELAY (2)
'GENERATE AND SEND HIGH BYTE
    DATH = DAT AND &HF00
    DATH = DATH / 256
    SDATH = DATH OR &H60
    OUT ADDR, SDATH
    DELAY (2)
'SEND 12-BIT DATA TO ANALOG OUTPUT
    OUT ADDR, &H70
    DELAY (5)
LOOP
END

SUB DELAY (a)
 FOR i = 1 TO a
 FOR j = 1 TO 10: NEXT j     '1 ms delay loop
 NEXT i
END SUB
```

4.6.2 Example Program in Turbo Pascal 5.0

Determine the reference voltage input and output range / mode of AX5300P (Channel #0), refer to Section 2.2 for the setting of jumpers and Section 4.3 for the wiring. Execute below program. Input 12-bit data and it will be sent to the analog output of Channel #0.

```
PROGRAM AX5300P(OUTPUT);
USES CRT,DOS;

VAR
    FDW:TEXT;
    FDR:FILE OF INTEGER;
    ADDR,SLOTNO:INTEGER;
    CODE_L,SEND_DATA_L:INTEGER;
    CODE_M,SEND_DATA_M:INTEGER;
    CODE_H,SEND_DATA_H:INTEGER;
    DATA,SEND_DATA,PD,PW,CH:INTEGER;

BEGIN(*MAIN PROCEDURE*)

 CLRSCR;
 ASSIGN(FDW,'5300PDRV');
 ASSIGN(FDR,'5300PDRV');

REWRITE(FDW);
 WRITELN(FDW,'B1');
 RESET(FDR);
 READ(FDR,ADDR);

 REWRITE(FDW);
 WRITELN(FDW,'S1');
 RESET(FDR);
 READ(FDR,SLOTNO);

 CLOSE(FDW);
 CLOSE(FDR);
 WRITELN('BASE ADDRESS :',ADDR:10);
 WRITELN('SLOT NUMBER:',SLOTNO:10);
 IF ADDR <> 0 THEN WRITELN('THE INFORMATION ARE CORRECT');

CH:=0;
 WHILE CH=0 DO    (*IF CH <> 0 THEN EXIT*)
```

```
 BEGIN
  WRITELN('TYPE IN CHANNEL AND DATA LIKE THIS : CHANNEL
  DATA');
  WRITELN('INPUT DATA');
  READLN(CH,DATA);
  WRITELN(CH,DATA);

  CODE_L:=DATA AND $000F;
  SEND_DATA_L:=CODE_L OR $40;
  PORT[ADDR]:=SEND_DATA_L;
  DELAY(2);

  CODE_M:=DATA AND $00F0;
  CODE_M:=CODE_M SHR 4;
  SEND_DATA_M:=CODE_M OR $50;
  PORT[ADDR]:=SEND_DATA_M;
  DELAY(2);

  CODE_H:=DATA AND $0F00;
  CODE_H:=CODE_H SHR 8;
  SEND_DATA_H:=CODE_H OR $60;
  PORT[ADDR]:=SEND_DATA_H;
  DELAY(2);

  SEND_DATA:= $70;
  PORT[ADDR]:=SEND_DATA;
  DELAY(2);
 END;
END.
```

4.6.3 Example Program in Turbo C 2.0

Set jumpers to –5V reference and current sink mode, refer to Section 2.2 for the jumper setting and Section 4.3 for the wiring. Execute below program and follow the instructions shown on screen. This program allow you to input data in mA which will be converted to binary and sent to the analog current loop of the selected channel.

```
#include <stdio.h>
#include <dos.h>
#include <string.h>
#include <conio.h>
#include <stdlib.h>
#include <fcntl.h>
#include <io.h>

main()
{
  unsigned int ch, cur_sink, code,BASE;
  unsigned l_byte, m_byte, h_byte;
  int fd,base,busno,ans;

if ((fd=open("5300Pdrv",O_RDWR))==-1){
   printf("AX5300P OPEN FAIL!\n");
   exit(0);
  }
  else
   printf("OK\n");

  write(fd,"B1",2);
  read(fd,&base,sizeof(int));

  write(fd,"s1",2);
  read(fd,&busno,sizeof(int));

  close(fd);
  printf("BASE ADDRESS : %x\n",base);
  printf("SLOT NUMBER :%x\n",busno);
  if (base==0){
   printf("ERROR INFORMATION !\n");
   exit(0);
  }
```

```
clrscr();

ans = 'y';
while (ans == 'y')
{
  printf("Please Select Channel Number -- #0 or #1\n");
  printf("Channel : #");
  scanf("%d",&ch);
  if (ch==0)
            BASE = base;
  else if (ch==1)
            BASE = base+1;
  else
          {
          printf("Wrong number of channel !\n\n");
          continue;
          }
  printf("Please input the current sink (4 to 20 mA): ");
  scanf("%d", &cur_sink);
  if (cur_sink < 4 || cur_sink > 20)
          {
          printf("Current sink out of range\n\n");
          continue;
          }
  else if (cur_sink == 20)
          code = 4095;
  else
          /*refer to equation in section 4.1.3*/
          code = (cur_sink - 4) * 256;
  printf("Code (Dec) = %d",code);

  /*generate low byte*/
  l_byte = code & 0x000f;
  /*shift middle byte 4 places right*/
  m_byte = (code & 0x00f0) >> 4;
  /*shift high byte 8 places right*/
  h_byte = (code & 0x0f00) >> 8;

  /*control signal for loading low byte*/
  outp(BASE ,(l_byte | 0x40));
  delay(2);
```

```
/*control signal for loading middle byte*/
outp(BASE +0,(m_byte | 0x50));
delay(2);

/*control signal for loading high byte*/
outp(BASE +0,(h_byte | 0x60));
delay(2);
/*control signal for loading the three 4-bit bytes into the DAC*/
outp(BASE +0, 0x70);
delay(2);

 printf("\nDo you want to continue (y/n) ? ");
 ans = getch();
 putch(ans);
 printf("\n\n");
 }
}
```

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Chapter 5
Calibration

The AX5300P/AX5301 D/A calibration is separated into two parts (both parts depend on each other) :

1. Reference voltage adjustment
2. D/A calibration :
   a. *Voltage output adjustment*
   b. *Current sink adjustment*

Use a 3½-digit voltmeter and current meter for measurement in the calibration. Before distribution, all AX5300P have been calibrated at the factory. But to ensure that no change in calibration has occurred during distribution, it is suggested that you do the D/A calibration before using this analog output board (refer to Appendix C when locating the trim resistors).

The reference voltage adjustment is needed only if the original calibration from factory has deviated. The calibration procedures of Channel #0 and Channel #1 are similar. In this chapter, we will only provide the calibration procedure of Channel #0. Simply replace the VR, JP, and SW of Channel #0 with those of Channel #1, refer to the table below :

CHANNEL #0	----->	CHANNEL #1
VR1	----->	VR6
VR2	----->	VR7
VR3	----->	VR8
VR4	----->	VR9
VR5	----->	VR10
SW1	----->	SW2
SW3	----->	SW4
SW5	----->	SW6
JP1	----->	JP3
JP5	----->	JP7
JP9	----->	JP11
JP2	----->	JP4
JP6	----->	JP8
JP10		JP12

The calibration procedures of AX5301 are similar to that of AX5300P.

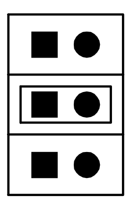
Simply replace the VR, JP, and SW of AX5300P Channel#0 with those of AX5301 P1 and P2, refer to the table below:

CHANNEL #0 OF AX5300P		P1 OF AX5301	P2 OF AX5301
VR1	----->	VR1	VR6
VR2	----->	VR2	VR7
VR3	----->	VR3	VR8
VR4	----->	VR4	VR9
VR5	----->	VR5	VR10
SW1	----->	SW1	SW4
SW3	----->	SW2	SW5
SW5	----->	SW3	SW6
JP1	----->	JP1	JP7
JP5	----->	JP2	JP8
JP9	----->	JP3	JP9
JP2	----->	JP4	JP10
JP6	----->	JP5	JP11
JP10	----->	JP6	JP12

5.1 Reference Voltage Adjustment

The reference voltage input is user definable to either -5V or –10V. Only do this part of calibration if your reference voltage needs adjustment. After the reference voltage has been fixed to –5V (or –10V), proceed to the D/A calibration for your voltage output and current sink adjustment. A brief description is given below.

1. To set the reference voltage input to –5V, configure the following jumper settings as follows:



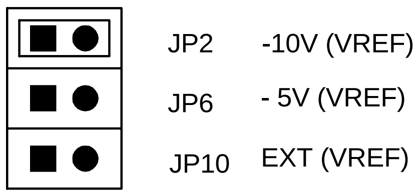
JP2 -10V (VREF)

JP6 - 5V (VREF) (Default setting)

JP10 EXT (VREF)

Connect your voltmeter to TP5 and with the other end of its test lead kit to TP8 (Analog Ground). Adjust VR5 until the voltmeter shows –5.00V.

2. To set the reference voltage input to –10V after doing step(1), proceed directly by changing the placement of jumper caps as follows:



Connect your voltmeter to TP5 and TP8 (analog ground). Adjust VR4 until the voltmeter reads –10.00V. Adjusting VR4 in step(2) will cause deviation to the –5V voltage reference input in step (1). Repeat steps (1) and (2) twice until both voltage reference inputs are as close to the desired voltage references as possible.

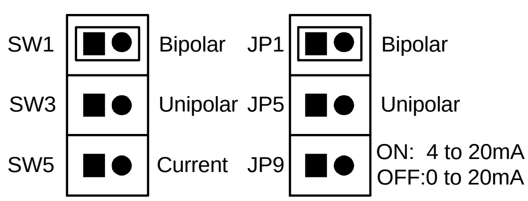
5.2 D/A Calibration

The D/A calibration is divided into two steps: ***voltage output*** and ***current sink adjustment***.

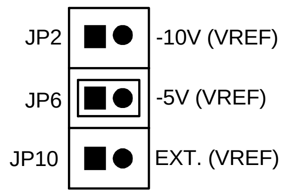
5.2.1 Voltage Output Adjustment

In ***Bipolar Mode***, follow the instructions below.

a. Put your jumper caps as shown in the following diagram.

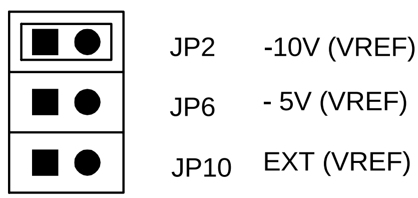


b. If the board uses <u>–5V as reference voltage</u>, set JP6 as follows:



Connect your voltmeter to TP1 and TP8 (Analog ground). Send data 0 (decimal) to the D/A. Adjust VR5 until the voltmeter reads –5.00V. Again send data 4095 (decimal) to the D/A and adjust VR3 until the voltmeter reads +5.00V.

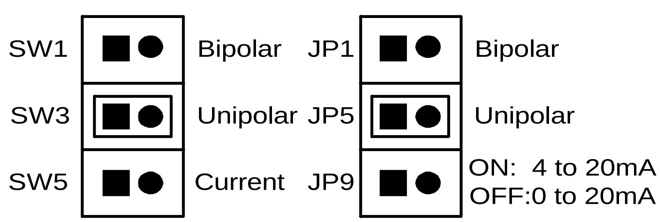
c. If the board uses <u>–10V as reference voltage</u>, repeat step(b) but set JP2 as follows:



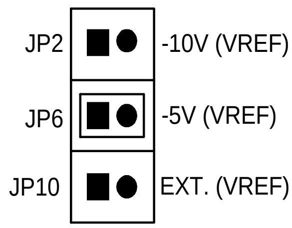
When data 0 (decimal) and 4095 (decimal) is sent to the D/A, the voltmeter must read –10.00V (adjust VR4) and +10.00V (adjust VR3) respectively.

In ***<u>Unipolar</u>*** mode, perform the following steps:

a. Put your jumpers cap as follows:

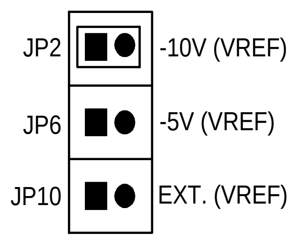


b. If the board uses <u>–5V as reference voltage</u>, set JP6 as follows:



Connect your voltmeter to TP1 and TP8 (Analog ground). Send data, for instance 4095 (decimal), to the D/A and adjust VR5 if the voltmeter doesn't read +5.00V.

c. If the board uses <u>–10V as reference voltage</u>, set JP2 as follows:



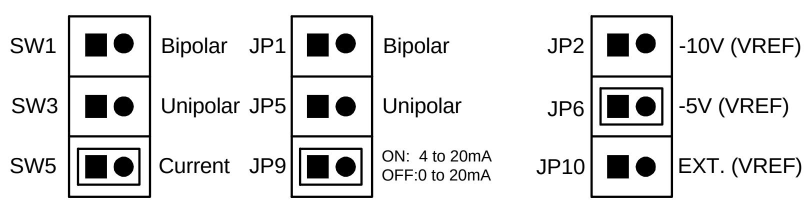
Connect your voltmeter to TP1 and TP8 (Analog ground). Send data, for instance 4095 (decimal), to the D/A and adjust VR4 if the voltmeter doesn't read +10.00V.

5.2.2 Current Sink Adjustment

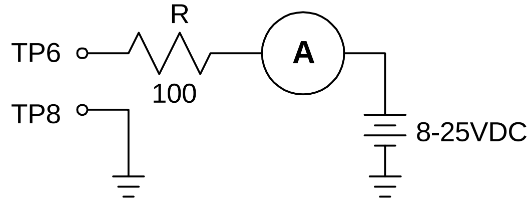
Here you will need to adjust two trim resistors: ***VR1*** and ***VR2***.

Follow the instructions below:

a. Set jumpers as follows :



b.



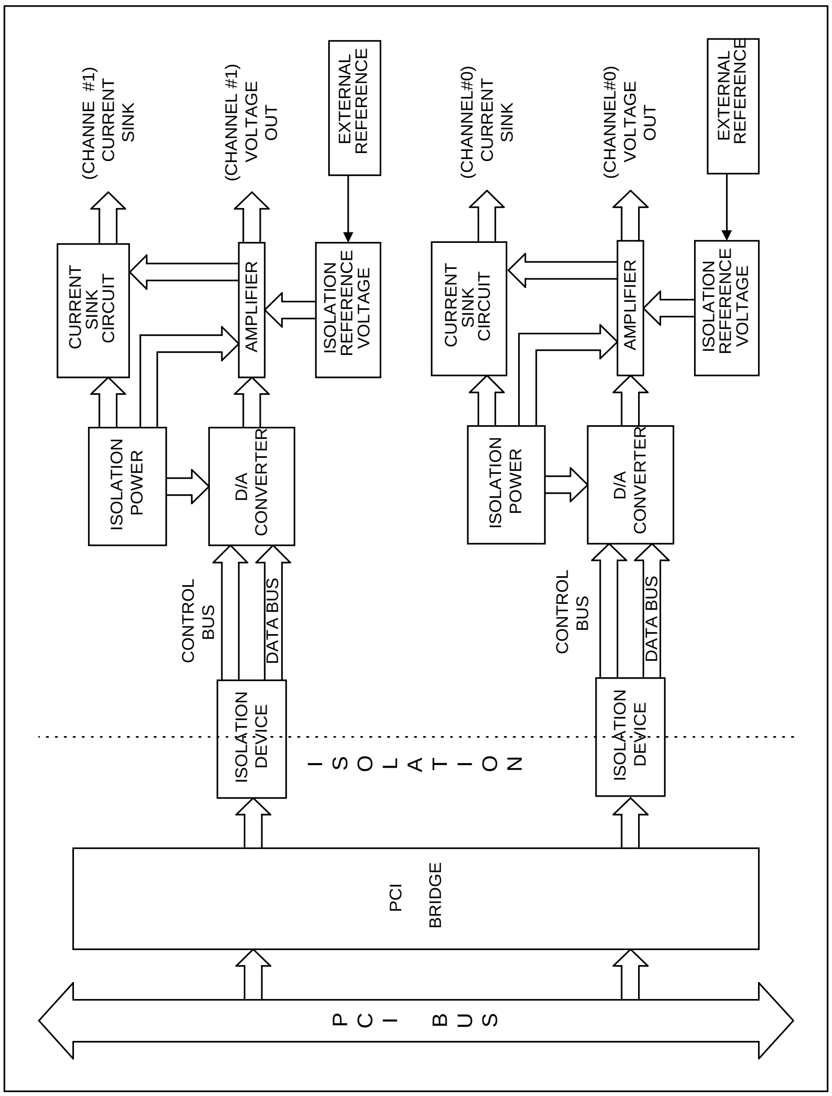
Connect your current meter to TP6 and TP8 as illustrated above.

c. Send data 0 (decimal) to the D/A. Adjust VR1 until the current meter shows 4.00mA.

d. Without removing the current meter from TP6 and TP8. Send data 4095 (decimal) to the D/A. Adjust VR2 until the current meter reads 20.00mA.

e. The procedure above is for the 4-20mA current loop adjustment. If the current output is set to 0-20mA by opening JP9 (channel #0) or JP11 (channel #1), repeat steps (a) and (b). Then you will only need to send data 4095 (decimal) to the D/A. Adjust VR2 until the current meter reads 20.00mA.

Appendix A
Block Diagram



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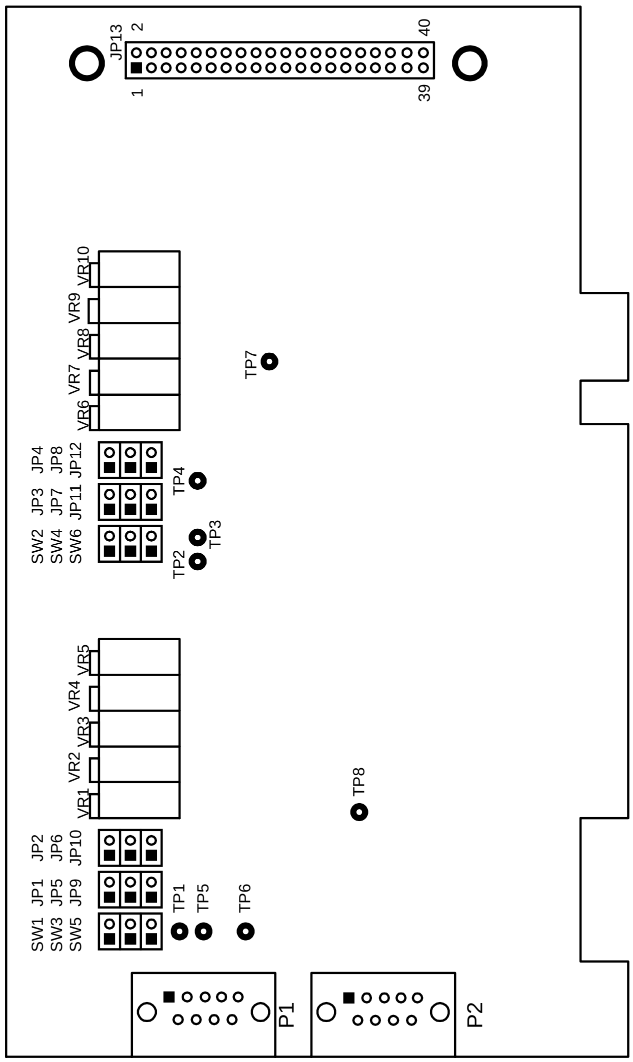
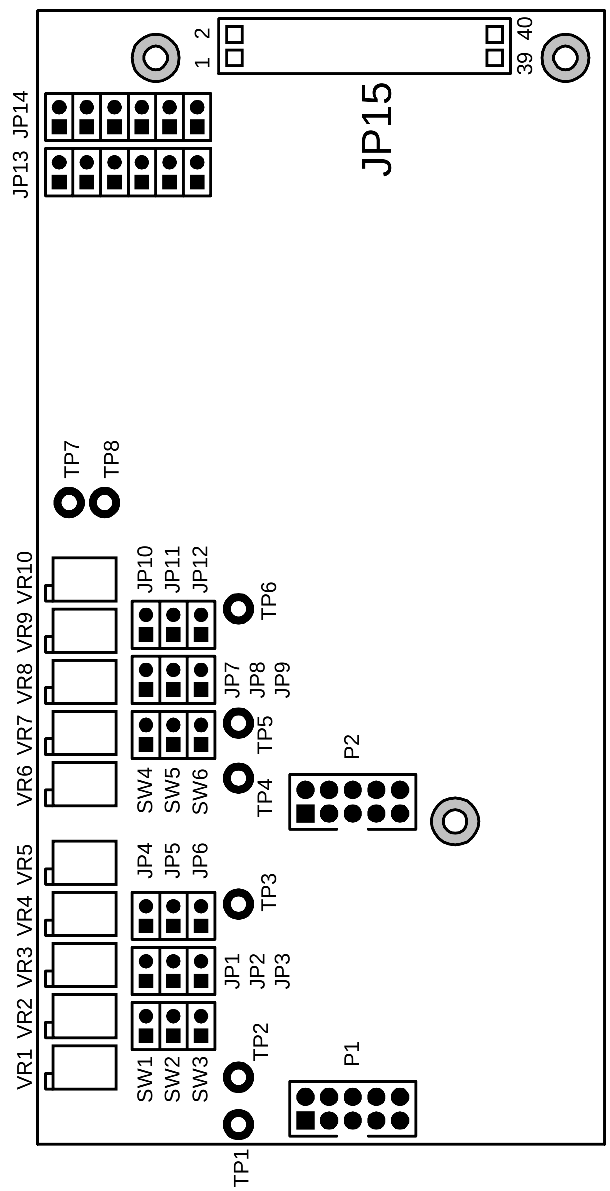
Appendix B
Location Diagrams

AX5300P



AX5301


JP15
1
2
39
40
JP13
JP14
TP7
TP8
VR1
VR2
VR3
VR4
VR5
VR6
VR7
VR8
VR9
VR10
JP10
JP11
JP12
JP7
JP8
JP9
JP4
JP5
JP6
JP1
JP2
JP3
SW1
SW2
SW3
SW4
SW5
SW6
TP1
TP2
TP3
TP4
TP5
TP6
P1
P2

Appendix C
Technical Reference

About AD7542

The DAC used within the board is AD754, it has three 4-bit data registers and one 12-bit DAC register. Data is loaded into the data registers in three 4-bit bytes, and subsequently transferred to the 12-bit DAC register.

Since the D/A's have 12-bit resolution, the digital data consist of: low, middle and high bytes. The byte, which is being sent, is determined by the operation address (A1, A0 refer to the following truth table). Low-byte is written and stored in middle-byte data register and high-byte data register respectively. At last transfer all of the data registers into a 12-bit DAC register.

Each time the PC or system power is turned ON, it simultaneously sets the CLR of AD7542 to active. The active CLR clears the DAC to 0000 0000 0000. When operating the AD7542 in a unipolar mode, an active CLR causes the DAC output to assume 0V. In the bipolar mode, an active CLR causes the DAC output to go to –VREF.

AD7542 Truth Table

<table>
<tr><th colspan="4">AD7542 Control Inputs</th><th colspan="2" rowspan="2">AD7542 Operation</th></tr>
<tr><th>A1</th><th>A0</th><th>WR</th><th>CLR</th></tr>
<tr><td>X</td><td>X</td><td>X</td><td>0</td><td colspan="2">Reset DAC 12-bit register to 0000 0000 0000</td></tr>
<tr><td>0</td><td>0</td><td>↑</td><td>1</td><td>Load LOW byte data register on edge as shown</td><td rowspan="3">Load data register with data at D3~D0</td></tr>
<tr><td>0</td><td>1</td><td>↑</td><td>1</td><td>Load MIDDLE byte data register on edge as shown</td></tr>
<tr><td>1</td><td>0</td><td>↑</td><td>1</td><td>Load HIGH byte data register on edge as shown</td></tr>
<tr><td>1</td><td>1</td><td>↑</td><td>1</td><td colspan="2">Load 12-bit DAC register with data in LOW byte, MIDDLE byte and HIGH byte data register</td></tr>
</table>

NOTE: *1. 1 includes logic high*

2. 0 includes logic low

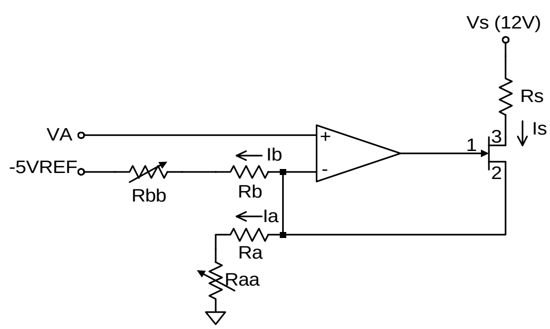
3. X indicates don't care

4 . ↑ indicates low to high transition

XXXX	XXXX	XXXX ← *LSB*
high byte	middle byte	low byte

Current Sink Circuit

AX5213 provides a 4-20mA current sink loop, which is controlled from VA output (0 to 4.9976V). The following diagram shows its application connection and calculation.



1. When VA = 0V, Is = 4mA

$\rightarrow$ Ia = 0

$$Ib = 4mA = \frac{0-(-5Vref)}{(Rb+Rbb)} = \frac{5V}{(Rb+Rbb)}$$

$\rightarrow$ (Rb+Rbb) = 1.25K

2. When VA = 4.9976, Is = 20mA

$$\rightarrow Ib = \frac{4.9976 + 5}{1.025K} = 7.998mA$$

Ia = 20mA – 7.998mA = 12.002mA

$$\rightarrow (Rb+Rbb) = \frac{4.9976V}{12.002mA} = 416.4\Omega$$

(Raa enables user to adjust for an accurate Is $\rightarrow$ 20mA)

Rs and Vs are a load resistance and an external power source respectively. The limitation of Rs is as follows:

$$Rs * Is + VA(max) < Vs - 0.5V$$

At normal use, VA(max) = 4.9976V

$$Is = 20mA$$

When Vs = 12V, Rs must be less than 325Ω

AXIOMTEK recommends the use of a 250Ω for Rs to generate 1 to 5V load voltage which is proportional to 4 to 20mA.

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