# ISO-4

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ISO-4 Manual

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by

**KEITHLEY METRABYTE/ASYST/DAC**

## WARRANTY INFORMATION

All products manufactured by Keithley MetraByte are warranted against defective materials and workmanship for a period of one year from the date of delivery to the original purchaser. Any product that is found to be defective within the warranty period will, at the option of Keithley MetraByte, be repaired or replaced. This warranty does not apply to products damaged by improper use.

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CHAPTER ONE
Introduction

## 1.1 Summary of ISO-4 Functions:

The ISO-4 is a high speed, universal expansion interface and isolation amplifier designed for use with virtually all data acquisition systems. The ISO-4 consists of 4 fully isolated, differentially measured input channels supporting 7 jumper selectable gains of X1, 2, 10, 50, 100, 200, and 1000 on a per channel basis. It also has provisions for user installable resistors to customize the gain to your specific requirements. Provisions have been made for thermocouple temperature measurements using J, K, T, R, S, B, and E type thermocouples. Built-in Cold Junction Compensation (CJC) providing 24 mV/Deg C resolution is standard. Each input channel provides very high isolation to +/- 1000 Vdc (peak, continuous). Open thermocouple sensing, input filtering and provisions for milliAmp measurements make the ISO-4 one of the most versatile, industrial quality multiplexors available. The ISO-4 also provides an isolated 1mA current source and an isolated, fully adjustable voltage source (+/- 6.9 Vdc) for RTD and strain gage bridge excitation. Multiple ISO-4's may be easily cascaded to a maximum of 128 input channels (112 thermocouples) with every channel isolated from all others. The ISO-4 is a passive amplifier/active multiplexor design that is compatible with MetraByte's EXP-16 (High Speed Analog Input Amplifier/Multiplexor), the DAS-8, the DASCON-1, and the STA-08 Screw Terminal Accessory Board.

All input connections to the ISO-4 may be made via the screw terminal block located on the board (wire sizes 12-22 AWG) while interconnection to the host data acquisition system is made through the 37 pin D male connector provided. The ISO-4 may be connected directly to MetraByte's DASCON-1 or DAS-8 (an 8 channel, 12-bit ADC board). IBM PC compatible software is provided for automatic conversion of thermocouple measurements to temperature when used with the DAS-8.
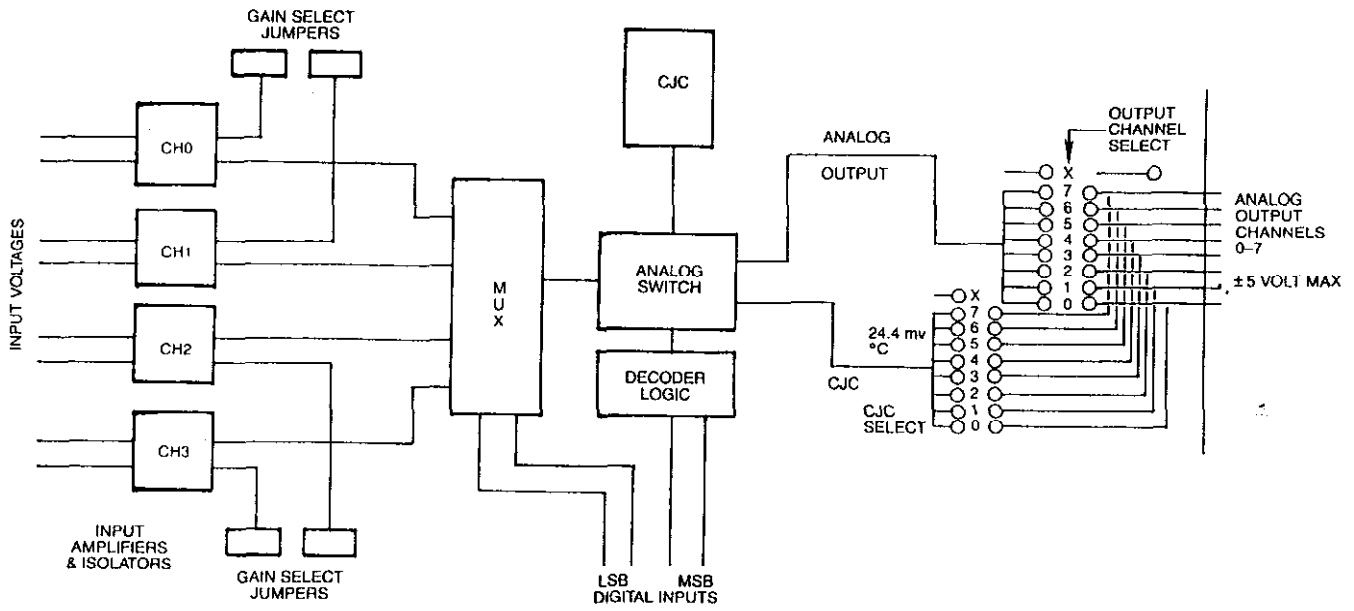
**ISO-4**
**Functional Block Diagram**

# CHAPTER TWO
Hardware Setup & Operation

## 2.1 Typical Input Channel Configuration

The illustration below shows a typical ISO-4 input channel. The ISO-4 employs a X1 gain isolation amplifier preceded by a gain stage using a low drift operational amplifier in the noninverting mode.  Also shown is a cross reference table for each ISO-4 channel, the jumpers associated with each channel and their function.
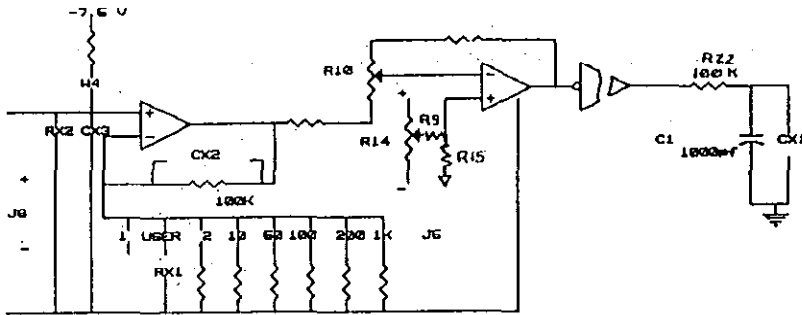


| CH0 | CH1 | CH2 | CH3 | CJC | REF | FUNCTION |
|-----|-----|-----|-----|-----|-----|----------|
| --------- J4 --------- | | | | | | OUT SEL |
| ------- S1/S2 ------- | | | | | | BD SEL |
| | | | | | J3 | OUT SEL |
| J6 | J8 | J9 | J12 | | | INPUTS |
| J5 | J7 | J10 | J11 | | | GAIN SEL |
| RX1 | RX3 | RX5 | RX7 | | | USER GAIN |
| R10 | R25 | R52 | R55 | | | GAIN TRIM |
| R14/ R9/ R15 | R28/ R24/ R30 | R49/ R53/ R47 | R58/ R54/ R60 | | | ZERO ADJ |
| RX2 | RX4 | RX6 | RX8 | | | CUR SHUNT |
| W4 | W3 | W2 | W1 | | | OPEN TC |
| R22/ C1 | R37/ C4 | R40/ C9 | R67/ C10 | | | FILTERING |
| CX2 | CX5 | CX8 | CX11 | | | FILTERING |
| CX3 | CX6 | CX7 | CX12 | | | FILTERING |
| | | | | | J13 | REF OUTPUT |
| | | | | | R80 | VOLT REF |
| | | | | | R73 | CUR REF |
| | | | | R84 | | CJC ADJ |

## 2.2 Power Supplies & Cables

When used with the DAS-8, the ISO-4 is powered directly from the computer's I/O bus through the C1000 series cable.  Note that each ISO-4 may draw up to 400 mA (max) and that three or more ISO-4s (daisy chained) on the same cable may require auxiliary power (@ +5 Vdc) applied directly to additional pairs of boards (connector pins and ribbon cables have limited current carrying

capability). DAS-8/ISO-4 interconnection cables should be kept as short as possible to avoid excessive voltage drop. The DAS-8 supplies +5 volts on pin 29 and power return on pin 11 of connectors J1 and J2.

When used with a DASCON-1 the board jumper adjacent to the 74LS85 can be switched from A to B allowing the DASCON-1 to supply +5 Vdc on pin 20 of J1/J2. Auxiliary power may be supplied to the ISO-4 by removing this jumper and connecting +5 Vdc to the unmarked terminal and the return to one of the ground feed throughs. The low level ground (pins 12 through 18) must be connected to the +5 volt return (Pin 11). This connection is already made in the DAS-8. Care should be taken to avoid ground loops when connecting power.

The S-1600 cable allows the ISO-4 to be easily connected to the DAS-16 board. The S-1600 makes all required analog input, digital control and power supply connections.

## 2.3 ISO-4 Gain Selection

The ISO-4 supports 7 standard gains of X1, 2, 10, 50, 100, 200, and 1000 on a per channel basis. Gain selection is made by placing a jumper plug over the appropriate position on J5 for channel 0, J7 for channel 1, J10 for channel 2 or J11 for channel 3. In addition to the standard gains, each channel on the ISO-4 may be configured for any other desired gain by simply inserting a resistor at RX1 for channel 0, RX3 for channel 1, RX5 for channel 2 or RX7 for channel 3. The value of this resistor for the desired gain is calculated according to the formula below.

$$RX1 = 100k/(GAIN - 1)$$

Note that the gain times the signal must not exceed the maximum full scales input range of +/-5 Vdc. The following table shows the gain, the resultant full scale input range and suggests appropriate gain settings for various thermocouples.

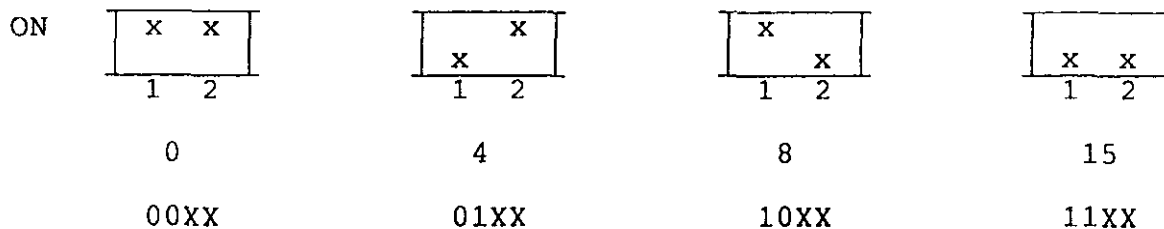| GAIN | BIPOLAR RANGE | | THERMOCOUPLE TYPE |
|------|------|------|------|
| X1 | +/- 5 | V | |
| X2 | +/- 2.5 | V | |
| X10 | +/- 500 | mV | |
| X50 | +/- 100 | mV | K, E |
| X100 | +/- 50 | mV | J |
| X200 | +/- 25 | mV | T, S, R, B |
| X1000 | +/- 5 | mV | |

Since gain is set on a per channel basis and CJC is done in software, any of the thermocouples listed may be used on any channel as well as mixing thermocouples with straight voltage inputs. The gain is adjusted using potentiometer R10 for Ch 0, R25 for Ch 1, R52 for Ch 2, and R55 for Ch 3.

## 2.4  Signal and CJC Output Channel Selection

A total of 4 address lines are used to configure 16 ISO-4 channels. Since each ISO-4 contains 4 input channels, the 16 channels are distributed among four ISO-4's.  Switch S1 acts as the 2 most significant bits of the 4-bit address.  As illustrated below a single ISO-4 may be set for channels 0-3, 4-7, 8-11, or 12-15.  In this way, four ISO-4's can multiplex into the same output channel while "looking like" a single 16 channel MUX for software purposes.  This allows up to 32 ISO-4's (128 channels) to be connected to 8 analog inputs (such as MetraByte's DAS-8) without the need for special cabling.

Jumper J4 is used to select the ISO-4 output channel. It acts as the 2 least significant bits of the 4-bit address. One of 8 output channels is selected by placing a jumper plug over the desired output channel number.  This output channel is used for signal output to the analog board being used.  Note that 4 ISO-4's may share the same output channel assignment if they are part of the 0-15 configuration as set by switch S1.

**Switch S1**

| ON | | | |
|----|----|----|----|
| x  x<br>1   2 | x<br>x<br>1   2 | x<br>x<br>1   2 | x  x<br>1   2 |
| 0 | 4 | 8 | 15 |
| 00XX | 01XX | 10XX | 11XX |

The ISO-4 provides all necessary hardware for Cold Junction Compensation (CJC).  This CJC circuitry produces a +24 mV/Deg C (0.1 Deg C/bit) signal with 0.0 Vdc at 0 Deg C.  This signal eminates from an isobar located on the ISO-4 as near the signal connections as possible.  The CJC signal may be output on any of the output channels by placing a jumper plug over the desired CJC output channel on J3.  Note that compensation is done in software and therefore the CJC output channel must be an unused, distinct channel so that it can be read without interference from any other channel.  If CJC is not used, place the jumper in position X.

When used with the DAS-8, DAS-16 or DASCON-1 A/D boards the ISO-4 output channel must match the A/D board input channel.  It is recommended the the user first become familiar with the A/D board prior to integrating the ISO-4 into the system.  See especially the comments on modes on selecting the A/D input channel, performing an A/D conversion, and controlling the digital outputs.  The chart below shows the relationship between ISO-4 output and DAS-8 input via the specified connector pins.

| Output Jumper | A/D Brd Channel | J1/J2 Pin Connection |
|---|---|---|
| 0 | 0 | 37 |
| 1 | 1 | 36 |
| 2 | 2 | 35 |
| 3 | 3 | 34 |
| 4 | 4 | 33 |
| 5 | 5 | 32 |
| 6 | 6 | 31 |
| 7 | 7 | 30 |
| X | NC | NC |

## 2.5  Current Measurement

The ISO-4 may be configured to measure milliAmp signals by placing a shunt resistor in parallel with the desired input channel.  Provisions have been made on the board for easy insertion of the shunt on a per channel basis.  RX2 is used for channel 0, RX4 for channel 1, RX6 for channel 2 or RX8 for channel 3.  Using these insertion points produces an isolated current loop input which can then be measured by the analog board.  The following formula can be used to calculate the value of the shunt (Rs) for the corresponding full scale mA signal.

$$Rs= 2/Full\ Scale\ input\ current$$

For example, if +/- 20 mA F.S., then:
$$Rs=2/0.020 \qquad Rs=100\ Ohms$$

## 2.6 Open Thermocouple/Input Detection
The ISO-4 includes biasing resistors to allow for open thermocouple detection.  These resistors are not connected when the ISO-4 is shipped but may easily be connected by inserting a jumper at W4 for channel 0, W3 for channel 1, W2 for channel 2 and W1 for channel 3. The use of these biasing resistors will cause an open channel (thermocouple) to saturate at -5 Vdc. This can be detected and a flagged in software.

## 2.7  Filtering
Signal input filtering may be accomplished by using a resistor/capacitor (RC) combination on a per channel basis. These RC filters may be implemented using R22-C1 for channel 0, R37-C4 for channel 1, R40-C9 for channel 2 and R67-C10 for channel 3.  A break point of 1.592KHz will attenuate the 25 KHz chopping frequency of the isolation amplifier.  This break point can be lowered by the addition of external capacitors CX1 for channel 0, CX4 for channel 1, CX9 for channel 2 and CX10 for channel 3.  The value of the external capacitor in microfarads for a break point of f Hertz is given by;

$$C = -.001 + 10/(6.28f) \qquad uF$$

A capacitance of 0.22uf, for example, will result in a break point of 7.2 Hz and provide 18db attenuation at 60Hz.

The external capacitors CX2 for channel 0, CX5 for channel 1, CX8 for channel 2 and CX11 for channel 3 shunt the respective gain resistor for the channel. This causes the gain (if greater than 1) to initially decrease with frequency and eventually level off at 1. There will be a low frequency break point fl causing an initial decrease in gain and high frequency break point (at fh = GAIN DC x fl) causing the gain to level off at 1. Again, for fl in Hertz and C in microfarads the capacitance necessary for a given low frequency break point is;

$$C = 10 \ / \ (6.28fl) \qquad uF$$

One possible use of external capacitors CX3, CX6, CX7 and CX12 is described below ("Offset Drift"). These capacitors shunt the input terminals and could also be used for input filtering if an external resistor were placed in series with the input signal.

## 2.8 Input Offset Drift
The drift of the isolation amplifier is +-20uV/deg C. The drift of the operational amplifier (OP-07D) is +-2.5uV/deg C times the gain. The total offset will be the sum of these two components. At high gains the offset of the OP-07D will dominate. Should this drift be excessive, a pin compatible stabilized TSC911A with a drift of +/-.15uV/deg C could be substituted for OP-07D. In this case a 0.1uF capacitor may be necessary at CX3 for channel 0, CX6 for channel 1, CX7 for channel 2 or CX12 for channel 3 in order to filter switching spikes of the TSC911A.

## 2.9 Input Offset Trim
The offset voltages for the 4 ISO-4 channels can be adjusted to 0 Vdc using potentiometers R14 for channel 0, R28 for channel 1, R49 for channel 2 and R58 for channel 3. The voltage dividers R9-R15, R24-R30, R53-R47 and R54-R60 for channels 0 through 3 make for a fine null adjustment. By varying the voltage dividers, corresponding offsets from -7.5 to +7.5 Vdc can be obtained.

## 2.10 Voltage and Current References
The ISO-4 provides a voltage reference between -6.9 volts and +6.9 volts and a precision current source of 1 ma. The sources are provided at the screw terminals of J13. The left terminal sources the current and the right terminal is the voltage reference. The center terminal is the return in both cases. The current source may be used for 100 ohm RTD's while the voltage source may be used for strain gage bridge excitation.

## 2.11  Cascading Multiple ISO-4's

Since the ISO-4 provides 8 jumper selectable output channels and 4 switch selectable board decodes it is possible  to cascade up to 32 ISO-4s for a single, 8 channel analog input board.  As mentioned before, each group of 4 ISO-4's must have a different, unused output channel and each board within the group must have a different switch decode (Base Address).  This allows a system with 128 channels of standard voltage (and/or current) measurement or up to 112 thermocouple channels (with CJC).  This cascading is particularly easy when used in conjunction with MetraByte's DAS-8.  Each group of 4 ISO-4s should be set to a distinct output channel corresponding to one of the A/D board's input channels.

The ISO-4 may also be cascaded to MetraByte's EXP-16 Universal Expansion Interface provided separate outputs are configured for each group of 4 ISO-4 boards and the individual EXP-16s.  Similarly the MetraByte STA-08 Screw Terminal Accessory Board may be connected directly to an ISO-4 group leaving 6 or 7 single-ended inputs available on the STA-08 (depending upon CJC implementation).

**CHAPTER THREE**
Programming


## 3.1 CHANNEL SELECTION

The following section deals mainly with ISO-4 usage in conjunction with MetraByte's DAS-8 and DAS-16(F) boards. , An example is given in BASICA as implemented on the IBM PC using DAS-8 mode programming.  This chapter is not intended to teach the basics of DAS-8 programming since these topics are covered in depth in the DAS-8 manual (note especially modes 1-9 and 14). However, since the ISO-4 may be used in conjunction with any data acquisition system, an overview of ISO-4 software access is presented.

ISO-4 programming is quite straightforward using a 4-bit address to specify 1 of 16 ISO-4 channels.  The ISO-4 is a passive amplifier/active multiplexor design meaning that the user need merely activate the channel MUX on the ISO-4 in order to receive the amplified signal.  This 4-bit address may be specified by any 4 TTL compatible output signals (the address is not latched and must be held by the TTL signals).  The 4-bit address is mapped to pins 7-10 on connector J1/J2 with pin 7 being the least significant bit and pin 10 being the most significant bit.   Since many data acquisition systems automatically initiate an A/D conversion upon channel access, the suggested ISO-4 programming sequence might be:

1) Specify the 4-bit ISO-4 output channel (0-15).
2) Access the analog input channel and initiate the A/D conversion.
3) Retrieve the digitized data.


## 3.2  ISO-4 Programming with the DAS-8

ISO-4 channel access is chosen using a "mode 14" DAS-8 call routine. The "mode 14" call sets digital output bits OP0 - OP3 which are mapped directly to the 4 ISO-4 address bits. Once the "mode 14" call is executed OP0 through OP3 outputs remain set. Subsequent A/D conversions will be performed on that channel.  To read other channels the "mode 14" routine should be called again and a new input channel selected.  By using a BASIC "FOR ... NEXT" loop the input channels of the ISO-4 can be scanned.  The following example shows the programming steps required to scan the channels of a single ISO-4, read the A/D (using mode 4) and store the data in an array called DIO%. Note that the DAS-8 must have previously been configured (see the DAS-8 manual for details.).

```
xxx10 DIM DIO%(3)                        'DIM DATA ARRAY FOR
                                         '4 ENTRIES
xxx20 MD%=1: LT%(0)=1: LT%(1)=1          'SET DAS-8 CHANNEL
xxx30 CALL DAS8(MD%,LT%,FLAG%)           'TO 0 (THIS MUST
                                         'MATCHISO-4 CHANNEL)
xxx40 FOR I=0 TO 3                       'SCAN 4 INPUTS
xxx50 MD%=14: OP%=I                      'SET ISO-4 ADDRESS TO
xxx60 CALL DAS8 (MD%,OP%,FLAG%)          'BOARD 0, LINE I
xxx70 MD%=4                              'DO CONVERSION AND
xxx80 CALL DAS8(MD%,DIO%(I),FLAG%)       'STORE IN DIO(I)
xxx90 NEXT I                             'COMPLETE SCAN
```

Data from channel 0 will be in array DIO%(0), channel 1 in DIO%(1) etc. For single ISO-4 usage with a DAS-8, refer to the program ONE-ISO.BAS on the accompanying floppy disk.

Suppose a second ISO-4 had been setup to respond to address 4 and output on channel 0. Further suppose DIO% had been dimensioned for 8 in statement xxx10 and the FOR loop in xxx40 was from 0 to 7. Then data from channels 0 through 3 of the first ISO-4 (address 0) would be in DIO%(0) through DIO%(3) and data from channels 0 through 3 of the second ISO-4 (address 4) would be in DIO%(4) through DIO%(7). A more general case is included on the accompanying floppy under the name MANY-ISO.BAS.

## 3.3 Thermocouples and Other Transducers

Low level signals such as thermocouples, strain gage bridges (load cells, pressure and force transducers), etc. require significant amplification prior to A/D conversion on many high level analog boards. The ISO-4 incorporates stable amplification, cold junction compensation for thermocouples and an isolated reference for strain gages.

The disk accompanying the DAS-8 (Rev 1.7 or latter) contains BASIC programs illustrating ISO-4 usage with a DAS-8. Though this package has been written to interface directly with the MetraByte DAS-8, the thermocouple linearization routines can easily be generalized to perform the linearization on any set of thermocouple data. The included programs are as follows:

```
ONE-ISO.BAS - An example using 1 ISO-4 with a DAS-8
MANY-ISO.BAS - An example using 3 ISO-4s with a DAS-8
ISO-J.BAS - Examples using thermocouples inputs
J.BAS thru R.BAS - Thermocouple linearization subroutines
ISO4TST.BAS - A program to assist setting up and
              calibrating the ISO4.
```

A similar set of programs have been developed based on the MetraByte DAS-16 and DAS-16F.  These programs are included on the DAS-16 Utility disk.  The following list details the program names and their functions

    ONE-ISO6.BAS - An example using 1 ISO-4 with a DAS-8
    MANYISO6.BAS - An example using 3 ISO-4s with a DAS-8
    ISO-J16.BAS - Examples using thermocouples inputs
    J.BAS thru R.BAS - Thermocouple linearization subroutines
    ISOTST16.BAS - A program to assist setting up and
                   calibrating the ISO4.


    The thermocouple subroutines are stored in ASCII format, so they can be easily merged into your own BASIC programs.  Each example has distinct  line numbering so that several can be merged and used together for different types of thermocouples. The subroutines are commented and consist of a data section that should be GOSUB'ed in the initialization section of your program. These routines load a look up array (it may take a few seconds to load).  The second section of each subroutine performs a linear interpolation.  This method is both fast and accurate over the full operating temperature range of the thermocouples.  To avoid error messages, data should be bounded to physically realizable min/max values before entering the subroutines.

    The programming examples are one way (not necessarily the best) of programming the ISO-4 with the DAS-16 and DAS-8 and can serve as a starting point for user specific programs.

# CHAPTER FOUR
Calibration

## 4.1  Calibration and Test
Periodic recalibration of the ISO-4 is recommended to retain high accuracy.  The recalibration interval, to a large extent, depends upon the type of service to which the board is subjected. For an environment with large temperature changes or vibration a 3 month recalibration interval is recommended.  For laboratory or office conditions 6 months to 1 year is generally acceptable.

Accurate calibration requires a 4 1/2 digit DMM and a precision voltage calibrator or other stable, noise-free DC voltage source usable with the multimeter.  In addition, if CJC circuitry is to be calibrated a digital thermometer (or other temperature measuring device with +/-2 degrees C accuracy) is required.

The ISO4TST.BAS program included on the DAS-8 disk (Rev 1.7 or latter) or the ISOTST16.BAS included on the DAS-16 disk may be used for data channel and CJC circuit calibration.  Both programs are fully prompted, and the user need only follow the directions to perform a complete board test and calibration.

## 4.2 Calibration Procedure
Connect +5 volt power to the ISO-4.  The simplest way to power the ISO-4 is to connect it with the C-1800 cable to a DAS-8. Otherwise connect +5 to Pin 29 of J1 or J2 and +5 return to Pin 11 of J1 or J2.  The +5 volt return must also be connected to one of the low level grounds (Pins 12 through 18).

Set the DMM to DC Volts and wire it between the LL GND and one of the jumper pins on the upper side of the output channel jumper connector J4.

It will be necessary to activate each channel using "mode 14" DAS-8 routine or (if not using the DAS-8) supply high and low levels to the address lines A0 Pin 7, A1 Pin 8, A2 Pin 9 and A3 Pin 10 of J1 or J2.  Because LS-TTL inputs float high it probably suffices to pull the desired lines low. Configuring the ISO-4 to respond as address 3 would allow A2 and A3 to be floated so that A0 and A1 could be used to address the individual channels.

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To ZERO each channel, short the input terminals together (J6, J8, J9 or J12) and set the channel gain to the gain that you would normally use by placing the jumper over the appropriate position of the gain selection jumper block (J5, J7, J10 or J11). Adjust the ZERO potentiometer (R14 for channel 0, R28 for channel 1, R49 for channel 2 and R58 for channel 3) for best 0 Vdc reading.

To set GAIN remove the shorts at the input terminals (J6, J8, J9 or J12) and connect a +5 volt source with the positive source terminal to "+" and the negative source terminal to "-". Adjust the input voltage so that the input voltage times the gain is equal to +5 volts. For example, if the gain is 10 set the input to 5v/10 = 0.5 volts. Adjust the GAIN potentiometer (R10 for channel 0, R25 for channel 1, R52 for channel 2 or R55 for channel 3) for +5.000 volts plus or minus 1 mV on the DMM.

## 4.3 CJC Circuit Calibration
Connect the DMM (set to DC volts) between LL GND and one of the jumper pins on the upper side of the output channel jumper connector (J3).

Monitor the temperature in the vicinity of the ISO-4 board. For greatest accuracy the temperature should be measured close to the ISO-4 temperature sensor (CR10).

Adjust the CJC ADJ potentiometer (R84) for best reading of 24.4 mV per degree C. For example, if room temperature is 17.0 degrees C, the CJC ADJ should be adjusted for 24.4 x 17 = .4148 volts.

## 4.4 Reference Calibration
To adjust the VOLTAGE reference connect the positive DMM lead to the right terminal and the negative lead to the center terminal of J13. Adjust potentiometer R74 for a DMM reading between -6.9 and +6.9 volts.

To adjust the CURRENT reference connect a 0.1% resistor with a value approximating the transducer resistance between the left and center terminals of J13. Measure the voltage across the resistor. Adjust R73 for a voltage of 0.001 times the resistor value (negative lead to center terminal of J13. For example with a 100 ohm resistor the meter should read 0.1 volt.

Alternatively connect a DMM (set to milliamps) with its positive lead to the left terminal and its negative lead to the center terminal of J13 and adjust R73 for best 1 mA reading. Most DMMs are not good enough for an accurate adjustment of R73 however.

## CHAPTER FIVE
Specifications

## SPECIFICATIONS

### Analog Data Specifications

| | |
|---|---|
| Input Bias Current | 3na Typ, 14na Max over temp range |
| Safe Diff Voltage | +/- 30 volts continuous |
| Common Mode Voltage | +/- 1000 volts continuous |
| CMR | 100db @ 60 Hz |
| Output Voltage | +/- 5 volts |
| Maximum Output Current | +/- 15 ma |
| Voltage Drift, RTO | +/-(20 + 2.5*GAIN) uVolts/deg C |
| Nonlinearity | +/-0.025% TYP |
| Settling Time | 1 ms to +/-10mv with 10V step |
| Bandwidth | 5KHz with switching filter removed |

### Cold Junction Compensation

| | |
|---|---|
| Origin | 0.0 volt at 0.0 deg C |
| Variation | +24.4 mv / deg C |

### References Sources

| | |
|---|---|
| Voltage Source | +/- 6.8 volt @ 5ma MAX (user adjustable) |
| Current Source | 1.000 mA (1000 Megohm output impedance at DC Current Source) |
| Compliance | -10 volts to +2.5 volts |
| Temperature Coefficient | +/-30 ppm / deg C |

### Environmental

| | |
|---|---|
| Operating Temp Range | 0 to 50 deg C |
| Storage Temp Range | -20 to 70 deg C |
| Humidity | 0 to 90 % non-condensing |

## Power Requirements

+ 5 Vdc @ 400 mA (max)

## Physical

| | |
|---|---|
| Dimensions | 8"x4.75"x.75" (no standoffs) |
| Screw Term Spacing | 0.197"      (5 mm) |
| Screw Term Wire Size | 12-22 AWG |
| Standoffs | 1/2 "      (12.7 mm) |

## Interface Connectors J1 and J2

All computer interface connections are made through two parallel 37 pin D type connectors.  In addition pins 2 through 6, 12,13,15,19 and 21 though 28 are brought out to plated through holes on the board allowing the user access to these pins for DAS-8 clocks or interrupt usage.

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 | NC | NO CONNECTION |
| 7 | A0 | LSB OF DIGITAL CONTROL CHAN |
| 8 | A1 | 2SB OF DIGITAL CONTROL CHAN |
| 9 | A2 | 4SB OF DIGITAL CONTROL CHAN |
| 10 | A3 | MSB OF DIGITAL CONTROL CHAN |
| 11 | COM | DIGITAL COMMON (+5 VOLT RETURN) |
| 14 | LLG | LOW LEVEL GROUNDS |
| 16 | LLG | |
| 17 | LLG | |
| 18 | LLG | |
| 20 | +5V | +5 VOLTS FORM PC (DASCON-1 config) |
| 29 | +5V | +5 VOLTS FROM PC (DAS-8 config) |
| 30 | OUT7 | ANALOG OUTPUT 7 |
| 31 | OUT6 | ANALOG OUTPUT 6 |
| 32 | OUT5 | ANALOG OUTPUT 5 |
| 33 | OUT4 | ANALOG OUTPUT 4 |
| 34 | OUT3 | ANALOG OUTPUT 3 |
| 35 | OUT2 | ANALOG OUTPUT 2 |
| 36 | OUT1 | ANALOG OUTPUT 1 |
| 37 | OUT0 | ANALOG OUTPUT 0 |