ISO-AD32

Hardware Manual

ICP DAS

Industrial Computer Products
Data Acquisition System

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Table of Contents

1.   Introduction

1.1   General Description

The ISO-AD32H/L (H for high gain / L for low gain) is a bus-type isolated 12-bit A/D board for PC/AT compatible computers. The isolation inputs can operate with up to 500Vrms of common-mode voltage.

The ISO-AD32H/L features a 200KHz 12-bit analog-to-digital converter, on board 1 K byte FIFO buffer, 32 singled-ended or 16 differential analog input channels. The analog input allows auto-channel/gain scan. This board support gap-free A/D conversion at 200KHz sampling rates for single channel or 100KHz sampling rates for channel scan.

The "Hands-Off" design permits all board parameters (channel selection, gain, input type, operating mode) to be performed in software. Once installed, you will never have to take care it again.

The board's innovative design improve several drawbacks of the conventional isolated A/D card. Such as :

1.   The speed is faster; up to 200KHz
2.   The sampling rate can be programmable
3.   On board FIFO buffer support gap-free A/D conversion and work well under NT and 95 environment.
4.   High channel count input can be implemented in half size .

1.2 The Block Diagrams

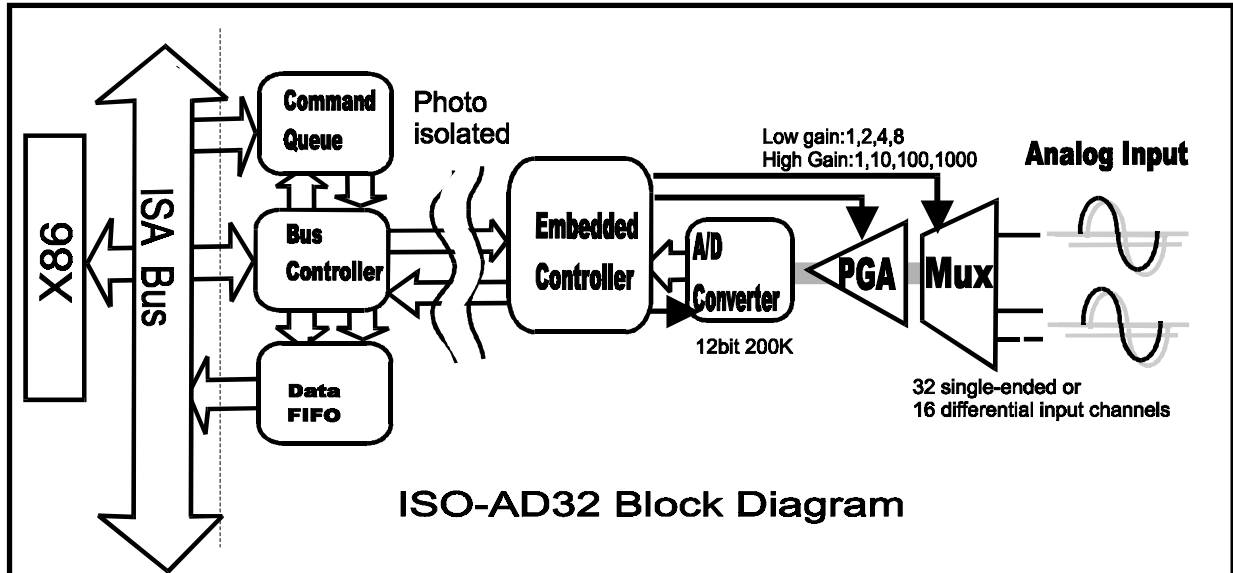The block diagram of ISO-AD32 series is shown below :

Fig 1 : The block diagram of ISO_AD32.

The X86 send one command to command queue through ISA bus. The embedded controller will auto read and execute this command. The results of this command will store in the data FIFO, therefore the X86 can read back and analysis the results through ISA bus.

The X86 site and the embedded controller is fully isolated. Therefore the noise from external device will be isolated from X86, this will improve the X86 reliability.

The X86 only need to send out command and the embedded controller will handle the control details. The features of command set system are given as following:

(1) : reduce X86 load
(2) : easy programming

1.3   Features

The general features of ISO-AD32 series are given as follows:

- 32 single-ended or 16 differential input channels, 500VDC photo-isolation protection
- Maximum 200K 12-bit sampling rate
- Built-in 1K byte FIFO
- Single -ended or differential input, can be jumper selectable
- Auto-channel / gain scan
- Command set programming
- Gap-free A/D conversion

1.4   Specifications

Analog Input Specifications
Channels : 32 single-ended/ 16 differential
Resolution : 12 bits
Conversion rate : 200KS/s max.
Input impedance : 10,000 MΩ‖6pF
Over voltage protection : +/-35V
Accuracy : 0.01% of reading   +/- 1 bit
Linearity : +/- 1 bit
On chip sample & hold
Zero drift : +/-25ppm/°C of FS max.

ISO-AD32H   Input Range
Bipolar : +/-10V,+/-5V,+/-1V,+/-0.5V,+/-0.1V,+/-0.05V,+/-0.01V,+/-0.005V
Unipolar : 0~10V,0~1V,0~0.1V,0~0.01V

Gain	Bipolar(V)	Unipolar(V)	Throughput
1/0.5	±5 / ±10	0~10	125k/s
10/5	±0.5 / ±1	0~1	80k/s
100/50	±0.05 / ±0.1	0~0.1	10k/s
1000/500	±0.005 / ±0.01	0~0.01	1k/s

ISO-AD32L Input Range
Bipolar : +/-10V,+/-5V,+/-2.5V,+/-1.25V,+/-0.0625
Unipolar : 0~10V,0~5V,0~2.5V,0~1.25V

Gain	Bipolar(V)	Unipolar(V)	Throughput
0.5	±10	X	200K/s
1	±5	0~10	200K/s
2	±02.5	0~5	200K/s
4	±1.25	0~2.5	200K/s
8	±0.625	0~1.25	200k/s

Power Requirements: +5V @850mA max.

General Environmental
Operating temp   0-50°C
Storage temp   -20°C   to   70°C
Humility   0 to 90%   non-condensing
Dimensions   173 mm x 122 mm

1.5   Product Check List

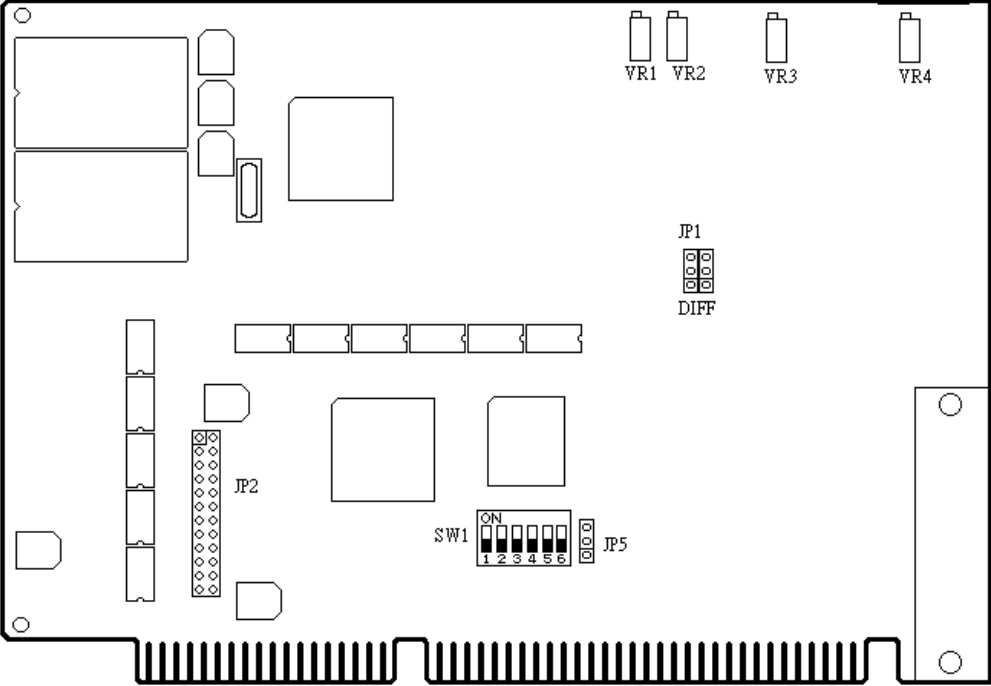In addition to this manual, the package includes the following items:

- ISO_AD32 multifunction card.
- One company floppy diskette or CD.
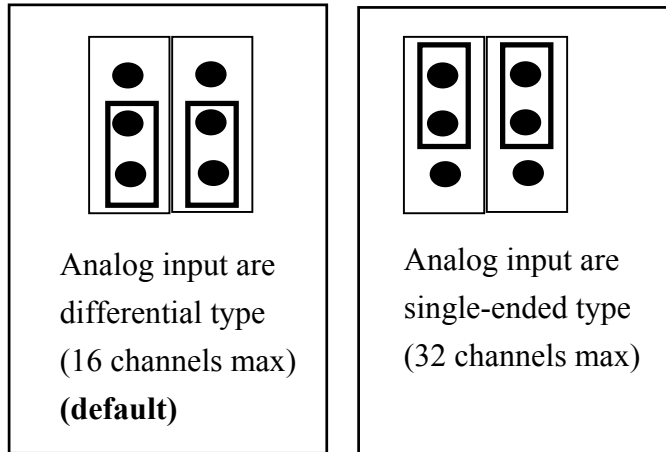- One DOS software user's manual.

Attention !

If any of these items is missing or damaged, please contact your local field agent. Save the shipping materials and carton in case you want to ship or store the product in the future.

2. Hardware Configuration

2.1 Board Layout

2.2　JP1 : Single-ended/Differential Analog Input Type Select

Analog input are
differential type
(16 channels max)
(default)

Analog input are
single-ended type
(32 channels max)

2.3　JP2 : IRQ Channel Selection

IRQ3
IRQ4
IRQ5
IRQ6
IRQ7
IRQ9
IRQ10
IRQ11
IRQ12
IRQ14
IRQ15
NC **(default)**
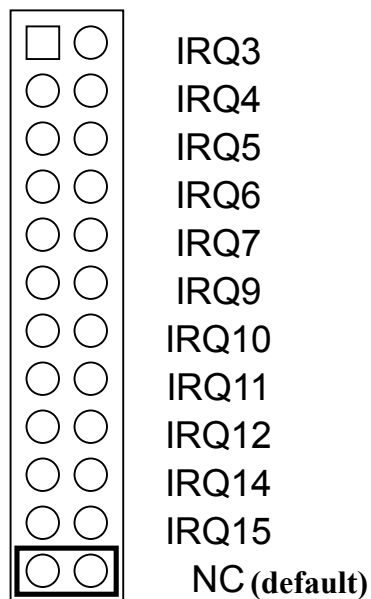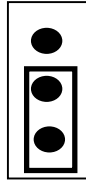
2.4　JP5 : Wait State
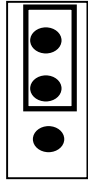
Normal Speed
(default)

ISA bus select
zero wait

2.5　VRs

V1 : AD offset adjustment
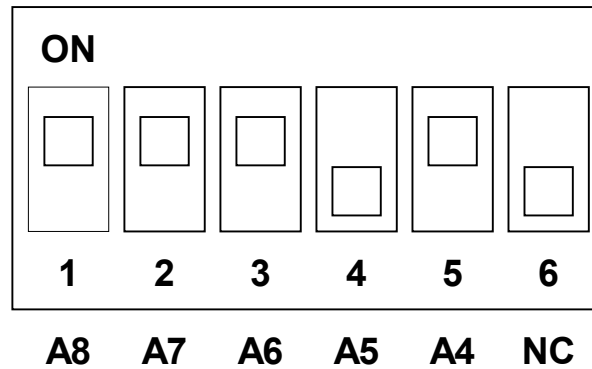
VR2 : AD gain adjustment

VR3 : -5V adjustment

VR4 : PGA offset adjustment

The detail calibration steps are given in "DOS software manual" Sec. 4.1.4.

2.6 I/O Base Address Setting

The ISO-AD32 occupies 8 consecutive locations in I/O address space from BASE to BASE+7. The default setting is 0x220 as following :

```
ON

  ┌─┐  ┌─┐  ┌─┐        ┌─┐
  │ │  │ │  │ │   ┌─┐  │ │  ┌─┐
  │ │  │ │  │ │   │ │  │ │  │ │
  └─┘  └─┘  └─┘   └─┘  └─┘  └─┘

   1    2    3    4    5    6

  A8   A7   A6   A5   A4   NC
```

Base Addr	A8	A7	A6	A5	A4
200	On	On	On	On	On
210	On	On	On	On	Off
220	On	On	On	Off	On
230	On	On	On	Off	Off
250	On	On	Off	On	Off
:	:	:	:	:	:
300	Off	On	On	On	On
:	:	:	:	:	:
3F0	Off	Off	Off	Off	Off

2.7   CN1 Connectors

Pin assignment for single-ended analog input

Pin	Name	Pin	Name
1	AI0	20	AI16
2	AI1	21	AI17
3	AI2	22	AI18
4	AI3	23	AI19
5	AI4	24	AI20
6	AI5	25	AI21
7	AI6	26	AI22
8	AI7	27	AI23
9	AI8	28	AI24
10	AI9	29	AI25
11	AI10	30	AI26
12	AI11	31	AI27
13	AI12	32	AI28
14	AI13	33	AI29
15	AI14	34	AI30
16	AI15	35	AI31
17	Analog Common	36	Analog GND
18	Digital +5V output	37	Digital GND
19	External Trigger Input		
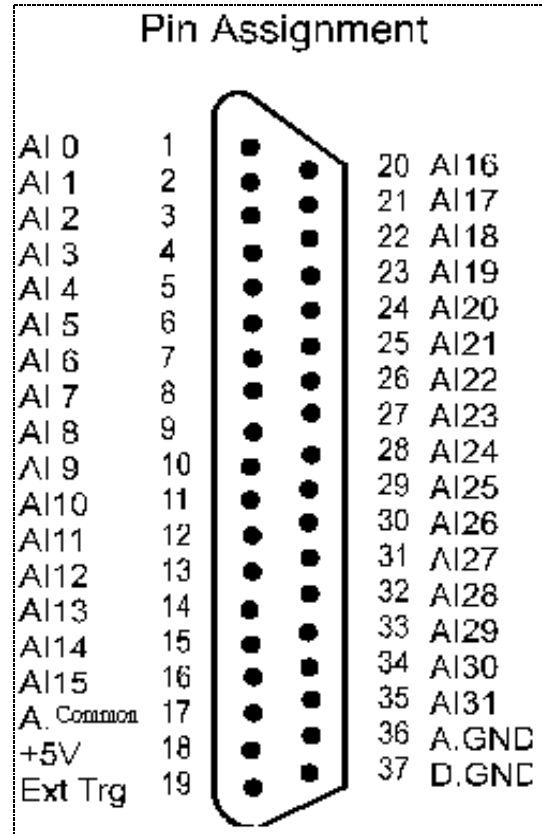
Pin Assignment

Pin assignment for differential analog input

| Pin	Name	Pin	Name
1	AI0+	20	AI0-
2	AI1+	21	AI1-
3	AI2+	22	AI2-
4	AI3+	23	AI3-
5	AI4+	24	AI4-
6	AI5+	25	AI5-
7	AI6+	26	AI6-
8	AI7+	27	AI7-
9	AI8+	28	AI8-
10	AI9+	29	AI9-
11	AI10+	30	AI10-
12	AI11+	31	AI11-
13	AI12+	32	AI12-
14	AI13+	33	AI13-
15	AI14+	34	AI14-
16	AI15+	35	AI15-
17	Analog Cmmon	36	Analog GND
18	Digital +5V output	37	Digital GND
19	External Trigger Input		
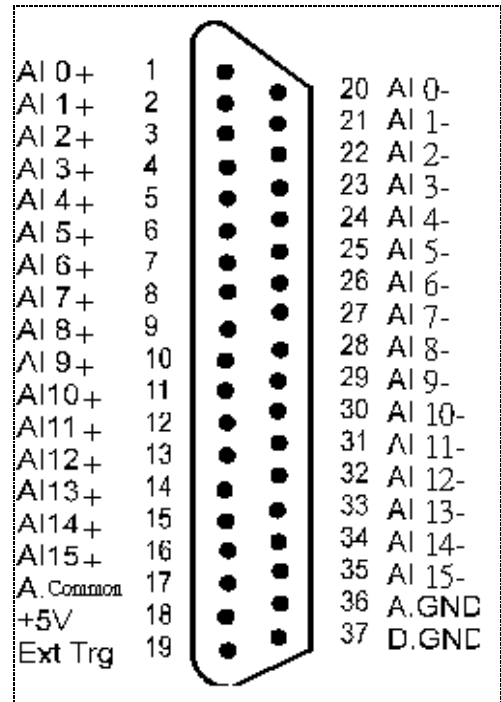
2.8   Daughter Boards

2.8.1   DB1825

The DB-1825 is a daughter board designed for 32 channels AD cards such as ISO_AD32 or PCI-1802. Refer to Appendix A for DB-1825 user manual.
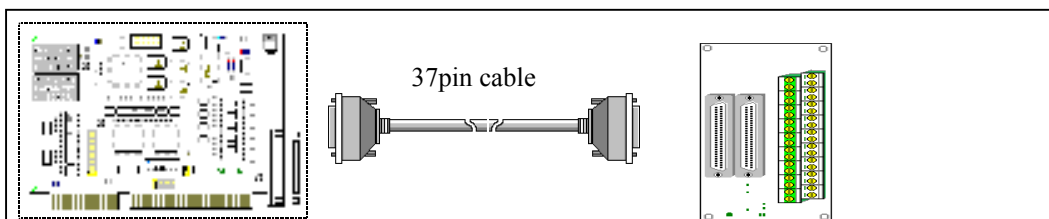

37pin cable
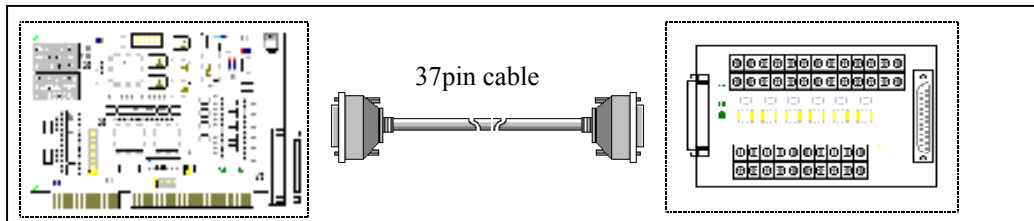
2.8.2   DB37

The DB-37 is a daughter board for D-sub 37 pins. It is designed for easy wire connection.

37pin cable

connection 1 : by 37 pin cable

connection 2 : direct connect
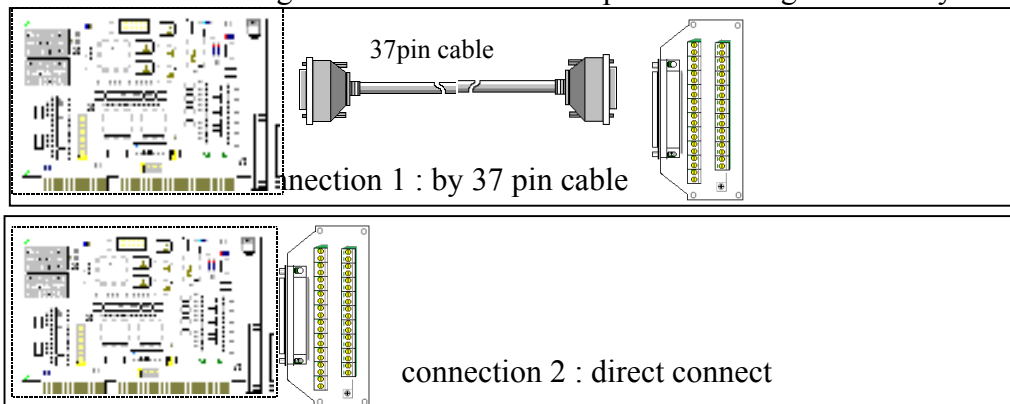
2.8.3   DN37

The DN-37 is a daughter board for 37 pins DIN Rail Mounting. It is designed for easy wire connection.

37pin cable

3.   Function Operation

3.1   AD Conversion Operation

The user do not need to know about the detail control of AD operations, the embedded controller will handle the details.

3.1.1   The Configuration Code Table

ISO-AD32L Input Range Configuration Code Table

Bipolar/Unipolar	Input Signal Range	Gain	Settling Time	Configuration Code
Bipolar	+/- 5V	1	3 us	0x00
Bipolar	+/- 2.5V	2	3 us	0x10
Bipolar	+/- 1.25V	4	3 us	0x20
Bipolar	+/- 0.625V	8	3 us	0x30
Bipolar	+/- 10V	0.5	3 us	0x80
Bipolar	+/- 5V	1	3 us	0x90
Bipolar	+/- 2.5V	2	3 us	0xA0
Bipolar	+/- 1.25V	4	3 us	0xB0
Unipolar	0V ~ 10V	1	3 us	0x00
Unipolar	0V ~ 5V	2	3 us	0x10
Unipolar	0V ~ 2.5V	4	3 us	0x20
Unipolar	0V ~ 1.25V	8	3 us	0x30

ISO-AD32H Input Range Configuration Code Table

Bipolar/Unipolar	Input Signal Range	Gain	Settling Time	Configuration Code
Bipolar	+/- 5V	1	23 us	0x00
Bipolar	+/- 0.5V	10	28 us	0x10
Bipolar	+/- 0.05V	100	140 us	0x20
Bipolar	+/- 0.005V	1000	1300 us	0x30
Bipolar	+/- 10V	0.5	23 us	0x80
Bipolar	+/- 1V	5	28 us	0x90
Bipolar	+/- 0.1V	50	140 us	0xA0
Bipolar	+/- 0.01V	500	1300 us	0xB0
Unipolar	0V ~ 10V	1	23 us	0x00
Unipolar	0V ~ 1V	10	28 us	0x10
Unipolar	0V ~ 0.1V	100	140 us	0x20
Unipolar	0V ~ 0.01V	1000	1300 us	0x30

3.1.2   Analog Input Type Selection

The analog input signal can be single-ended or differential. If select single-ended, there can be 32 channels max. If select differential, there can be only 16 channels max. But some signal can not be connected as single-ended input, such as thermocouple couple sensor. Refer to Sec 3.7 for analog signal input type selection.

The embedded control can read back the JP1 setting. If the software tell the embedded controller to perform single-ended operation and the JP1 **in the wrong setting**, the embedded controller will **return a error code**. Refer to software manual for details.

3.1.2.1   Unipolar/Bipolar

If the analog input signal is unipolar, you can measure this signal with bipolar setting (**this will reduce resolution only**). If the analog input is bipolar, you must select bipolar configuration code to measure this signal.

3.1.3 The Input Signal Range

If the input range of analog signal is +/- 1V, you can measure this signal wih +/-10V, +/-5V, +/-2.5V and +/- 1.25V configuration code setting. The only difference is the resolution. The resolution of +/- 2.5V is 4 times higher than in +/- 10V setting. **Select the correct configuration code will get the best resolution**.

3.1.3.1 The Gain Factor

The analog input signal will be amplified by gain factor. If the user wish to compute the real value, the AD data must divided with the gain factor. The general real value computation functions is given as follows:

```
double AD32L_ComputeRealValueBipolar(WORD wAdConfig, WORD wAdHex)
{
WORD wZERO=2048;
double dfMAX, dfVal;

switch (wAdConfig)
      {
      case 0x00 :   dMAX=5.0;       break;
      case 0x10 :   dMAX=2.5;       break;
      case 0x20 :   dfMAX=1.25;     break;
      case 0x30 :   dfMAX=0.625;    break;
      case 0x80 :   dfMAX=10.0;     break;
      case 0x90 :   dfMAX=5.0;      break;
      case 0xA0 :   dfMAX=2.5;      break;
      case 0xB0 :   dfMAX=1.25;     break;
      default : return(ConfigCodeError);;
      }

dfVal=(((double)(wAdHex)-wZERO)/2048.0)*dfMAX;
return(dfVal);
}
```

```
double AD32L_ComputeRealValueUnipolar(WORD wAdConfig, WORD wAdHex)
{
WORD wZERO=0;
double dfMAX, dfVal;

switch (wAdConfig)
        {
        case 0x00 :   dMAX=10.0;      break;
        case 0x10 :   dMAX=5.0;       break;
        case 0x20 :   dfMAX=2.5;      break;
        case 0x30 :   dfMAX=1.25;     break;
        default : return(ConfigCodeError);;
        }
dfVal=(((double)(wAdHex)-wZERO)/2048.0)*dfMAX;
return(dfVal);
}
```

```
double AD32H_ComputeRealValueBipolar(WORD wAdConfig, WORD wAdHex)
{
WORD wZERO=2048;
double dfMAX, dfVal;

switch (wAdConfig)
        {
        case 0x00 :   dMAX=5.0;       break;
        case 0x10 :   dMAX=0.5;       break;
        case 0x20 :   dfMAX=0.05;     break;
        case 0x30 :   dfMAX=0.005;    break;
        case 0x80 :   dfMAX=10.0;     break;
        case 0x90 :   dfMAX=1.0;      break;
        case 0xA0 :   dfMAX=0.1;      break;
        case 0xB0 :   dfMAX=0.01;     break;
        default : return(ConfigCodeError);;
        }

dfVal=(((double)(wAdHex)-wZERO)/2048.0)*dfMAX;
return(dfVal);
}
```

```
double AD32H_ComputeRealValueUnipolar(WORD wAdConfig, WORD wAdHex)
{
WORD wZERO=0;
double dfMAX, dfVal;

switch (wAdConfig)
        {
        case 0x00 :   dMAX=10.0;      break;
        case 0x10 :   dMAX=1.0;       break;
        case 0x20 :   dfMAX=0.1;      break;
        case 0x30 :   dfMAX=0.01;     break;
        default : return(ConfigCodeError);;
        }

dfVal=(((double)(wAdHex)-wZERO)/2048.0)*dfMAX;
return(dfVal);
}
```

3.1.3.2   The Settling Time

If the channel number or gain factor is change, the hardware need **extra time for signal ready**. This is called the settling time. This limitation will apply both to the **Fixed-channel mode** and **MagicScan mode** AD conversions. So the user must take care to avoid the settling error. Refer to "DOS software manual" Sec. 3.6.

3.1.3.3   How to Delay the Settling Time

The **software driver** can auto delay the settling time. Refer to "DOS software manual" Sec. 3.6 for **fixed-channel** AD conversion.

It is **no need** to delay the settling time in the **channel-scan** mode AD conversion

3.1.4   The AD Conversion Mode

The AD operation can be **fixed-channel** mode or **channel-scan** mode. In the fixed-channel mode, the AD operation will fix at one channel until the **change channel command** is received. Refer to "DOS software manual" Sec3.6, Sec. 3.7, Sec. 3.9, Sec. 3.10 for details.

In the channel scan mode, the embedded controller will auto scan and change gain. The **scan sequence** and **gain for each channel** can be programmable. Refer to the software manual for details. Refer to "DOS software manual" Sec3.16, Sec. 3.17, Sec. 3.18 for details.

3.1.5   The Channel Scan Circular_Scan_Queue

     The channel scan controller equips with a **circular queue** for scan sequence control. The scan sequence is **one by one** and **repeatable** with the limitation of maximum 32 channels. So the following scan sequence are all validate :
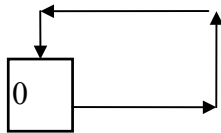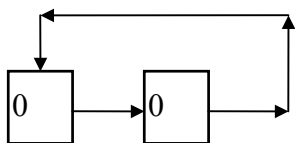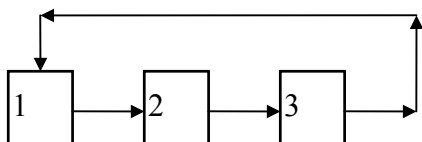
One channel scan
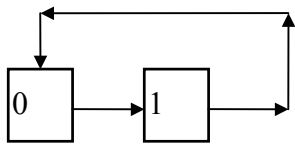
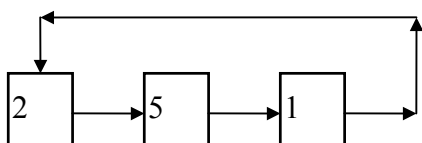two channel scan, scan sequence=010101
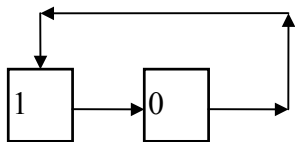
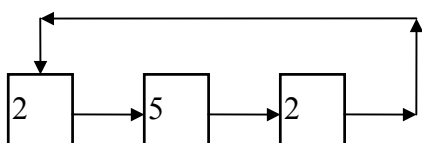two channel scan, scan sequence=101010
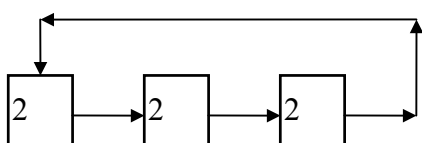
two channel scan, scan sequence=000000

Three channel scan : 123123123

Three channel scan : 251251251

Three channel scan : 252252252

Three channel scan : 222222222

3.1.6   Trigger Methods :

The trigger methods are giving as following:

(1) Internal trigger = software trigger + pacer trigger
(2) External trigger = post-trigger + middle-trigger + pre-trigger
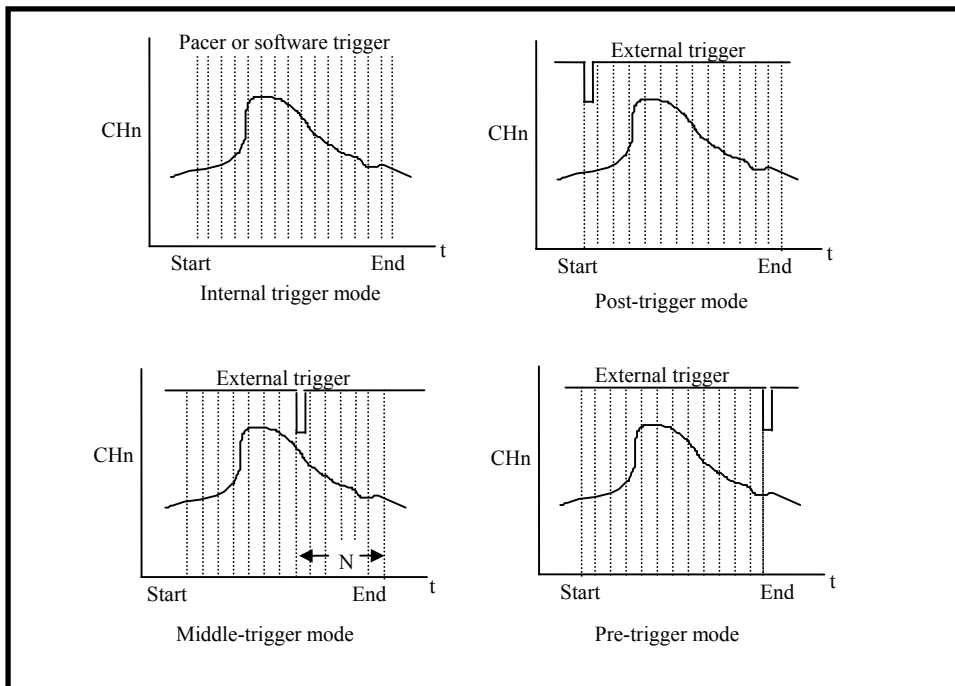

Fig 1-2: Trigger methods of ISO-AD32.

The software trigger is the easy way and isn't suitable for input wave form reconstruction. The pacer trigger provide a programmable pacer for fixed time interval AD sampling, therefore it is suitable for input wave form reconstruction.

The external trigger must used with pacer timer. This pacer timer is same as the internal pacer trigger timer. Both the internal pacer trigger and external trigger use the same pacer timer. The external trigger can be post-trigger, middle trigger or pre-trigger software programmable.

The user can select one of these trigger. Refer to software manual for details.

3.2   Diagnostic Program

Refer to   "ISO-AD32 DOS software manual" Chapter 4 for details.

3.3   Calibration

Refer to   "ISO-AD32 DOS software manual" Sec 4.1.4 for details.

3.4   Analog Signal Connection

The ISO_AD32 can measure single-ended or differential type analog input signal. Some analog signal can be measured in both of single-end or differential mode but some only can be measured in one of the single-ended or differential mode. The user must decide which mode is suitable for measurement.

In general, there are 3 different analog signal connection method as shown in Fig1 to Fig3. The Fig1 is suitable for grounding source analog input signals. The Fig2 can measure more channels than in the Fig1 but only suitable for large analog input signals. The Fig3 is suitable for thermocouple and the Fig4 is suitable for floating source analog input signals.

Note : In Fig3, the maximum common mode voltage between the analog input source and the AGND is 70Vp-p, so the user must make sure that the input signal is under specification first. If the common mode voltage is over 70Vp-p, the input multiplexer will be damaged forever.
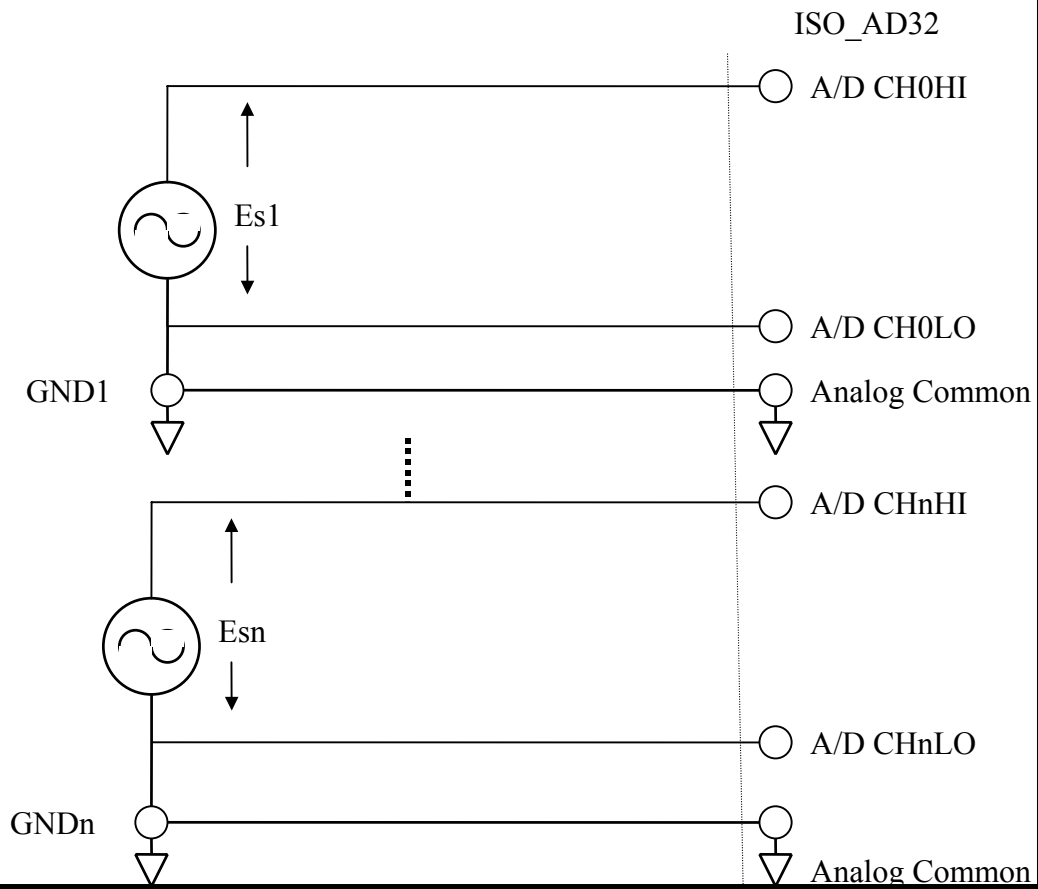
The simple way to select the input signal connection configuration is as below.

1. **Grounding source input signal $\rightarrow$ select Fig1**
2. **Thermocouple input signal $\rightarrow$ select Fig3**
3. **Floating source input signal $\rightarrow$ select Fig4**
4. **If <u>Vin > 0.1V</u> and <u>gain<=10</u> and need more channels $\rightarrow$ select Fig2**
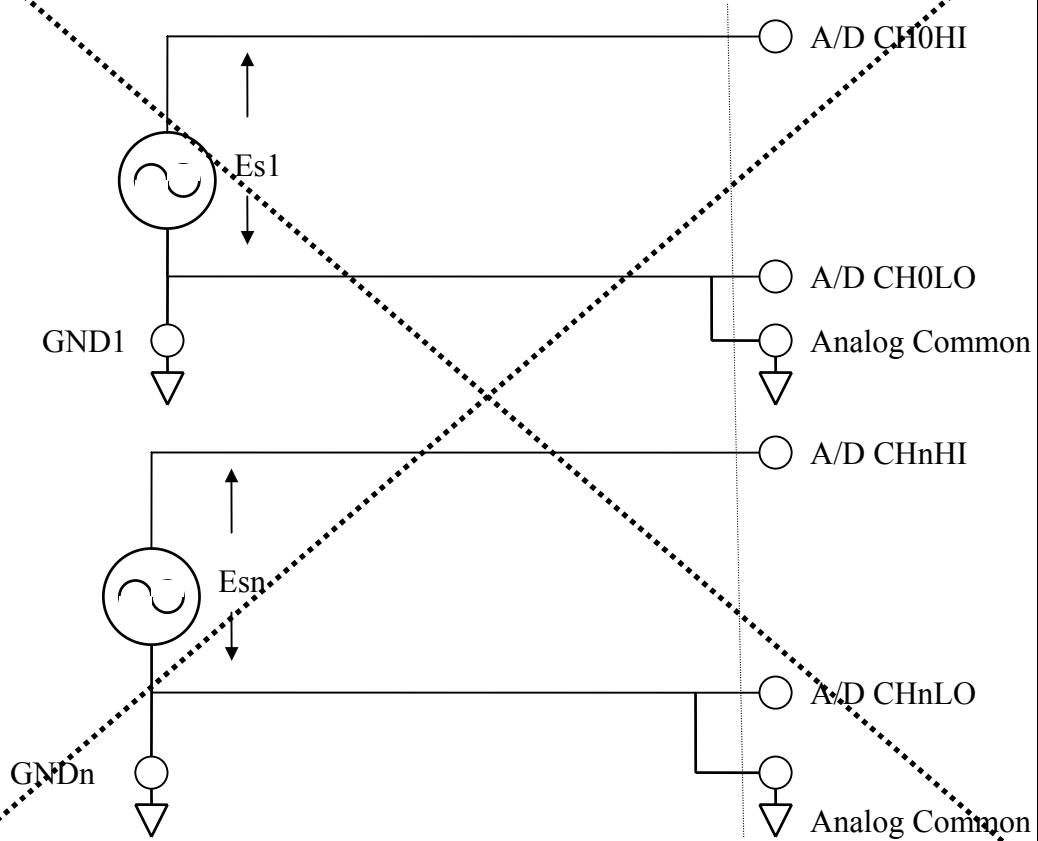
If the user can not make sure the characteristic of input signal, the test steps are given as below:

1. **Step1 : try Fig1 and record the measurement result**
2. **Step2 : try Fig4 and record the measurement result**
3. **Step3 : try Fig2 and record the measurement result**
4. **Compare the measurement result of step1,step2,step3 and select the best one**
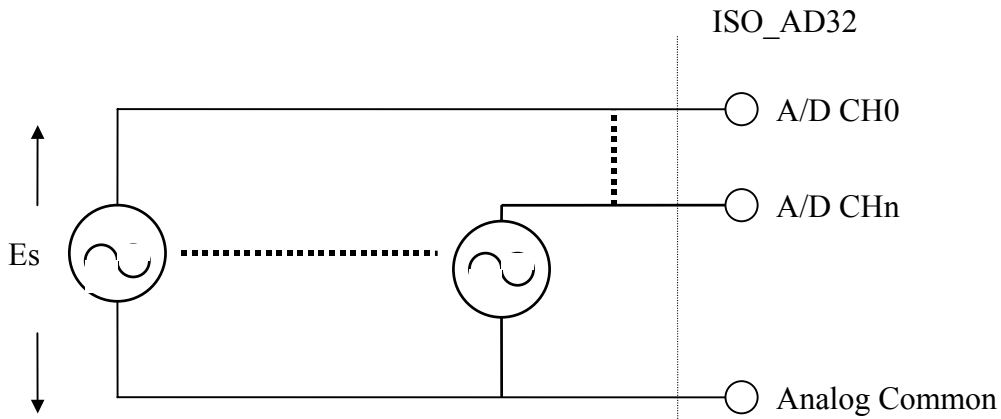
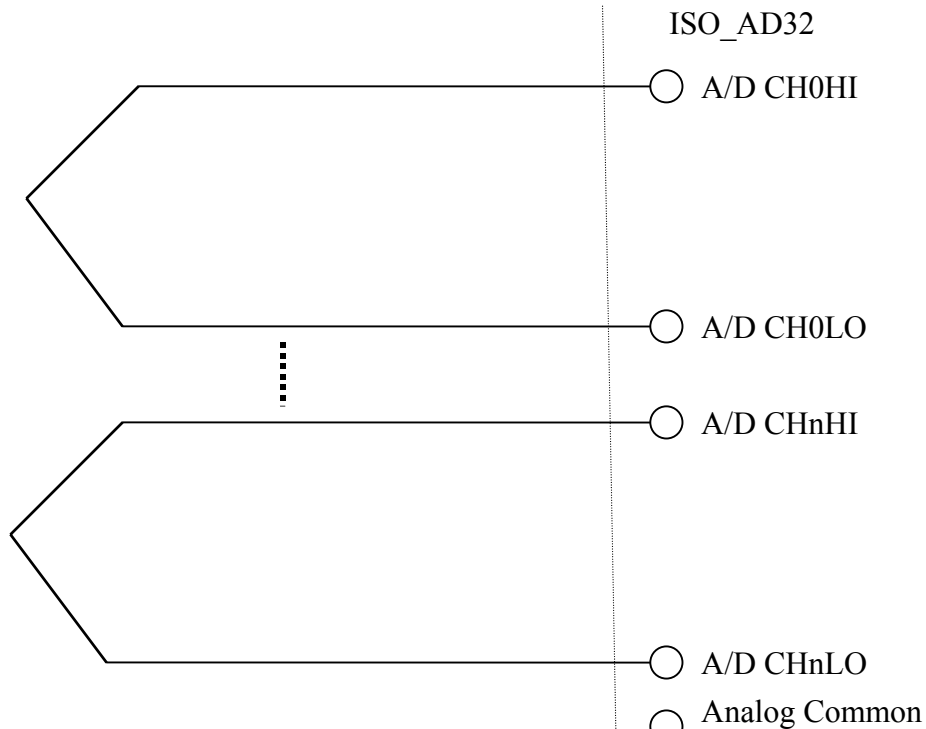## 1. FG1 : Connecting to grounding source input (Right way)

ISO_AD32

○ A/D CH0HI

Es1

○ A/D CH0LO

GND1 ○ Analog Common

○ A/D CHnHI

Esn

○ A/D CHnLO

GNDn ○ Analog Common

FG1 : Wrong way

○ A/D CH0HI

Es1

○ A/D CH0LO

GND1 Analog Common

○ A/D CHnHI

Esn

○ A/D CHnLO

GNDn Analog Common

FG2 : Connecting to singled-ended input configuration

ISO_AD32

○ A/D CH0

○ A/D CHn

Es

○ Analog Common

FG3 : connecting to thermocouple configuration

ISO_AD32

○ A/D CH0HI

○ A/D CH0LO

○ A/D CHnHI

○ A/D CHnLO

○ Analog Common

Note : If the input signal is not thermocouple, the user should use oscilloscope to measure common mode voltage of Vin before connecting to ISO-AD32. Don't use voltage meter or multimeter.

Do not join LO to **Analog Common** at the computer

CAUTION : In Fig3, the maximum common mode voltage between the analog input source and the AGND is 70Vp-p, so the user must make sure that the input signal is under specification first. If the common mode voltage is over 70Vp-p, the input multiplexer will be damaged forever.

FG4 : connecting to floating source configuration

ISO_AD32

A/D CH0HI

Es

A/D CH0LO

Analog Common

A/D CHnHI

Esn

A/D CHnLO

Analog Common
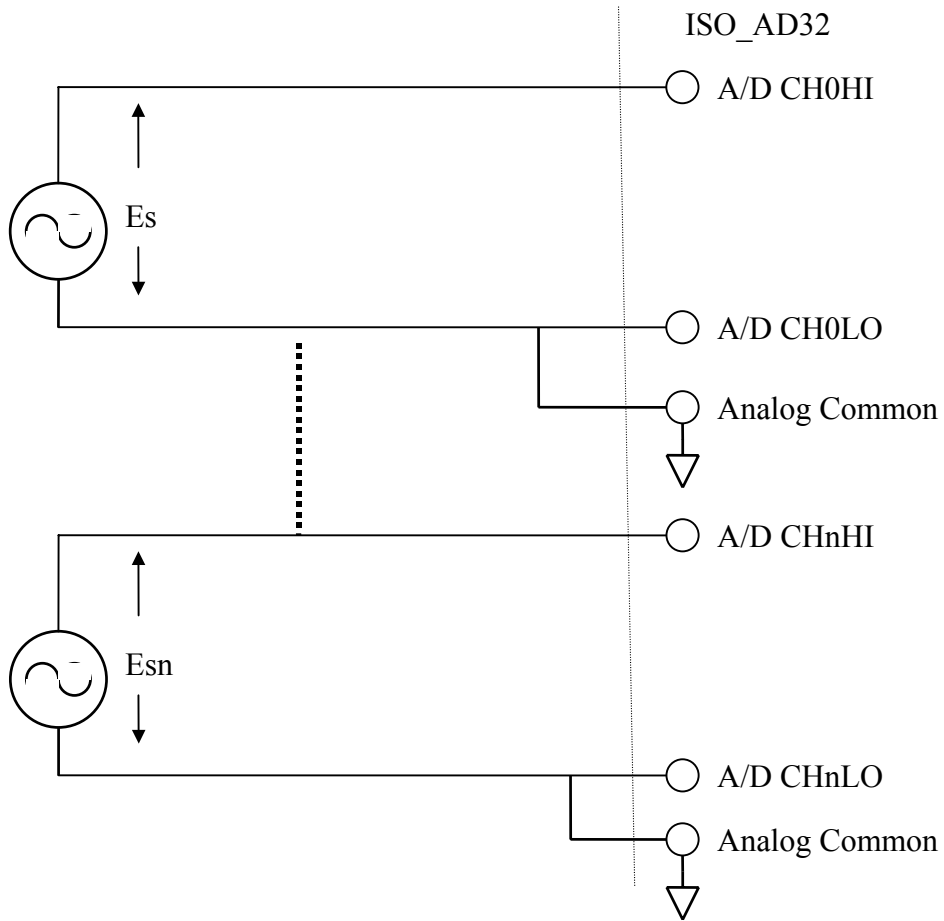
Signal Shielding
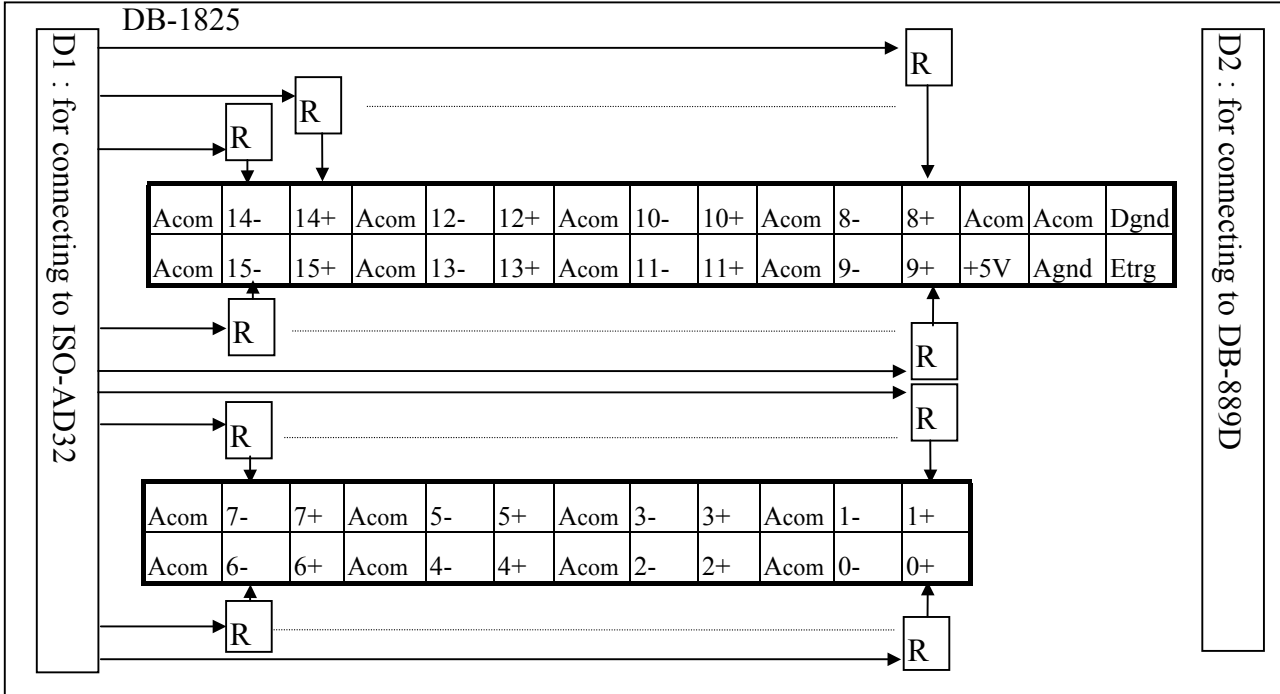
- Signal shielding connections in Fig1 to Fig4 are all the same
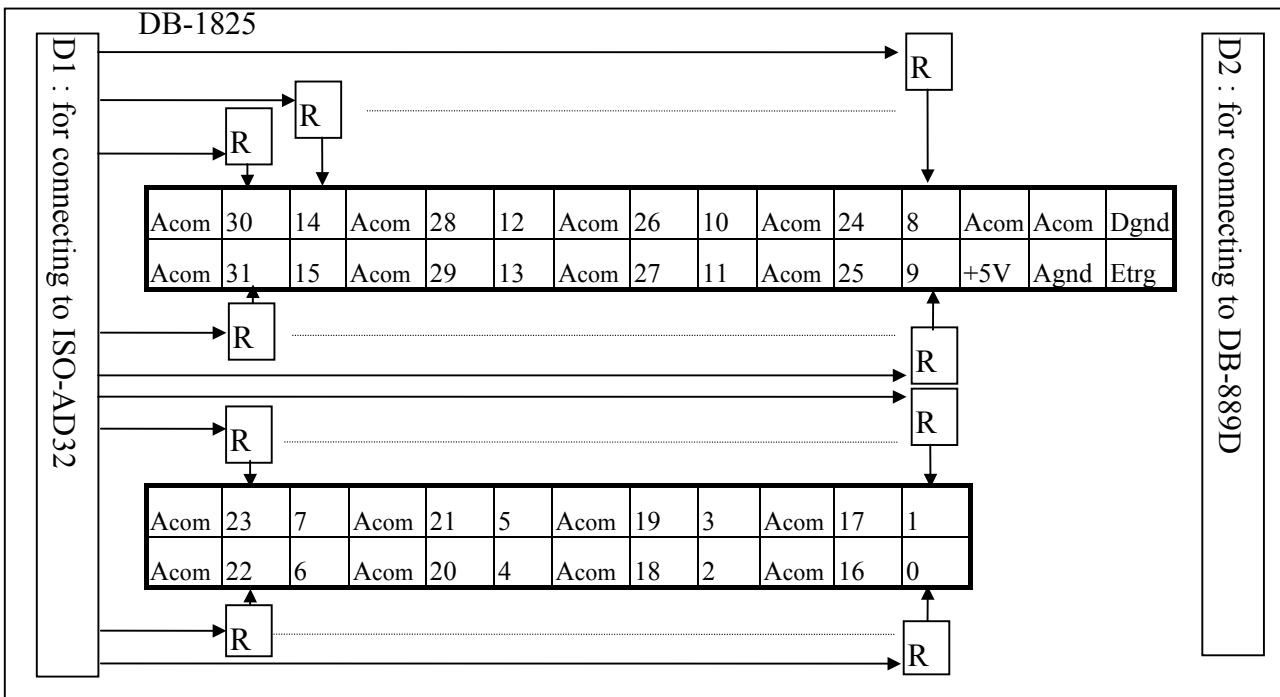- Use single-point connection to **frame ground (not AGND or DGND)**

Vin

ISO_AD32
AGND
DGND

Frame Ground
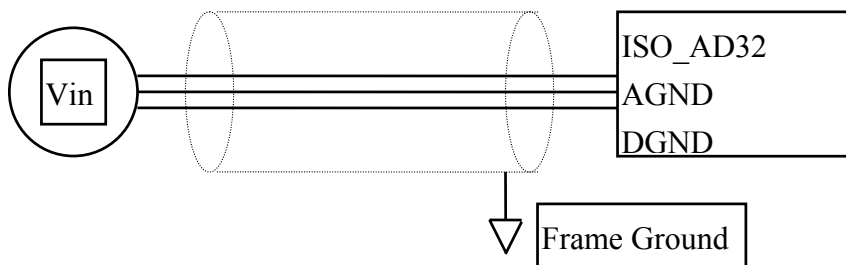
Appendix A : The DB-1825 user manual

A.1 : PCB layout for connecting to ISO_AD32:

for differential input (R=0 ohm)

DB-1825

D1 : for connecting to ISO-AD32

D2 : for connecting to DB-889D

| Acom | 14- | 14+ | Acom | 12- | 12+ | Acom | 10- | 10+ | Acom | 8- | 8+ | Acom | Acom | Dgnd |
| Acom | 15- | 15+ | Acom | 13- | 13+ | Acom | 11- | 11+ | Acom | 9- | 9+ | +5V | Agnd | Etrg |

| Acom | 7- | 7+ | Acom | 5- | 5+ | Acom | 3- | 3+ | Acom | 1- | 1+ |
| Acom | 6- | 6+ | Acom | 4- | 4+ | Acom | 2- | 2+ | Acom | 0- | 0+ |

for single-ended input (R=0 ohm)

DB-1825

D1 : for connecting to ISO-AD32

D2 : for connecting to DB-889D

| Acom | 30 | 14 | Acom | 28 | 12 | Acom | 26 | 10 | Acom | 24 | 8 | Acom | Acom | Dgnd |
| Acom | 31 | 15 | Acom | 29 | 13 | Acom | 27 | 11 | Acom | 25 | 9 | +5V | Agnd | Etrg |

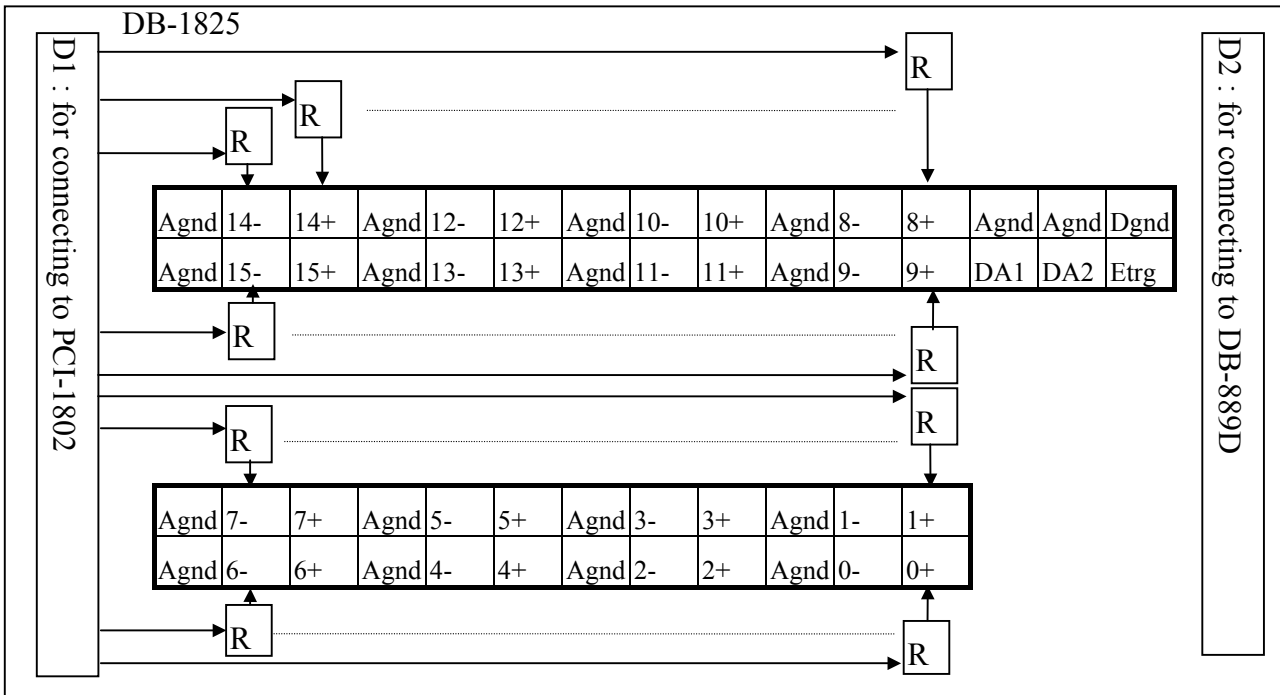| Acom | 23 | 7 | Acom | 21 | 5 | Acom | 19 | 3 | Acom | 17 | 1 |
| Acom | 22 | 6 | Acom | 20 | 4 | Acom | 18 | 2 | Acom | 16 | 0 |

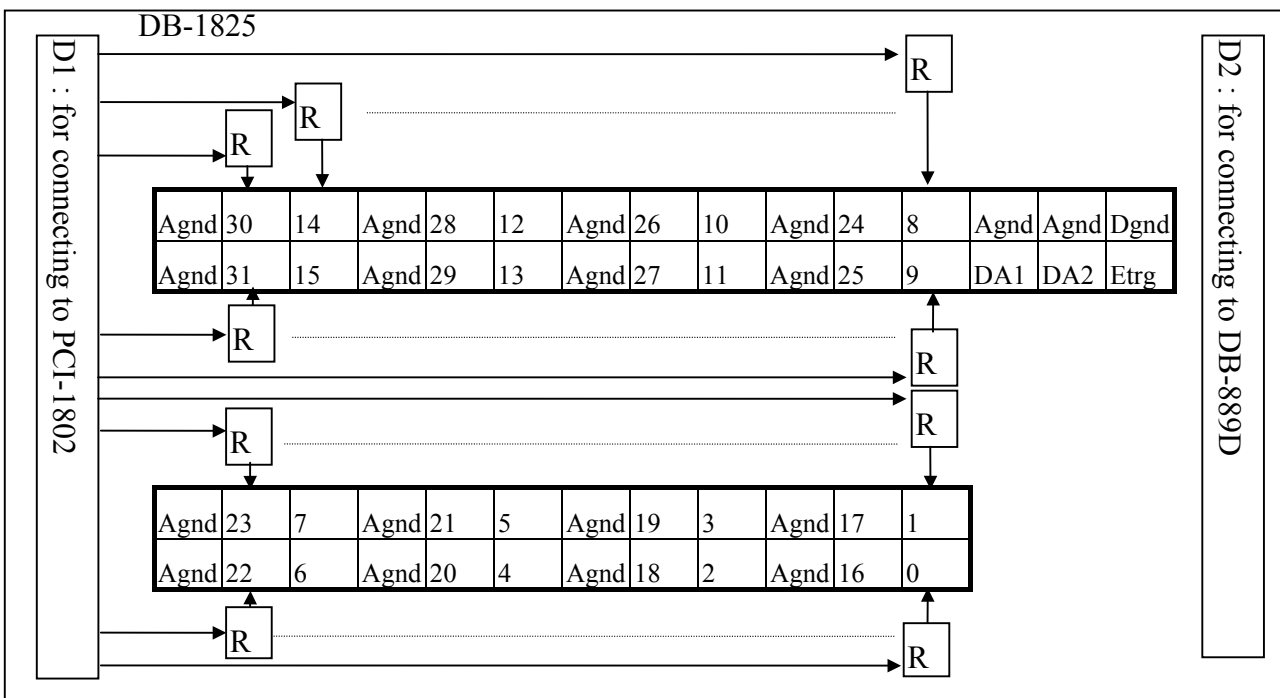Pin assignment of D1 same as **CN1 of ISO-AD32**

Pin assignment of D2 same as **CN1 of DB-889D**

A.2 : PCB layout for connecting to PCI-1802:
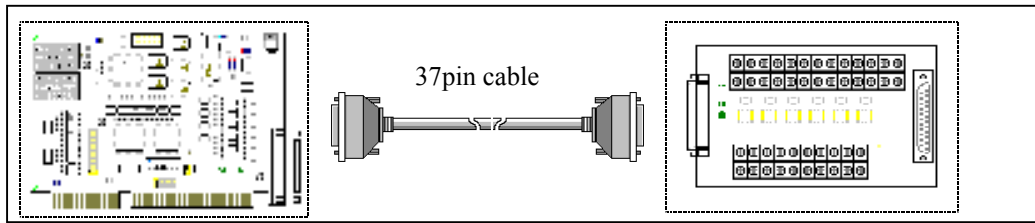
for differential input (R=0 ohm)
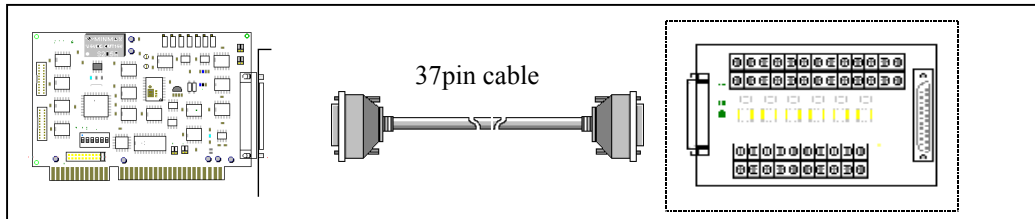

for single-ended input (R=0 ohm)

Pin assignment of D1 same as **CON3 of PCI-1802**

Pin assignment of D2 same as **CN1 of DB-889D**

A.3 : connection to ISO-AD32

37pin cable

A.4 : connection to PCI-1802

37pin cable

A.5 : connection to PCI-1802 and multiple DB-889D(16 channels differential)

37pin cable

37pin cable

20 pins flat cable